INFORMATION SYSTEMS AS DIALECTIC, TOOL-MEDIATED ACTIVITY

Helen Hasan
Head of Discipline, Information Systems
University of Wollongong,
helen_hasan@uow.edu.au

ABSTRACT

Information Systems (IS) draws its significance from the uniqueness of computer-based information and communications tools and their place in shaping recent human history. Advances in the field come from a better understanding of how to develop and use these tools and what impact they have on the way we work, and live. As IS is still an evolving field of study, two views, the objective and the subjective, are in constant tension and, though these may be considered complementary, it is rare that they come together as a unified whole. A more balanced, and integrated, foundation for IS may be found in the subject-object dialectic arising out of the German philosophical tradition. An extension of this approach from the Cultural-Historical Activity Theory is presented in this paper. This theory views all human endeavour as a purposeful, dynamic, dialectic relationship between subject and object, mediated by tools, such as technology and information, and by the social environment or community. An adaptation of this holistic theory, to incorporate the best of other theoretical approaches used by IS researchers, could span and integrate the breadth of the field IS providing it with unity and identity.

INTRODUCTION

There is a legitimate tendency for researchers to categorise, classify and compartmentalise the basic constructs of their discipline. Information Systems (IS) is a new and evolving field of study whose basic constructs are still being established. IS is also an applied field so there is a need to embed such constructs in practice, yet look for constant, enduring concepts that will give the field a firm foundation. Finding constants is difficult in a field that is intimately enmeshed in a technology that is constantly evolving at such a rapid rate that the only constant seems to be change itself. In pursuit of a firm foundation for the field, this paper begins with an identification of the characteristics of two extreme views of IS, the objective and the subjective, and then suggests that a more balanced, and integrated, foundation for IS may be found in the subject-object dialectic (Spencer & Krauze 1999, Vygotsky 1978). An extension of this approach from the Cultural-Historical Activity Theory (CHAT) will then be presented. CHAT views all human endeavour as a purposeful, dynamic relationship between subject and object, mediated by tools, such as technology and information, and by the social environment or community.

EXTREMES OF OBJECTIVITY AND SUBJECTIVITY

An objective starting point in the quest for constructs in the foundation of IS could be the two component concepts, information and systems. Information is usually classified as one of four entities: data, information, knowledge and wisdom. These are defined either independently or in a circular, recursive manner (eg. Information is processed data; knowledge is information made actionable). The distinctions between data, information and knowledge are frequently debated, with a contentious point being whether each can be stored or enabled by IT. This debate surfaces from time to time in forums such as ISWORLD with only superficial resolution. The concept of system implies an integrated, working whole that is active, purposeful and more than just the sum of its parts. There is a relatively simplistic view that an information system is a tool that processes data into information and is based on information and communication technology (ICT). However there is general consensus that ICT, while a fascinating invention and development of people is not, in itself, the main focus of the field of IS. This highlights the confusion that comes from the association between the name of the field, "Information Systems", and the artefacts studied; that is, actual information systems themselves. Introductory textbooks in IS tend to focus on the artefacts, identifying five components (hardware, software, storage, people, procedures) and define these as having a basic function of processing data into information. Information systems are also categorised by their level of application, whether they are at the operational (TPS), tactical (MIS) or strategic (DSS, EIS, KMS) levels of organisations and whether they automate or "informate" work (Zuboff 1988). If IS is to be considered a discipline, it may be helpful to hold a more subjective view of information as a universal concept that supports work practices and systems as dynamic, purposeful and holistic entities. However, this still leaves much to consider in establishing a comprehensive and stable foundation for "Information Systems" as a discipline or field of study.

Approaches to IS can therefore be grounded in different worldviews, two extremes of which are a purely objective view and a purely subjective one, with many variations or combinations of these adopted in practice. Pictures of the two extremes will now be painted in order to mark out the boundaries of the IS territory.

An extremely objective approach to IS sees data as atomic facts, while information is processed data, abstracted from its context and highly codified, or codifiable, and therefore readily diffused by ICT. In this approach, information is usually intentionally sought and used by people in rational decision-making processes. Closely

aligned to an object view of information is that of knowledge as either explicit or, if tacit, able to be converted into an explicit form so that it can be codified and stored in a repository or even captured in an expert system. Methodologies for objectively based IS research tend to be positivist, experimental, quantitative and technical. The ideal information system automates as much information processing as possible in accord with the artificial intelligence paradigm.

In an extremely subjective view, information is viewed as data that is meaningful and in context, and hence is not abstract, codifiable or easily diffused. Knowledge, quite distinct from information, is viewed as tacit, embedded in people and not able to be codified or stored using ICT. Wisdom plays a critical role in decision-making to determine what is right and ethical. Information systems may, or may not, involve the use of technology, although advances in technology have greatly changed the significance of information. ICT is only able to store and manipulate data in transaction processing systems or databases that are relatively uninteresting. The systems of most interest in IS research are those that provide support for the work of people such as DSS, GDSS, ESS, KMS, intranets and portals. Such systems allow for browsing and general sense-making rather than intentional information seeking. Methodologies for subjective IS research tend to be interpretivist and qualitative.

THE SUBJECT-OBJECT DIALECTIC

Although in practice IS research generally falls between the two extremes it is rare that the objective and subjective aspects are treated with equal emphasis and even more rarely are they integrated. A balanced theoretical position, bringing together the objective and the subjective, is found in the German philosophical tradition, in particular the work of Hegel, who asserts that, in order to advance a thesis, its antithesis should be proposed (Spencer & Krauze 1999). The thesis and its antithesis should then be worked through to a more advanced synthesis. Taking the objective view of Information Systems as thesis and the subjective as its antithesis, an integrated approach to IS, involving a subject-object dialectic would then be a synthesis of the two extreme views. This is not an average or middle view but a more mature understanding of the field.

For example, currently in the field of Knowledge Management there are two opposing views of organisational knowledge. One, the thesis, sees knowledge as an object that can be codified and then stored in a computerized system to be made available on demand and so "the fundamental purpose of all knowledge management activity is to acquire, capture, access and reuse knowledge throughout the organisation" (Fowler 2000). The implication is that knowledge can be separated from its source and context. The antithesis says that knowledge can only reside in people and a knowledge management system can only enable individual knowledge seekers to identify and communicate with knowledge sources, i.e. experts. The implication here is that group knowledge is simply the sum of the knowledge of its members and "the goal a knowledge management system is to create a connected environment for knowledge exchange - a technical embodiment of corporate memory" (Mentzas et al, 2001). The following quote is a step towards the synthesis of the objective and subjective views of knowledge management:

> "Knowledge management caters to the critical issues of organisational adaptation, survival, and competence in face of increasingly discontinuous environmental change. Essentially it embodies organisational processes that seek synergistic combination of data and information processing capacity of information technologies and the creative and innovative capacity of human beings."
> (Malhotra 2000)

A candidate for a mature integrated theoretical basis of IS may be found in the social psychology of Vygotsky (1978), which takes the dialectic relationship between subject and object as a fundamental unit of analysis for all human endeavour. Vygotsky, a contemporary of Pavlov in the early 20th century, argued against the extrapolation to humans of the stimulus-response behaviour observed by the latter in animals. According to Vygotsky, what makes humans distinct from animals is that all activity is purposeful, much more complex than a response to stimuli, involves the use of tools and produces outcomes that are distinct from the perceived object. Vygotsky's work, continued after his death by his students (Leontiev, Luria and others), evolved into the Cultural-Historical Activity Theory, where, in all human activity, the subject (or person) has a relationship with the object (the purpose) of the activity and tools and community mediate this relationship. The theory is premised on the notion that all meaningful work and learning take place in a social setting where, according to CHAT, the most powerful human tool is language. In the latter half of the 20th century, ICT has been the tool that has revolutionised human work and society. It is therefore reasonable that tool mediated activity, as understood by CHAT, could be the synthesis of the subjective and objective that ideally suits research into Information Systems.

In order to substantiate this claim a short description of CHAT is now presented. The reader is referred to the original works such as those of Vygotsky (1978) and Leontiev (1981) for a more in depth exposé of the theory.

THE CULTURAL HISTORICAL ACTIVITY THEORY (CHAT)

Although CHAT has its roots in the work of the Russian psychologist Vygotsky during the first half of the 20th century, his writings were not published in the West until several decades later (Vygotsky, 1978). The theory has a well-established research tradition and has been applied in a range of fields and disciplines, including education, linguistics, anthropology and cultural research. It has the same standing in Eastern European research communities that cognitive psychology has in the West, but it is much richer in terms of its interpretation of human behaviour when using technology such as computers.

The significant difference that CHAT brings to the study of IS is that it places the focus of study on the activities that are carried out by people in support of their interpretations of their role, the opportunities available, and the purpose for which the activity exists. This is both subjective, in the sense that it is a matter for individual interpretation, and objective, in the sense that the motives, purpose and context are a vital part of the reality of human work. In contrast to Western cognitive science, thinking, feeling and acting are considered as integrated parts of the one object in CHAT.

The theory recognises an objective reality. The object, or purpose, of all human activity is what defines that activity and that object is real, whether physical or ideal. Indeed activities are often poly-motivated as, for example, employees may be good corporate citizens, and therefore be motivated to cooperate with fellow employees, but also compete with them when they have their own careers to consider. A failure by management to take these different motives into account can have disastrous consequences.

In CHAT, an activity is the only complete meaningful unit of analysis of work and includes purpose, motive and context. In IS terms, this has implications for what is studied and the approach taken research into information systems as artefacts. What is objective is not the rational analysis of what should be done but what really is done, affected by messy contexts and driven by conflicting motives. Schultze and Boland (2000) report low success rates of around 30% for information support systems, attributable to technologists' lack of understanding of the situated work practices of user communities. They believe that systems designers do not have accepted models for the large invisible and complex nature of work that systems are expected to support. Rather than see things such as personal motives and particular contextual factors as soft and inconsequential, they should be part of the objective reality of the whole to be analysed in the system.

Activity, defined by the dialectic relationship between subject-object, both mediates and is mediated by the tools used and the social context of the work activity. This two-way concept of mediation implies that the capability and availability of tools mediates what is able to be done and the tool, in turn, evolves to hold the historical knowledge of how the communities works and is organised. With ICT, this mediation process is happening at a rapid rate that is proving stressful for many workers and disruptive for many work practices. New technology is driving changes to organisational structures and activities and this in turn is placing increasing demands on the capability and capacity of the technology. The changes that ICT, and in particular the Internet, has made to the way information is perceived and used in society today, is illustrative of this concept.

It is through the dynamic process of mediation that learning and development occurs, both in the individual and in the society as a whole (Hasan & Crawford, 2002). CHAT uses the term "always active subject" to describe the way people are not static subjects of activities but are continually changing and growing as they engage in those activities. Another exclusively CHAT concept is that of the "zone of proximal development" or ZPD. This describes the potential for an individual to proceed to the next phase of develop beyond their present level, aided by teachers, co-workers and such, known as "significant others".

Figure 1 Kaptelinin's (1996) view of the computer as an extension of the IPA

COMPUTER TOOL AS AN EXTENSION OF THE IPA

central cognitive structures

IPA

COMPUTER TOOL

OUTER WORLD

subjective reality   personal space
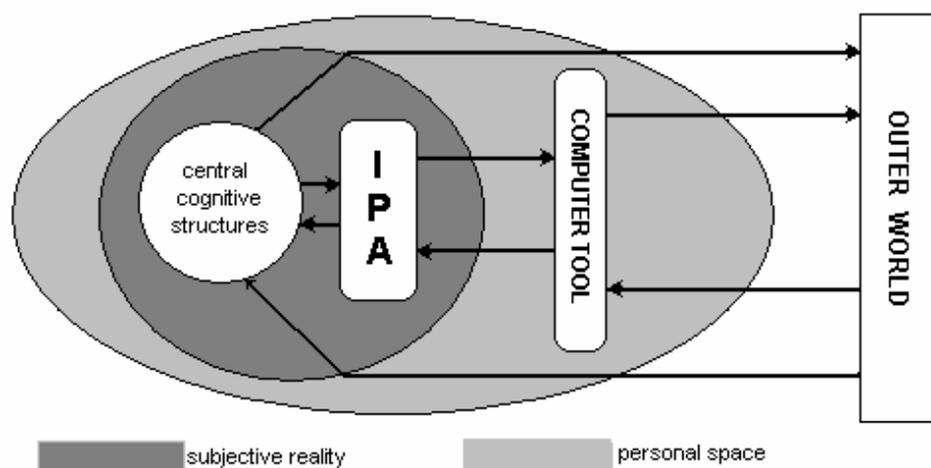
Much of Vygotsky's work is concerned with the study of human development through the processes of internalisation and externalisation. His insight into the dynamics of human consciousness was that it is essentially subjective and shaped by the history of each individual's cultural experience. Learning and development occurs through a social process where what happens in the external world is manipulated in the individual's internal plane of action (IPA), a type of working storage before being internalised. Correspondingly, when an individual externalises what they know, it is rehearsed in the IPA. It is this human process of reflection before acting that intervenes in the automatic Pavlovian response to stimuli observed in animals. Kaptelinin (1996) has done significant work, which conceptualises a computer as an extension to the IPA as shown in Figure 1.

Vygotsky's work was continued by his students, amongst them Leontiev (1981), who developed a popular conceptual framework for a complete theory of human activity. Leontiev saw the theory of activity as the foundation of a unified, monolithic psychology that makes possible a consistent, coherent reconstruction of non-reductionist psychological reality. Activity, according to Leontiev, is neither a reaction nor a totality of reactions but a system that has structure, its own internal transitions and transformations and its own development.

Activity - Motive	
↓↑	↓↑
Action - Goal	
↓↑	↓↑
Operation	Conditions
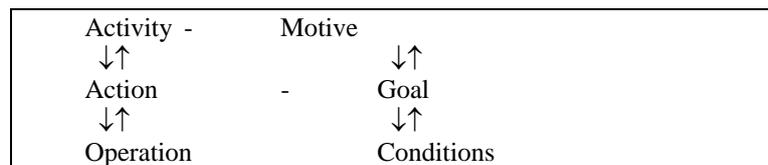
Figure 2 The Hierarchical Structure of Activity (Leontiev 1981)

Leontiev (1981) proposed that "activity" should be the unit of analysis in the study of sustained human endeavour and placed this at the top of the hierarchy shown in Figure 2, associated with purpose and motive over the long term. This is a conceptual level above that at which most business analysis takes place, which is at the level of actions, undertaken towards specific and often short-term goals. Under certain conditions, conscious actions can be driven to a lower level of automation, often in computer systems, as they become standardised as operations.

The Leontiev hierarchy is probably the best-known CHAT concept although it can be difficult to fully appreciate the distinction between activities and actions on first encounter. An activity is comprised of sets of actions (creative new responses towards specific goals) and operations (routine and well known habitual cognitive or behavioural processes, now commonly the domain of IT systems). Whereas an activity is defined by purpose and motive and is typically a long-term affair, actions are more planned with specific goals and a more limited time span. Actions are not meaningful in themselves unless they are part of an activity. For example it makes no sense to drive to work (an action) unless there is a work activity to go to.

There may be legitimate alternative sets of actions that can enable the successful performance of an activity. There are many instances of this kind of situation. For example, it is common practice in IS development to assess the feasibility of different solutions to an organisational problem once the problem is defined. It is usual to then choose one solution to implement on a cost benefit analysis. However there may be instances where it is feasible to allow different solutions (i.e. different sets of actions) for an activity under different circumstances (e.g. in different countries where cultures vary or in different divisions of a company that operate differently). It is important, however, to have a common understanding of the object of the activity itself.

In practical terms, Engeström's (1987) triangular representation of Vygotsky's concept of activity, shown in Figure 3, can be used as a means of identifying and representing an activity. This image shows the central subject-object relationship of the activity leading to outcomes and being mediated by tools (instruments) and the community. The community imposes rules on the subject and establishes the division of labour needed to conduct the activity, which is defined by its object. The components of this representation of an activity are listed and described in Table 1.
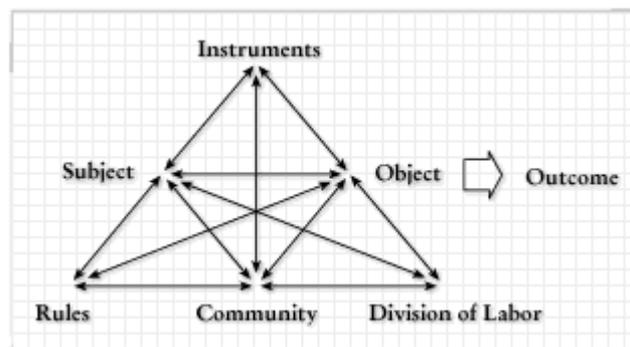
Figure 3 The Components of an Activity (Engeström, 1987)

Table 1	
Components of Activities according to Engeström (1999)	
Component:	**Definition and Clarification**
object	the purpose and motives that define the activity.
subjects:	the person or people who carry out the activity
outcomes:	both intended and unintended results of carrying out the activity
tools/instruments:	both physical and non-physical instruments that are used in the conduct of the activity
community:	the community in which the subjects carry out that activity
rules	the formal and informal rules that the community imposes on the subject
division of labour	relationships in the community that determine the roles that subject have in carrying out the activity

The dynamic nature of CHAT is apparent in the activity system approach of Engestrom (1987), who uses activity as a unit of analysis in his research into developmental work in organizations. In longitudinal case studies in the workplace he follows the progress of a dominant activity, together with any interacting secondary activities, as an activity system (idealised in Figure 4). Learning occurs from contradictions and tensions within activities and between the activities and their environment. Engestrom depicts this in the Cycle of Expansive Learning (Figure 5) as the dominant activity evolves into a more advanced form after each cycle
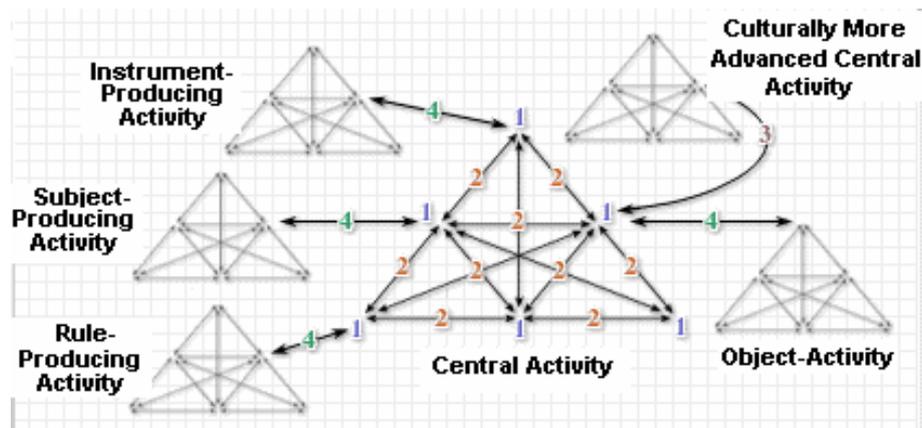

1: Primary inner contradiction (double nature) within each constituent component of the central activity.
2: Secondary contradictions between the constituents of the central activity.
3: Tertiary contradiction between the object/motive of the dominant form of the central activity and the object/motive of a culturally more advanced form of the central activity.
4: Quaternary contradictions between the central activity and its neighbour activities.

Figure 4: Four levels of contradictions in a network of human activity systems (Engestrom 1999)

Activity systems are constantly working through contradictions within and between their elements and with other related activities. In this sense, an activity system is generates a virtual disturbance and thus becomes an

innovation-producing machine. There are periods of incremental growth interrupted by discontinuities of growth spurts leading to knowledge creation and organisational learning.

Figure 5 Engestrom's view of a dynamic activity system
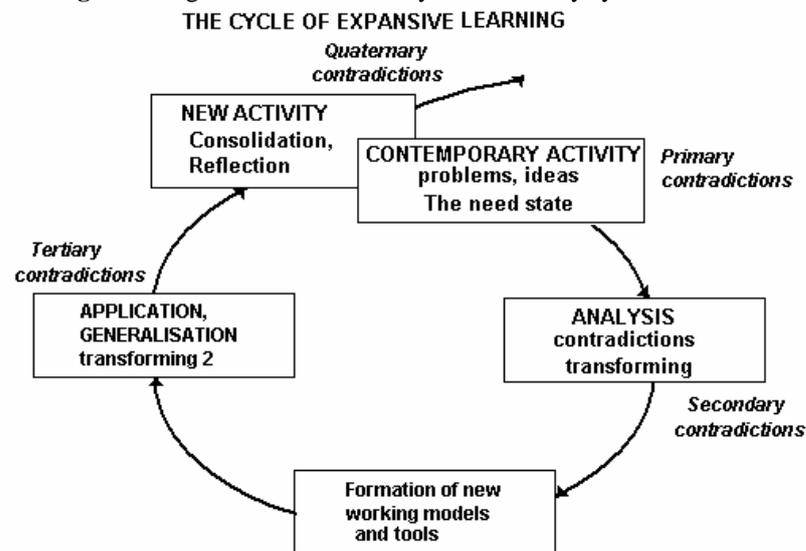
The CHAT concepts of internalisation and externalisation are echoed in the current knowledge management literature much of which distinguishes tacit from explicit knowledge based on Polanyi's (1966) original concepts. The model describes a dynamic process in which explicit and tacit knowledge in organisations are exchanged and transformed through four modes. Socialisation enables tacit knowledge to be transferred from one individual to another. Combination allows the existing explicit knowledge to be combined into new explicit forms. Externalisation converts tacit knowledge into explicit knowledge in the forms of concepts and models. Internalisation allows individuals to absorb explicit knowledge and broaden their tacit knowledge so that new knowledge could be developed. This has led to the knowledge creation spiral of Nonaka and Takeuchi (1995), shown in Figure 6, which views organisational knowledge creation as a process involving a continual interplay between explicit and tacit dimensions of knowledge.
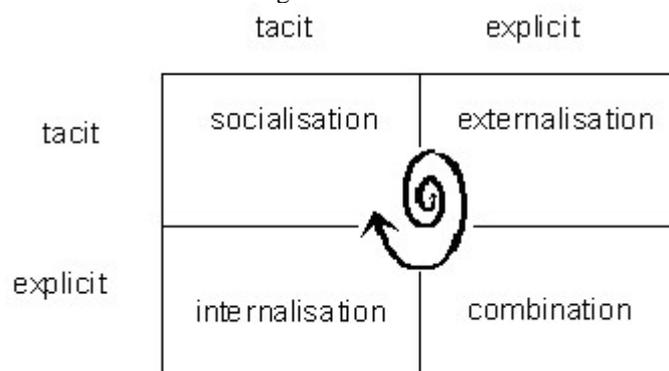

Figure 6 The Knowledge Creation Spiral

RESEARCH USING CHAT AS A THEORETICAL FRAMEWORK.

Researchers in various disciplines, related to the multi-disciplinary field of IS, are using frameworks based on the Cultural-Historical Activity Theory for the study of technology, cultural, organisational and managerial issues. Several research teams have successfully applied a CHAT framework to areas such as organisational theory (Blackler 1993), organisational learning (Engestrom 1999), organisational memory (Kuutti & Virkkunen 1995), human-computer interaction (Bodker 1991) and organisational sense-making in knowledge management (Hasan 2000). Bodker's seminal work (Bodker, 1991) concerned the interaction of two activities in IT: the design activity whose outcome is the tool for the use activity.

According to Kuutti (1996), CHAT is a philosophy and cross-disciplinary framework for studying different forms of human practices and offers a set of concepts, structures and terms that are eminently suited to research undertaken within the communities of practice. Blackler (1993) eloquently describes his reasons for adopting a CHAT approach, stating that it offers a way of synthesising and developing various notions of knowledge,

organisations and management and it deals with the messy problems encountered at the strategic level in organisations by attributing significance to incoherency and dilemma.

Choo (1998) also recommends that organisational knowing relate to an understanding of its socially distributed activity systems. These are collective, situated and pragmatic. They involve the active participation of employees and must incorporate the significance of history as well as an understanding of anticipated changes and new goals. There is a prevalence of incoherence and dilemma in activities, which may have more that one motive. The contradictions within and between activity systems can be leveraged for organisational innovation and growth. Choo (1998) sees this approach as public common sense, where language is the most important tool, opposing the tendency for organisations to view talking as socialising and detracting from work. CHAT provides a unifying holistic approach to the work of organisations, incorporating culture, history, situation and context, and allowing for contradictions and unintended consequences of activities. The CHAT approach of Engestrom (1987) is particularly well known. His work uses cycles of expansive learning shown in Figure 5, and demonstrates how positive interventions into activity systems can promote growth and innovation. As already noted this is not unlike the knowledge spiral of Nonaka and Takeuchi (1995) in Figure 6 where the contradictions between tacit and explicit knowledge promotes new learning. Whereas most approaches categorise or reconcile the anomalies and dichotomies that arise in sophisticated information systems, CHAT welcomes these as contradictions that stimulate the activities into a more advanced state.

To illustrate how CHAT can be applied in the field of IS, two research projects conducted by the author and published elsewhere in more detail, are now described. The first of these uses the construct of the cycle of expansive learning as a holistic and dynamic tool for the analysis of a complex long-term case study. The second is a project where the CHAT concept of "activity" is used as the building block of a knowledge architecture in a knowledge management system.

Project 1

The first project was a case study, using an action research methodology, involving performance evaluation on strategic objectives in tertiary education (Hasan 2001b). The site of the case study was an Australian university. Among its strategic objectives, the university management had agreed on nine attributes that all graduates should acquire through any course of study at that institution. These attributes included independent learning, discipline knowledge, communication skills, teamwork, analysis skills, diversity, information literacy, continuous improvement and individual rights. In order to demonstrate that this strategic objective was being achieved, senior management believed that it was necessary to audit what was taught and assessed in each subject[7], counting each separate instance of servicing one of the nine attributes. These counts could then be summed over whole courses. Low counts would reveal which attributes were not addressed in a particular course taken by students and this knowledge would result in appropriate changes to the relevant course curricula.

The project began in February 2000 when it was decided to begin the auditing process by ascertaining the extent to which the nine attributes were taught and assessed in subjects in the undergraduate Commerce degree. The Bachelor of Commerce had the largest enrolment of any course offered by the university and, while there is one generic award, there are 13 single majors and 57 combined majors on offer. There was a very large set of possible combinations of subjects that could be taken by any one student in the course of their study. The project therefore had two parts: one to ascertain and tally the attributes that were addressed in each subject and the other to calculate the coverage of each attribute over all possible sets of subject combinations. The problem was complex as there was no obvious means of identifying how educational activities contributed to the graduate attributes, and complicated by the fact that subject content changed when coordinated by different lecturers.

The author began as one of the subject coordinators participating in the project and was subsequently asked to design and develop an appropriate database information system for recording the collected data. The direct involvement in the restructuring of the data collection and responsibility for the design of the supporting system provided the author with rich insights into the events as they unfolded. Over a period of two years the project went through a number of major changes of personnel and techniques for data gathering and analysis, each major change triggering a new cycle of expansive learning. For example, the project was initially coordinated by a senior, experienced academic, who left the university soon after the project began, and a junior, inexperienced person then took over. This was a disruptive change but brought with it new enthusiasm and a questioning of the purpose of the study, which proved beneficial to the project. Another cycle was triggered when the attribute identification process began. This involved a series of voluntary workshops that were later replaced by individual interviews to make the process more focussed. This corresponded to the need for a more structured

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[7] The university uses the word "subject" to refer to each unit of study undertaken by the student (e.g. Microeconomics I).

form of the data for each subject compared with the initially free form nature of data reported at the workshops so that it could be recorded and analysed in a database

When the project concluded at the end of 2001 there was no clear outcome in the form of a set of proposed changes to subjects so that courses would produce graduates with the desired attributes. However, it was felt by participants that the project had been a positive learning exercise in that, on the one hand, teaching staff were now aware of the attributes and, on the other, management had a much improved understanding of what these entailed. The CHAT approach provided a technique suitable for examining these issues, enabling the identification of the cycles of learning and the events that triggered them. CHAT also allows, at least from a research point of view, that a project may have useful learning outcomes when not a success from a business perspective.

Project 2

The second project involved a much more explicit use of CHAT (Hasan 2001a). Researchers and practitioners in information systems have, over several decades, developed and refined techniques for modelling the real world and these techniques are routinely used to design computer-based business systems. The resulting systems have architectures determined by "units of analysis", such as a record in a relational database, an object in an OO program or a rule in an expert system. Given the close relationship of organisational knowledge to work practices, it was proposed that a promising unit of analysis for the architecture of a knowledge management system (KMS) is that of "activity", as understood in CHAT.

A knowledge architecture with activity as the unit of analysis has been developed and constructed from the structure of activity. This activity-based knowledge architecture combines the activity system of Engeström (see Figure 3 with Tables 2 and 3) and the activity hierarchy of Leontiev (see Figure 2) integrating their structures into a workable architecture of group knowledge that is quite pragmatic and so is implementable in a practical computer-based system. A prototype of a KMS using this architecture is currently being evaluated.

Table 2. Elements of the activity-model for KMS

Activities: who is doing what, for what purpose
Components of each activity as listed in Table 2
Relationships between those activities.
Actions and Operations by which Activities are carried out
An historical record of the above elements

Table 3. Components of activities according to Engeström

Component:	Definition and Clarification
object	the purpose and motives that define the activity.
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The meaningfulness of this representation of work has been tested with three typical workgroups where members were asked to identify their activities, their components and relationships. A paper describing this work has been recently accepted for publication (Hasan 2003) and the reader is referred to this article for a further explanation of the research that is beyond the scope of this paper.

DISCUSSION AND CONCLUSION

It is generally agreed that IS is not yet a mature discipline and may never have a distinct, theoretical basis as in other more traditional disciplines. IS may continue for some time as a multidisciplinary research field that borrows and adapts theories and methods from more established areas. At the current time researchers in IS come from different backgrounds or have placed emphasis on a variety of issues from technical to

organisational, from quantitative to qualitative, from economic to social. It may prove important to the field to maintain its breadth with specialists is different skills and issues. Eventually a theory or methodological approach that can span and integrate the breadth of the field could provide unity and identity, or at least a line of communication between a multidisciplinary band of specialists.

CHAT is one such theory that, among others, can be used as a basis for IS research. Its basic philosophy, that all human activity is a relationship between subject and object, mediated by tools and community, makes it relevant to the study of ICT as a tool used to support human work in organisation. It has the advantage of being holistic, flexible and dynamic.

Currently, the question is not which approach is best for IS in an absolute sense, but what is useful for particular research approaches to particular problems. It is worth the investment of time and effort by individual IS researchers to understand one such theory in depth, identifying its relevance to IS and informing the IS community of insights it provides. In CHAT terms these theories would be considered tools, which mediate the research activity, and synthesise the range of epistemologies from objective to subjective. As noted above, the mediation works in both directions so not only could the theories contribute to the field of IS, but the field of IS could be a vehicle for these theories to adapt and grow, incorporating concepts from other theories, into one that particularly suits IS.

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