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Support for the sense-making activity of managers

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Abstract

The knowledge management literature has focussed on the creation and capture of organisational knowledge, but little attention has been paid to the ways in which senior managers make sense of, and use, this knowledge for decision making. This paper describes a new approach to the study of this problem using the cultural-historical activity theory. This theory takes activity, mediated by tools and the community, as the basic component in purposeful human work. A consequence of using this theory is the recognition of the pivotal role of the sense-making activity in linking the processes of knowledge management and strategic decision-making. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

The design of computer-based systems to support decision making is inspired by the notion that information of good quality, both in content and presentation, is essential for good decisions [26,29]. There has been an unfortunate tendency to view both the computerised information systems and the decision makers as comparable information processors where the output of the computer is the input to the decision making process [17]. Used as the basis of systems to support management decision-making, the concept of knowledge management is a promising alternative to that of information processing, but there will be little gained if the computer and the human continue to be viewed as comparable systems, and the term information is simply replaced by knowledge.

The focus of the emerging knowledge management literature is the capture, creation, codification, amplification integration representation and dissemination of knowledge [1,30]. However the point at which managers use this knowledge for decision making has received little attention and there is little understanding of what is meant by the notion that knowledge rather than information is involved in decision making. Research in this area is hampered by the view that the decision-making processes of senior managers are messy [35], unstructured [27], and unsuited to support by conventional management information systems. Recent qualitative research using ethnographic, phenomenological or hermeneutic techniques has contributed to the identification and description of the issues associated with the use of organisational knowledge at the strategic level. Boland and Tenkasi's [9] work on "communities of knowing" exemplifies this approach making the point that it is important to consider diverse individual and group perspectives when creating and deriving meaning from data. However, when building systems, it is

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necessary to reconcile, or at least acknowledge, these differences as there remains a contradiction between the formal requirements of computer-based systems and the amorphous nature of unstructured decision-making. Research in this area would therefore benefit from the application of a theoretical framework that has structure and substance, while at the same time providing a holistic view of the problem and allowing for the messiness of context and diversity of stakeholder perspectives.

This paper will begin with a description of a case study, which reveals features of the use of organisational knowledge by managers that are difficult to understand within existing information systems frameworks. A new theoretical framework, based on the cultural–historical activity theory (CHAT), will then be developed, which provides a richer but more holistic appreciation of the problems of strategic decision-making revealed in the study. The framework allows the researcher to identify the core phenomena of interest, which appears to be an activity of sense-making by senior managers. CHAT provides an explanation of how this activity plays a pivotal role in linking the processes of organisational knowledge management and strategic decision-making.

2. The study

Commencing in 1995, a three-year, longitudinal case study was conducted into systems which could provide knowledge of research performance to managers in an Australian university. This study followed an earlier historical study of five successive projects at the university, which aimed at improving managers' knowledge of how the university was performing [14]. One result of the early study was to observe that none of the five projects provided information on performance in the area of research, supposedly the most prestigious business of a top-flight university. This apparent lack of concern for research performance information by university managers motivated the subsequent study, which is presented here.

The study was conducted in three phases: (1) an investigation into the effect of new funding policies of the Australian government based on research performance indicators, (2) a series of interviews with research managers in the university to ascertain their knowledge and use of research performance information and (3) a piece of action research carried out by one of the authors who took part in the development of a system to assist managers in the university to collect and track research performance data.

The study used an interpretivist approach to the analysis of qualitative data gathered by interview, observations and relevant documents. Such methods, commonly employed in the social sciences are now becoming well accepted in information systems research [16].

2.1. Government research performance indicators

In Australia, the federal government has traditionally been the main provider of research funding to public universities through a process of peer-reviewed grants. In 1995, there were planned changes to the government funding policy that would drastically reduce research funding to all but the top-tier institutions rated by overall research performance. In a response to this threatened change, it was recognised that better management of the research "business" within the university was becoming a matter of some urgency. Decisions to re-organise research structures were made by the executive of the university in an endeavour to maximise the university's score on the government's performance criteria.

A federal government commission had been set up in the late 1980s to develop a "broad range of quantitative indicators suitable for evaluating relative performance in higher education" and report on their "practicability, data requirements and appropriate conditions of use" [37]. The research performance indicators that were devised fell into the categories of research grants, publications and other original works, paid consultancies and professional service activities. A performance evaluation group was commissioned to carry out a study of 40 candidates for research assessment of 1990 data [38]. The group's aim was the identification of the definitions and representational scope of alternative, quantitative measures of research performance. The focus of the report was on "testing and refining the performance indicators identified in the 1991 report for reliability, verifiability and collectability". It appears that this

report was driven by the need for specifications for the new computer systems being developed by a joint consortium of universities. Consideration of the concrete implementation issues raised awareness of the inherent difficulties in attempting to objectively measure research performance.

The problem was again addressed in a 1996 government report [39], which measured research income and expenditure, as well as output performance, across institutions and across fields of study. There emerged great diversity in terms of research expenditure, income and publications patterns both between universities and between disciplines. The report looked at the policy implications of the proposed two-tiered research system and stressed the need to collect data to assess the implications of the proposed policy.

Meanwhile the government brought in a requirement for all universities to collect data for new performance indicators, which included outputs, such as publications, and inputs, such as success in obtaining competitive grants. A formula was then applied to this data for the allocation of funds from government to the universities. Within the university there was discussion on how funds could be distributed internally on a similar basis with some small variation to ensure equity for new researchers. This topic was hotly debated between members of the academic community, who did not want to lose the freedom of the traditional research culture, and university administration that wanted more accountability and a more business-like approach to research. A senior executive, the Pro-Vice Chancellor (Research), set up a Research Office to coordinate university-wide research effort and their first task was to collect the data needed for the government performance indicators. However, there was no intention for this data to be provided, in an easily accessible form, to those who managed the research within the university. Neither the senior research executives nor managers of research centres and projects were consulted on their needs for research performance information.

2.2. Research performance information for management

In 1996, semi-structured interviews were held with the heads of university's Research Office, a senior researcher in a unit known as the Center for Research Policy (CRP) and two leaders of university research institutes. Interviewees were specifically asked for their experience of, and views on, performance knowledge required by those who managed research in the university. The latter admitted that they had not given this matter much thought mainly because they had not believed that there was any suitable data available and that quantitative data alone would not be very meaningful. The focus of research by the CRP has been on comparative studies between institution and disciplines and had avoided comparisons internal to the university because of political implications. The Research Office claimed that their data, collected for government reports, was available internally but that they received no requests for this information and it was not stored in a form that would provide much information that would be of use internally. Both the CRP and the Research Office did provide us with several internal reports and documents on research policies that were of value to our study as follows.

In 1995, the university drew up a Research Management Plan (RMP) which was evaluated in 1996 by a survey conducted by the Centre for Research Policy [2] as a part of the ongoing quality improvement processes. This survey of university research staff indicated that there was an "unresolved cultural gap" between those who supported the RMP and those who thought it was irrelevant. The report showed that there was a perception that funding mechanisms, based on output indicators, were biased in favour of some disciplines (mainly the natural and applied sciences). For this reason, the report concluded that "while electronic databases would help increase the transparency of the RMP activities, in-depth interviews suggest that personal contact is the key to building trust and cooperation". One requirement of a research information system should therefore be the ability to link quantitative data with qualitative assessment records.

In 1997, interest was shown by the Pro Vice-Chancellor of Research and the Research Office in the issues of internal research performance indicators, but it was an extremely complex and sensitive area. The challenge was to ascertain how the performance indicators similar to those used by the government, related to the university's objectives and

Table 1
A summary of the university's research planning

University mission

"The University aims to explore, develop and apply human and technological capacity for the benefit of its region, the nation and the international community."

Objectives

- To be a centre of excellence in scholarship, teaching and research.
- To attract good students.
- To develop a diverse, socially responsible culture receptive to new ideas and critical enquiry.
- To foster co-operation, teamwork and collegial relationships with an international orientation.
- To provide equity of access.
- To contribute to the social and economic development of its region.

Strategies

- Promotion of the University's aspirations, achievements, philosophies and social and environmental attributes.
- Identification and commitment of resources to selected research areas.
- Development of strategic alliances.
- Development and evaluation of quality control.
- Development and continuous improvement of management processes, which are open, responsive, accountable and committed to campus communication.

strategies shown in Table 1 and therefore how the performance information can be best presented to managers to support the research management processes. The question might even be whether these performance indicators are a suitable means of evaluating the quality of research and if not the problem would be to devise more appropriate and workable measures.

Two issues became apparent at this time. Firstly, that data on research performance in the university, collected annually according to government requirements, was stored by clerks in a primitive database system as a single list of items which excluded the possibility of meaningful queries by mangers. A new system would have to be designed for management information. Secondly, the accuracy and the integrity of the data was of national concern following an independent audit of the 1996 data. This was not surprising as the data was collected by self-reporting and those supplying the data were well aware that their funding was dependent on the outcome.

2.3. System development

A consequence of the interviews, described above, was that managers expressed some interest in the creation of a system to provide information on research performance, across the university, in order to assist their decision-making. In 1998, one of the authors was experimenting with a new OLAP tool provided for research purposes by Gentia and was asked to conduct a piece of action research to determine the effectiveness of a new multi-dimensional data representation in producing information that would be useful to managers. This was done with the data available at the time for the three years 1995–1997.

The project began with an analysis of the government reports on output performance measures for research activities. Then a representative research manager was enlisted to determine what facts and dimension would be useful as research performance information for planning and management. The measures or "facts" chosen were: numbers of publications, publication index (publications weighted on different categories), number of staff involved and publication rate (publication index per staff member). The dimensions chosen were: time, publication category and location within faculties and departments.

Next, the available data collections were analysed to discover how to extract this data from currently stored in a single flat-file for each year's publications. With some massaging it was possible to export the required data to one comma-delimited text file.

Using Gentia, a multi-dimensional data model was designed and constructed as a prototype with a GUI front end.

This prototype was shown to a group of nine users, representing academic and administrative managers at various levels and degrees of computer literacy. These users were asked to evaluate the suitability and usefulness of the prototype system, the degree of ease of use and the overall quality of the system (recognising that it was a prototype). They were also asked what other information they would like included. For example, one manager wanted to include dimensions on staff demographics such as age, gender and employment level. These requests were then analysed to see which could be included relatively easily and whether this would result in a suitably useful product. The system was then demonstrated to the staff responsible for the source data collection who suggested changing the current flat-file system to an RDB system. Such a change would enable the OLAP system to meet more of the managers' needs by providing access to other sources of data, such as staff demographics. This change should certainly be considered, as it would provide a significant improvement with little effort. From the perspective of our study it was illuminating to observe how effective a simple OLAP prototype was in raising awareness of both the concept of using knowledge on current performance to support management decisions and the creation of a system to provide that knowledge.

3. Analysing the case study in terms of knowledge management

While there is no accepted definition of knowledge management [13], the term is widely used in conjunction with modern information technologies such as the Internet, browsers, document managers, search engines, data warehouses and software agents [1]. These technologies have the potential to synthesise, facilitate and expedite firm-wide information and knowledge in many forms including numerical, textual, graphical, audio and video. Of particular relevance to the theme of our case study are the distinctive contextual characteristics of knowledge management applications, which, like decision support systems (DSS) and executive information systems (EIS), belong to the category of systems which "informate" rather than automate work practices [36]. Consequently, it was felt important not only to focus on specific technical and systemic issues, when carrying out the interpretive analysis of the contribution of the case study to an understanding of knowledge management, but rather to deal with broader issues of work, people and the organisation.

From a holistic perspective, the principle issue of concern in the case study was the need to put management of universities on a more business-like footing. This requirement came from the federal government, the main regulatory and funding body for public universities in Australia, as a response to industry and community pressure for more accountability in all areas of public spending. The government's solution to the problem of accountability in the tertiary education sector was the determination and use of performance indicators, as described in the first part of the case study. Not surprisingly, our study shows that these are difficult to determine for research, which, by its very nature, is rarely judged by objective criteria. There was no confidence among researchers that the compromise performance indicators were a good measure of research quality and there was concern for the undesirable consequences of using them to determine funding.

Within the university of the study, managers were facing problems in implementing the new business-like approach. The work of research managers was changing from a relatively unstructured activity into one where formal hierarchical structures were required with demands for accountability at all levels as described in the second part of the case study. This formal need to know about progress on specific performance criteria was new and was confounded by conflicting motives. While there was an immediate need to perform well on official indicators in order to get funding within the institution, there was still a need for researchers to retain their reputation with their disciplinary peers by traditional means that differed by discipline and often involved long-term endeavors that would not appear on the current year's performance record. Research managers were being pressured for evidence of past performance, usually produced by experienced researchers and this

left little time for identifying and encouraging new prospects.

Another consequence of the new approach to research was the desire to use information systems in a more business-like fashion. In the "informate" category of systems used in the commercial world were applications such as data-warehousing and OLAP together with new methods of development such as prototyping. As the university was being required to collect data on research performance for government reporting, the development of the system described in the third part of the case study was an obvious response offering a useful tool to support research managers with the difficult decisions they now face. However, it was not just a matter of building a system using appropriate technology on top of the existing data. Consideration was also necessary on how information provided by the system might be used and particularly whether it would reinforce the current undesirable consequences of the use of performance indicators, which tended to narrow research effort towards short-term, quantifiable output. The system would only be worthwhile if it enhanced the managers' knowledge of current strengths and future prospects. The prototyping approach to development provided a means of determining the possible effects of the system before it was fully implemented.

At this point in the interpretive analysis of the case study, it was apparent that many of the metaphors and images that were inspired by Herbert Simon's rationalist information processing models [8] of both people and machine are now inappropriate. His purely rational, process-oriented view of the issue in question is that of data being processed into information, which is then used as input to the decision making process which in turn has the actual decisions as output. The phrase "knowledge management in support of decision making" provides a much richer view of the issue and suggests that a new approach is appropriate. The work of Boland [7–9] has done much to dispel the former view and his work is representative of a trend towards more contextual research into the way information systems are used to support people working in organisations. In Boland's [8] early work, he discovered that the *real* phenomenon of interest is not information technology but the "idiosyncronous way that individuals derive meaning from data available through information systems" [8, p. 377]. This implies that a means of identifying the "real phenomenon of interest" and having a meaningful unit of analysis is critical to the success of *this* type of research into *this* type of problem.

Boland's [9] later work on "communities of knowing" allows people in organisations to engage in activities of constructing networks of knowledge where both individuals and groups can make, and take, their own perspectives. Boland [9] also states that the "historically-bound sense-making of human subjects" is to be respected by the research and practice of IS. Through a lens of phenomenology, he treats IS as a communicative act in order to describe the essence of IS which is data becoming information in human consciousness [7, p. 344]. This view offers the best prospect for understanding the actual operation and significance of information systems in the context of knowledge management. What is now needed for further research in this area is a theoretical framework that provides this view with a rigorous, holistic justification and a well-established structure. The question then becomes: *What is a suitable unit of analysis with a workable structure which allows for the complexity and variability of the real world*?

In this paper, we suggest that a theoretical basis for practice and research into "informate-type" systems can be provided by an existing theory of tool-supported, human behaviour: CHAT. This theory has its origins in the cultural–historical psychology proposed by the Russian, Lev Vygotsky, in the 1920s and has been widely used in the fields of education and linguistics. CHAT takes as its focus of study, human activity, which is regarded as the basic component in purposeful human work [33]. An "activity" will be used as our unit of analysis, on the understanding that the term is only an approximate translation of the equivalent Russian word and has a wealth of meaning beyond its common use in English.

A most important assumption in a CHAT approach is that all activity is mediated by the use of tools and by the community in which it occurs. These notions, together with other CHAT concepts, will be explained later in the paper. However, if this theory is to be useful to the issue of knowledge management and its support for decision-making, it

is also initially important to establish just what the principal "activities" of interest are and what is their relationship to the problem at hand.

The purpose of the remainder of the paper is therefore twofold: firstly, to propose, and to justify the use of cultural historical activity theory as a foundation for the study of "informate" type systems and, secondly, to identify and describe at least one activity that is significant in the processes of knowledge management and decision making in the context of modern organisations using sophisticated information technology.

4. The cultural–historical activity theory

Any theory which can be applied to real people in real world situations is necessarily complex and CHAT is no exception. It requires a paradigm shift for most western researchers and it is not easily comprehended when first encountered. The foundation of CHAT was laid by the Russian psychologist L.S. Vygotsky during the 1920s and 1930s, and based on the idea that human activity is mediated by cultural signs: words and tools, which cause changes in that activity, and thus its internal mental reflection [34]. Vygotsky's inspiration came from 18th and 19th century German philosophy, which emphasised the idealistic role of mental activity (*Tätigkeit*) in constituting the relationship between subject and object. *Subject* refers to the active, cognising individual or social group with consciousness and/or will, while *object* refers to that on which the subjects cognitive or other activity is directed. A fundamental concept of Vygotsky is the dialectical relationship between the development of the individual and the society in which the person exists. The *dialectic* concept stems from Hegel's philosophy that only the whole is true, and there is a *totality*, in which is preserved each of the ideas or stages that it has overcome or subsumed. The concept of activity was brought into materialistic philosophy with the notion of an objective reality where practical–critical activity involved the transforming of material objects so that not only is the *object* altered through interaction with the *subject*, but knowledge by the subject develops only through the interaction of the *subject* and *object* [22].

Vygotsky's life goal was to create a psychology adequate for the investigation of human consciousness and psychological functions. In Vygotsky's cultural–historical psychology an individual's personality is treated as an outgrowth of social forces, rather than the autonomous being of the Western rationalist model [6] where the human child is abstracted from the social-historical body of which he/she is part. Vygotsky saw consciousness as an integral part of practical activity in which states and processes, such as attention and memory, are functionally related both to behaviour and to each other. He claimed that "any higher mental function necessarily goes through an external stage in its development before becoming an internal truly mental function because it is initially a social function". This led to his notion of externally mediated activity and the idea that mental processes could only be understood by realising the tools and signs that mediate them. Because thought and speech are such tools and signs, consciousness is inseparably linked to language and communication with others. It is through communication that the habits of practical activity are acquired. It is because human subjects treat objects with understanding and knowledge that their attitude to the world is called conscious and differs from the preconscious psyche of animals.

Vygotsky's work was continued by his students which included Leontiev [25] who developed the conceptual framework for the theory of activity that has been widely used in education, linguistics, anthropology, cultural research and more recently HCI [21], computer science [6], computer-support cooperative work (CSCW) [4] and IS [22].

5. The significant activity in knowledge management

An activity is a form of doing directed towards an object, which distinguishes that particular activity from another. The expression "objectless activity" is devoid of any meaning and one should always uncover the object when studying an activity [25]. Human activities are driven by certain needs and usually mediated by one or more instruments or tools. Vygotsky believed that the most fundamental CHAT principle was the unity of consciousness and

activity, where "the human mind emerges and exists as a special component of human interaction with the environment" [21]. The mind therefore "can be analysed and understood only within the context of activity" [ibid]. Activities can be individual or collective and those in organisations usually comprise a number of people working on something shared in an organised way to produce a joint outcome. Such activities are usually identified by examining the shared objects of work and jointly produced outcomes.

The CHAT framework of an individual activity is shown in Fig. 1. An *activity* is undertaken by a human *subject* motivated towards an *object* producing *outcomes* and mediated by *tools* and *community*. Activities are distinguished from each other according to their objects where the word *object* is used in the sense of the "object of the exercise" and is related to the motive driving the activity. Transforming the object into an outcome motivates the existence of an activity. The CHAT framework places the technology to one side of the main activity, viewing it merely as a tool and providing a structure that enables the identification of the mediating effect of the tool [22].

Once the CHAT concept and structure of activity is established, the next step is to identify the principal activity in the problem at hand, in our case knowledge management in the area of research performance in a university. In using computer technology to create systems which "informate", there has been, until recently, considerably more attention paid to the management of data and information than there has to the management of knowledge. There is often confusion among the three concepts: data, information and knowledge, and of the distinction among them. A useful delineation [20] is that data are things that we know (we have in mind, have learnt or can recall) but are relatively unimportant, whereas information is what we know that is noteworthy or of importance. From these definitions we need an answer to the question: "What does it mean to know?" before we can adequately understand a system that is for, or about, information. This implies that the activity of knowing, of making sense of the world, is central to the processes of knowledge management and decision making, an observation echoed by Boland [7] as described above and by eminent researchers [3,22] who have used CHAT as a theoretical basis for information systems. The CHAT concept of tool mediation is of particular interest to research involving computer-based information systems as in enables the researcher to com-

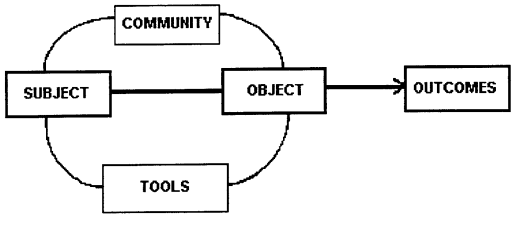

Fig. 1. The CHAT framework of an activity.

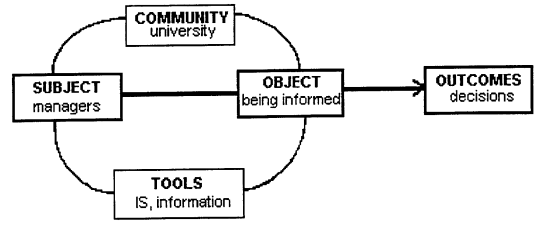

Fig. 2. The CHAT framework applied to the sense-making activity of managers.

Table 2
CHAT elements of the sense-making activity of managers

CHAT element	As used in sense-making activity of the study
The activity of interest:	information system support for the planning and management of the organisation.
The object of the activity:	variously described as: "understanding the situation", "being informed", "knowing where the organisation is going", "getting the picture" or just "sense-making".
Subjects:	administrators and managers.
Outcomes:	decisions, strategic plans.
Tools:	data, information and knowledge and the technological systems which provide them.
Community:	the organisation and its environment.

pare the effectiveness of different technological solutions to the problems of making sense of information in organisations. The term "sense-making" will be used throughout this paper as the principal activity of interest. The CHAT elements of the sense-making activity of managers are shown in Fig. 2 and illuminated in Table 2.

6. Why the sense-making activity?

Those who study the work of senior managers [27] and those who study the creation of computer-based systems to support their work [24], both make the assumption that a manager is, by definition, a decision maker. What managers do often involves complex sets of decisions but it is problematic whether a decision is the most appropriate concept to focus on when talking of support and whether academic notions such as problem, information, decision, plan, representation and goal, bear much relation to the everyday mundane realities of how people think and act in the world [3]. There is no question that goals have to be set and decisions made, but the relationship of these to the provision of information or knowledge to managers is by no means clear. There is an implicit assumption that some sort of sense-making activity sits between the organisational information systems and management decision-making. In practice, managers are concerned with "understanding the situation", "being informed", "knowing where the organisation is going", "getting the picture" and there is evidence that practitioners' experience does not fit with the models and expectation of researchers [ibid].

The traditional research approach to decision support is based on the rational model [26]. However, a decision is rarely entirely rational, that is, where all alternatives are discovered and evaluated and the best alternative is chosen. Instead, each manger's perceptions are coloured by experience, values and motives [29]. In particular, the work of strategic decision-makers has always been inherently complex and "unstructured" [27]. To make matters worse, managers are not always conscious of the relationship between their own decision-making and information. They can manage on a day-to-day basis without reflecting too deeply on how they make decisions or collect information, much to the chagrin of management theorists [10]. Consequently, decisions get made in organisations due to a variety of reasons that are poorly accommodated within the standard model of ratiocinative behaviour [4].

The concept of knowledge management support for decision-making highlights part of the difficulty that researchers have in studying this area. Knowledge management is by nature a collective, organisation-wide process whereas decision-making, particularly at the strategic level, fundamentally implies an individual process. It has been suggested [12] that decision-making at the organisational level exhibits the same structure as at the individual level so that the two processes can be combined into the parallel model where an implicit shared consensus underlies individual decisions which take place within the context of the organisational level. However, this retains the concept of an organisation as a system that processes information and solves problems. It is more useful to view an organisation as a knowledge society, where knowledge is developed by individuals, but organisations play a critical role in collecting, articulating, amplifying and distributing that knowledge [30]. The application of that knowledge comes back to the individual. The term "the always involved manager" has been used to describe how the manager makes sense of the world (information) and acts in ways that make sense of the situation (management) [20]. This view reinforces the notion that the sense-making activity of managers is pivotal to knowledge management in their organisations.

Organisational research using a CHAT approach [5] assumes that in the context of organisations, knowledge is both individual and collective and that by revealing the active nature of knowledge, opportunities are provided for both individual and collective development. On the collective side, the concept of *organisational memory* has been used as a metaphor relating to the collective memories of an organisation's members [23]. A CHAT approach has been used for this work on the development of methods and systems for capturing the knowledge of those who leave the organisation and make it available to new members of the organisation. On the individual side, the CHAT approach to the way people use computer-based technology has been

adopted by researchers in the fields of HCI and IS because of the limitation of the cognitive science approach [6,21]. Cognition can be defined as the activity of knowing: the acquisition, organisation and use of knowledge [28]. Cognitive research shows that managers have mental models of their organisation [31] and use map-like structure to make sense of information [15]. However, over the past decade the need to fundamentally enrich, or find alternative approaches to, existing information-processing psychology has been recognised [11].

In summary, decision makers in organisations continually face *messy*, wide-and-open, non-quantitative problems and it is up to the human problem solver to "make sense" of the problem. [35] Moreover, it has been observed that there are divergent views between decision-makers and those they employ to provide information to them on the importance of information to the decision-making process [10]. The activity by which managers make sense of the world is not perceived by them as a structured, rational or even conscious process whereas those who must develop systems to provide decision support need clear and structured specifications. By focussing on the activity of sense-making, it may be easier to elucidate specifications for a system to support this activity and at the same time give system developers a better understanding of the type of system required.

7. CHAT concepts applied to the sense-making activity

According to CHAT, activities are what people do. Such activities are driven by motives and are always undertaken for a purpose (i.e. towards a real object) even if that purpose is not made explicit by the subject. Activities are dynamic, embodying culture and history so that they are only meaningful in context. A considerable component of managerial work involves the use of organisational knowledge and could well be supported by knowledge management technology. If this is viewed as revolving around the sense-making activity, then there is a breadth and depth of rich understanding of this activity that can be drawn from aspects of CHAT, some of which are now described.

7.1. Internalisation, externalisation and the internal plane of action

The CHAT concepts of internalisation and externalisation [34] are highly relevant to knowledge management. Internalisation is the underlying mechanism for the origin of human mental processes all of which are derived, or internalised, from external actions. This is in opposition to conventional cognitive psychology, which emphasises the mind as the source of action. The concept of internalisation is widely used in the field of education to understand human learning and development, which can only occur through social interaction. It is through activity that we internalise ideas and concepts that then become psychological tools that are manipulated in the Internal Plan of Action (IPA). The IPA is a concept developed within CHAT that refers to the human ability to perform manipulation with an internal representation of external objects before starting actions with these objects in reality (the process of externalisation) [21]. IPA is more general than the cognitive concepts of working memory and mental models and is well suited to the analysis of the processes of dealing with the "messy", unstructured problems of senior managers.

The computer, which has been described as a cognitive artefact [31], can be viewed as an extension of the IPA as shown in Fig. 3, involved in the transmission and manipulation of information.

Managers, the subjects of the sense-making activity, take an active position in this model, selecting and interpreting information from computerised sys-

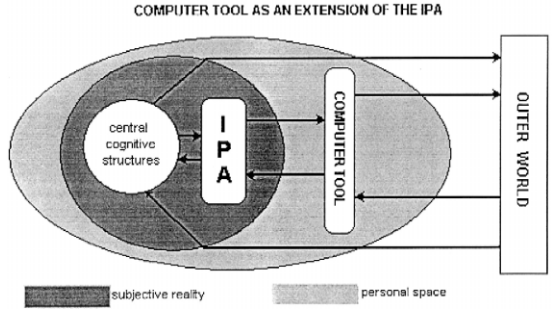

Fig. 3. Computer and the IPA from Kaptelinin [20].

tems, based on their existing mental model and biases. A person brings with them a whole range of baggage that will affect how they approach the activity: previous experience, cognitive skills, personality and culturally determined traits. These will continue to evolve as the person undertakes the sense making activity but are rarely taken into account as a whole. Most published research in this area will look at one set of factors, experience or cognitive skills or personality on performance in the workplace, but not combinations of these. These factors must surely interact and change over time, affected by the activity, which is the object of the study. One of the corner stones of CHAT is the existence of active actors who create and construct their own environment building on their cultural and material heritage [22].

7.2. The hierarchical structure of activities

The CHAT hierarchy (Fig. 4) is one of the best-known and most widely used concepts of the theory. Each of the three levels is fundamentally different in concept but within the levels of actions and operations there could be several layers formed by decomposing an action or operation into smaller units, which would still be actions or operations.

At the top of the hierarchy is the activity of interest, defined by its object, which may be one of two kinds: real (physical) or ideal (mental, i.e. present in the subject's mind). CHAT considers social and cultural properties of the environment to be as objective as the physical and biological ones. The motive of an activity is always objective whether real or ideal and an activity can be polymotivated. There is no activity without an object, i.e. activity is always purposeful although sometimes even the subject is not fully aware of that purpose.

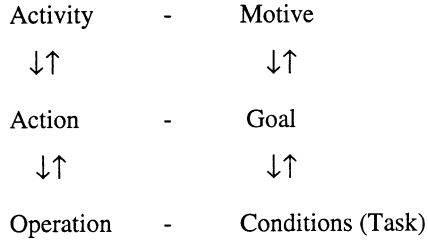

Fig. 4. The hierarchical structure of activity.

Participation in an activity involves performing conscious actions each of which has an immediate and definite goal. Whereas activities are always related to motives, actions are always related to specific goals. The same activity can be performed by different sets of actions. The same action can be used in several different activities, as most subjects are often engaged in several concurrent activities.

At the bottom of the hierarchy, where goals are always conscious, the operations, which make up actions, are usually non-conscious and performed automatically.

Although an activity can consist of many actions and operations in any given context, it is more than the sum of these. Most positivist research focuses on single goal-oriented actions whereas a CHAT approach claims that knowledge is more complete when directed at the level of the whole activity. CHAT research into the sense-making activity of managers incorporates both the technological and human dimensions, as well as the individual and organisational perspectives of knowledge and decision making.

The hierarchical structure shown in Fig. 4 is a dynamic one. What is initially a conscious action may with practise become a subconscious operation and what is usually an operation may in times of crisis be treated as an action. Computer technology has the capability of performing many of the tedious and error-prone operational tasks leaving managers to carry out the higher level actions. Developing a knowledge management system involves a decision as to how much of the cognitive load can and should be born by the computer system. In many valuable knowledge management systems, computer technology is simply used to collect, store and allow easy access to huge quantities of non-quantitative data leaving the intelligent tasks of selection and interpretation to people. A decade ago executive information systems were criticised for being quite simple information processors merely manipulating huge amounts of quantitative data using powerful OLAP engines. However, the graphical display of the resulting hyper-cubes has proved invaluable to many managers. The CHAT hierarchy provides an explanation for this situation by showing that human subjects en-

gaged in the activity of sense-making are able to perform goal-oriented actions aided by unsophisticated computer systems performing non-complex operations. The place of computerised information systems in knowledge management may often be only at the level of operations, where they are most efficient and powerful.

7.3. The use and mediating role of tools

The "rule of the tool" [27] is recognised as a problem in many organisational settings and CHAT addresses this problem by placing the tool to one side of the central subject–object relationship recognising that technology exists as a tool to support work, and is not an end in itself. However, CHAT adopts the position that all human activity involves the use of tools and that this distinguishes human activity from the activities of animals. Three kinds of tools mediate human activity:

- Primary tools: (artefacts, instruments, machines, computers, etc)
- Secondary tools: (language, signs, ideas, models, etc)
- Tertiary tools: (cultural systems, scientific fiction, virtual realities)

Primary tools are physical, material tools, while secondary and tertiary tools are psychological tools. While primary tools produce changes in the material object, psychological tools influence the psyche and behaviour of subjects. Computerised information systems, comprising the physical system, as well as the information and knowledge it provides, are primary, secondary and sometimes tertiary tools. Tools specify modes of operations and are historically developed in social terms possessing an evolutionary cultural component. Tools carry historical and cultural knowledge and the use of culture-specific tools shape the way people act.

The concept of mediation is central to the psychology of Vygotsky on which CHAT is based. The structure of activity is strongly cognisant of the power of tools to mediate and change the activity they support. The mediating property of a tool modifies existing activities and opens the possibilities for new ones. Developers rarely consider how the tool they design will mediate activities, changing work practices as well as social and cultural norms.

The CHAT concept of tool mediation anticipates that changes will take place in an activity through the use of the tool. Participants in an IS development project usually focus on what sort of system would be useful for the activity as it is now. A consequence of the application of the CHAT model is that the question should be: *What sort of system would adapt with the users as they became more competent with, and reliant on, the tool*.

7.4. The importance of context and community

CHAT provides a model of what humans do in their social and organisational context. Many western researchers adopt the CHAT approach because they realise the limitations of the dominant positivist ontology, which favours isolation from or control of environmental factors in research projects. Work on situated and distributed cognition [19,32] has been instrumental in raising awareness that there needs to be a body of research that specifically studies the role of context in the areas of work and IT.

The cultural–historical tradition which led to CHAT emphasises the social nature of human beings and it would be natural to expect that CHAT would support the study of group activities. Indeed, many of those currently applying CHAT to human–computer studies are in the area of computer-supported cooperative work.

In the 1970s and 1980s, the concept of collective subject was introduced into CHAT in order to account for the processes of communication between individuals. Additions have been made by researchers of work and IT in organisations to the original Russian versions of CHAT to deal with group activities, in particular the scheme of Engeström [14] as shown in Fig. 5. In this scheme, the entity of community is added to those of subject and object in the structure of activity. Here, the subject–object relationship is mediated by the tool, the community–subject relationship is mediated by rules. The relationship between community and object is labelled "division of labour" but this term may need rethinking outside the Scandinavian tradition. This model of activity offers promise for the study of computerised information systems, which

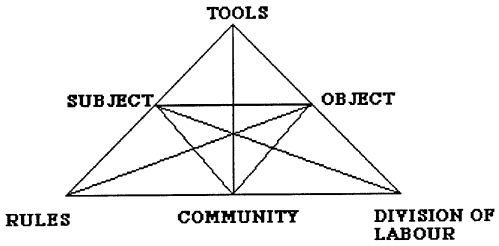

Fig. 5. The Engeström diagram.

are used in organisational contexts for strategic decision making.

8. CHAT concepts in research and practice

Previous sections of the paper have described the choice of an activity as the unit of analysis in research, together with other CHAT concepts that apply to activities. The interpretive analysis of the case study, described in Section 2 of the paper, identified the activity of sense-making as significant to an understanding of information systems that supported the work of research managers in a university. This method of analysis has revealed a number of basic issues that illustrate the power of the CHAT approach and the significance of the sense-making activity of managers.

A significant contextual element in the case study was that the attitude to information in a university is much more open than that in a private company. There is an expectation by members of the institution that any information they require is available and there is a corresponding obligation for members to make information under their control freely available to others. This does not mean, however, that everyone automatically knows everything about the organisation. There is no knowledge if information is not provided in a useable and meaningful form, as was initially the case in our study. The information had not been made available because the need for knowledge was new, generated by the changing in research culture to a more business-like activity. A CHAT analysis of the situation provided a framework by which need for knowledge could be articulated and a suitable solution found.

During the course of our research, we uncovered the following issues of importance to the activity of making sense of research performance knowledge.

- **Object**: The object of the sense-making activity implies an expectation that managers have a view of their area of responsibility that is accurate and up-to-date. A knowledge management system can help to ensure that all managers in the same area share the same accurate and up-to-date view. In the university research, context decisions, such as the allocation of resources, are often made democratically by committee and consensus is more likely if committee members share a coherent view of knowledge. A central, authoritative collection of knowledge, using any technology, is useful in this regard.
- **Outcomes**: One activity can have several outcomes, some of which are intended and some unanticipated. This variety is due to the different motivation of the collective subjects of the activity. In the case of research, an obvious outcomes of the sense-making activity is that the manager can see whether the research is contributing to the prestige of the university and the betterment of society. Another outcome is that the manager may have better support for claim for increased funding.
- **Subject**: CHAT uses the expression "active position of the subject". This means that the subject of the sense-making activity comes to a better understanding both of the technology and their knowledge requirements from the continued use of the tool (the knowledge management system). In the study, this was demonstrated by the fact that our intervention, by means of interviews and the demonstration of the prototype system, resulted in a greater awareness of the subjects, the research managers, of the way they could use performance knowledge in their work as managers. They could then better articulate their requirements of the system.
- **Community**: As mentioned previously, an information system can be considered as a communication act. In the case of the study, there were two communities that did not communicate well, the academics and the administrators. Our research and the prototype systems developed could be seen to assist this communication. Administrators were keen to make academics aware of the changing environment where research was a business, which had identifiable products and customers and where com-

petition meant accountability. At the same time, academics could communicate their perception that research was not the same as the other products or services and that for innovation and breakthroughs to occur, a researcher needs some freedom and support without a firm guarantee of a specific outcome.

- **Tool**: A critical factor in the development of the prototype in the case study was that it was essentially a simple tool for knowledge management. It merely presented the existing data in a different format, an OLAP multidimensional database, which was more meaningful to managers and which they could manipulate for their own view and interpretation. This allowed the managers, experts in their fields to do the information processing to structure the otherwise messy picture. This is preferable to attempting to design a sophisticated technical system that presupposed what managers wanted. The tool could thereby mediate the sense-making of the manager, not dictate it, which is consistent with the Vygotskian concept of the internal plan of action. In the IPA, managers can both develop, and manipulate, their model of the situation in order to then externalise this in the form of management decisions.

9. Dynamics of activity systems

The focus of this paper has been on a single activity, that of the sense-making activity of managers. The next phase of this research is to identify the whole set of inter-related activities of which the sense-making activity is only one. Two other activities have already been identified and described elsewhere [18]. These are firstly the activity of creating the information system and, secondly, the activity of data collection. The outputs of both activities are tools for the sense-making activity. It may also be appropriate to analyse research management as two activities, one of sense-making and another of decision-making, which uses the output of the sense-making activity as a tool. It appears, however, that the sense-making activity is pivotal to a holistic view of knowledge management for strategic decision-making.

Another activity inherent in this work is that of the research itself of which the researchers are the subject. The relationship between the activity of researchers and the activity, or activities, being researched is of particular interest when the research method is action research and the data analysis is interpretive. In action research, the researchers, members of the research community, become surrogate members of the community being studied enabling much richer interpretations of the activity under investigation. While the object of the researchers' activity is the conduct of the research, they inevitably acquire a stake in the object of the activity being studied through their involvement as action researchers, a fact that should be acknowledged when reporting the research findings.

In the case of the research presented here, it is clear that there are these two different activities, the activity of the researchers and that of the university administrators being studied. Ostensibly the subjects of these two activities belong to different communities, bring different sets of tools to their activity and seek different outcomes. However, the dynamic nature of activity systems is evident in the way that this study evolved over time. The construction and use of the prototype system became a common mediating tool for both activities so that, inherent in the object of both activities, was the successful development of the system. As a result, the two communities developed a greater understanding of each other evolving into new more unified community concerned with a joint outcome in the new system.

10. Conclusion

Because of the unstructured and messy nature of senior management decision-making, there is a need for new theoretical approaches to research and practice in the area of computer-based support. For "informate-type" systems, such as those that provide organisational knowledge management, we propose that CHAT is appropriate. This theory provides a practical model of what people do, focussing on the relationship between the subject and object of an activity, a relationship mediated by tools and community.

In this paper, we have explained the main ideas of the theory and proposed that sense-making is a central activity to the problem of knowledge management support for decision-making of senior man-

agers. To support this view, we have expanded on the CHAT concepts of internalisation–externalisation, the hierarchical structure of activities, tool mediation and the importance of context. Our own study of the work of senior managers in a university provides an example of how this theory can be applied to a practical, complex problem in a real organisation. The application of a theoretical framework based on CHAT provided structure and substance for the research, while at the same time maintaining a holistic view of the problem and allowing for the messiness of context and diversity of stakeholder perspectives. This approach is particularly suitable for interpretive studies using action research as it allows consideration of the relationship between the activity of the researcher and the activities being studied.

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