Matching competencies to enhance organisational knowledge sharing: An Intelligent Agent approach[i]

Claudia Roda	Albert Angehrn	Thierry Nabeth
Senior Research Fellow	Director of CALT	Research Fellow
Claudia.Roda@insead.fr	*Albert.Angehrn@insead.fr*	*ThierryNnabeth@insead.fr*
Tel. +33 (0)1 60724451	*Tel. +33 (0)1 60724361*	*Tel. +33 (0)1 60724312*
Fax +33 (0)1 60745544	*Fax +33 (0)1 60745544*	*Fax +33 (0)1 60745550*

INSEAD - Centre for Advanced Learning Technologies
Bd. De Constance, F-77300 Fontainebleau France
http://www.insead.fr/calt/

Abstract

This paper describes an agent-based system designed to guide, monitor, and stimulate managers towards the understanding of knowledge management concepts and the adoption of knowledge management practices in organizational contexts. In particular, we focus on the mechanisms needed to support the adoption of knowledge sharing processes, which are vital to knowledge management practices and often encounter the strongest resistance. A competency matching function, integrated in the presented agent system, allows dynamic matching of suppliers and consumers of information. Profiling (of people as well as of other resources) is used to supply knowledge-sharing partners with contextual information necessary for efficient knowledge exchange. Finally, we discuss another distinctive feature of the system, its capability to propose knowledge sharing actions within the context of user's activities and in relation with their level of adoption of knowledge sharing practices.

Keywords: knowledge management, knowledge sharing, software agents, change management, competency matching.

1. Introduction

Industrialised countries, over the last decade, have increasingly experienced a shift from a production-based economy to a service-based economy. As a consequence companies have come to value intellectual capital as much as their physical assets. Knowledge distributed within organisations (whether in formal storage systems, or in the head of people) is a part of this intellectual capital and it can retain its value only if it is well managed. Companies have therefore recognised the need to engage in some *knowledge management processes* [Davenport 98, Koulopoulos 97, Leonard 95, Nonaka 95] aimed at encouraging efficient acquisition, organisation, sharing, and use of knowledge. Many digital tools have been developed in the effort to support some parts of the knowledge management processes. However, it is widely recognised that one of the major barriers to the adoption of knowledge management practices is (active or passive) resistance to change [Dore 01, Lawel 01]. Knowledge workers are required to systematically implement practices (e.g. sharing knowledge, acquire and use knowledge produced by others) that are new to them or that they currently implement only sporadically or that plainly contrast with what they are used, or they perceive is in their personal interest, to do.

In section 2, we first describe an agent based system (K-InCA – Knowledge Intelligent Conversational Agents) which addresses the problem of resistance to change by providing to each individual (human) user a non-human entity (software agent) capable of guiding the transition from their current practices, to the knowledge management practices specified by their organisation. In particular, we focus on the mechanisms needed to support the adoption of knowledge sharing processes, which are vital to knowledge management practices and often encounter the strongest resistance. In sections 3 and 4 we discuss a competency matching function we are integrating in the K-InCA system to support and enhance the adoption of knowledge sharing practices in organizations.

2. Overview of the K-InCA system

The K-InCA system behaves as a personal Knowledge Management coach guiding, stimulating and monitoring the user towards the understanding of knowledge management concepts and the adoption of knowledge management practices. K-InCA agents can be seen as experts on organisational behaviour and change management assisting users in the transition from their current working habits to new habits that integrate some new behaviour (e.g. good knowledge management practices, entrepreneurial attitude, etc.). In our first implementation, the user initiates a K-InCA *coaching sessions* after a *practice period*. During the practice period the user performs his normal activity. During the coaching session the user reports his activities and interacts with the K-InCA agent who supplies advice and stimulus towards the adoption of a set of given knowledge management behaviours. As the system develops, K-InCA agents will be able to directly observe some of the user's actions (e.g. sending emails, browsing, etc.) and they will integrate direct observation with user's statements of activity supplied in the coaching session.

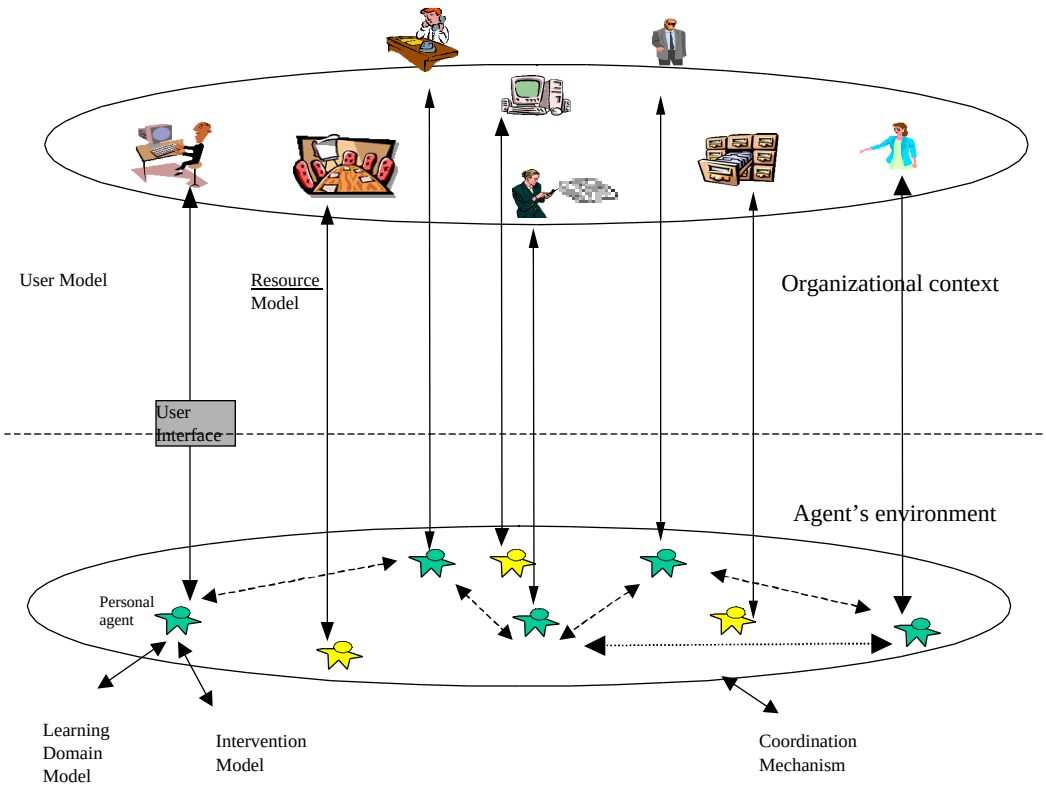

Figure 2 – An overview of the K-InCA system

The overall architecture of the K-InCA system is shown in Figure 1. The agent *coordination mechanism* (allowing agents to communicate and coordinate) and the *user interface*[ii] are not discussed in this paper. The domain of expertise of the system is represented in the *learning domain* model. The current domain of expertise of K-InCA is knowledge management, however other learning domains can be "plugged-in" the K-InCA system. The *user model* and *resource* model are discussed in section 3. In this section we discuss the current *intervention model* which is based on a specific model of the change process.

The system models the change process as defined by Rogers [Rogers 95]. Rogers introduces the *innovation-decision process* as "the process through which an individual […] passes (1) from first knowledge of an innovation, (2) to forming an attitude towards the innovation, (3) to a decision to adopt or reject, (4) to implementation of the new idea, and (5) to confirmation of this decision" [ibid, p.161]. We use the innovation-decision process as a model for organisational learning [Manzoni 98, Angehrn 97]. This model represents the change process as composed of five learner states:

- unaware - the user does not know about the innovation
- awareness - the user is introduced to the innovation (i.e. some knowledge management practice)
- interest - the user actively seeks information about the innovation or demonstrates interests in information about the innovation "pushed" by the system
- trial / appraisal - the user actively experiments in applying the innovation
- adoption - the user incorporates the innovation in his normal practices

K-InCA agents monitor and guide the user as he goes through these phases for each one of the desired behaviours/practices (those included in the knowledge management process). Figure 2 illustrates the strategies applied by the agent to guide the user towards adoption.

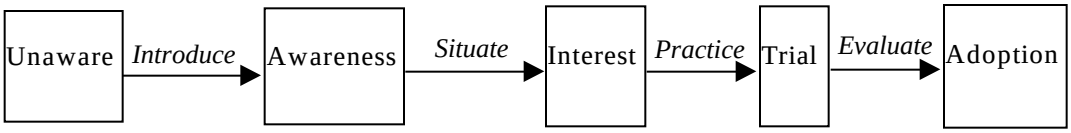

Figure 2 - Strategies guiding the adoption process

Awareness is raised by supplying information about the desired behaviours (introduction strategy). Interest is generated by situating the new knowledge and demonstrating to the learner that it is applicable to his situation (situate strategy). The transition to trial is pursued by proposing practical examples/exercises/problems that the learner can resolve, by changing his behaviour, using the new knowledge (practice strategy). Finally, adoption is solicited by evaluating the trial process and demonstrating the advantages of the new skill, process, behaviour or knowledge (evaluation strategy).

The final goal of the agent is to bring the user to adopt all the desired behaviours. In order to achieve this goal, K-InCA agents react to the current user activity on the basis of the information contained in the domain model and the user model, as well as interacting with other agents (see figure 1 and section 3). Target behaviours, those that the user should adopt, are described in the learning domain model. This model, which can be updated or completely replaced by selected users / tutors, includes a description of all the behaviours (what the behaviour is, why and for whom it is relevant, how to practice it, which are the benefits for the user who adopts the behaviours, etc.),

behaviour in the organizational context. Behaviour descriptions are used by the agent to supply the user with the information necessary to achieve awareness and interest. Behaviour relationships (such as "respond to colleagues request for information" is a sub-behaviour of "share knowledge") allow the agent's evaluation of the adoption state for one behaviour, given the adoption state for another. The actions associated to behaviours form the basis for the agent's recognition of relevant behaviours with reference to a [sequence of] user's action (i.e. behaviour that have been assumed, or should have been assumed, by the user).

3. Enhancing knowledge sharing conversations

As mentioned above, one of the vital knowledge management practices which encounters the strongest resistance in organisations is knowledge sharing. Obstacles to the adoption of knowledge sharing behaviours generally include: organisational barriers, lack of transparency, culture, habits, lack of incentives, etc. For instance, knowledge may be available (existence of a *supplier*) but access to it may be limited by factors such as the *consumer/demander* unawareness about it, or by the unwillingness of the supplier to make the information available. A recent survey on the implementation of knowledge management practices in banks and insurance companies [Dore 2001] reports that the main barriers to knowledge sharing are the "lack of understanding of the benefits derived from knowledge sharing" and the "technology inadequacies" due to the fact that "knowledge is held in too many formats and repositories". In order to achieve the widespread adoption of efficient, timely and relevant knowledge sharing practices, several conditions need to be met. First of all suppliers and consumers must be dynamically matched so that consumers are aware of possible suppliers and suppliers identify possible consumers. Secondly, the initiators of the knowledge sharing process (whether consumers or suppliers) must be given enough information to enable them to ask for knowledge or to package knowledge in a form that is understandable to the knowledge sharing partner. Thirdly, the involved parties must be motivated enough to engage in the knowledge sharing process. In order to meet this last requirement, K-InCA agents propose knowledge sharing actions which are relevant to the current user activity and, when necessary, supply the motivation information stored in the learning domain model. In order to meet the first two requirements, the system stores and maintains, in the user and resource models, information about knowledge sharing parties.

3.1. User and resource models supporting knowledge sharing conversations

The user model embedded in the K-InCA system includes a description of: (1) The adoption state of the user (e.g. the learner has entered the interest phase for the behaviour *share knowledge*, or he is in the trial stage for behaviour *acquire knowledge from people outside the company*, etc.) (2) The user's type: personality and attitudes towards innovation (users are classified along five categories which, in increasing order of resilience to change, are: innovators, early adopters, early majority, late majority, and laggards [Rogers 95, p.262]). (3) The user's social network (personal network, e.g. friends and acquaintances; and work environment, e.g. boss, colleagues, acquaintances, etc.). (4) The user's preferences: expertise, learning goals, interests, communication modes, and learning modes. (5) A record of previous user's actions. (6) A user profile: a presentation of the user. (7) The knowledge management agenda. This last element is central in the K-InCA system in that it mediates the interaction between the user and the agent and provides a concrete context to it. The knowledge management agenda contains the list of knowledge management actions proposed by the agent to the user during the coaching session.

The information contained in the user model is dynamically updated by the agent. Particularly relevant for the competency matching mechanism is the fact that the agent updates the user's preferences and social network on the basis of the user's actions (and his declarations). For

the agent adds project Alpha to the user's interests or it raises the level of interest of the user for that project. Similarly, Mr. Smith is added to the user's acquaintances or, the level of acquaintance of the user to Mr. Smith is raised. As a result, user's preferences and social network are assigned weights so that the agent can represent facts such as the user being "very interested" in a given subject and only "marginally interested" in another one; or the user "just knowing" Mr. Smith whilst being "well acquainted" with Mr. Black. All agents use the same weight assignment procedure (which cannot be detailed here for lack of space) so that, for instance, it is possible to compare the expertise level of several users on the same subject.

A set of Resource Manager Agents (RMA) are associated to resources such as information repositories about external people holding relevant competencies, formal/non-human organisational systems, knowledge bases or training systems, etc. Resource Manager Agents maintain a resource model and encapsulate their resources making them visible from within the K-InCA system. The resource model includes, amongst others, the following information: (1) a keywords description of the information that the resource may supply, (2) a keywords description of the information that the resource may be interested in acquiring, and (3) instructions on how the resource can be accessed (4) the resource type (e.g. external people, formal system, knowledge base, etc.)

4. Competency matching

Competency matching is achieved in the K-InCA system through a distributed consultation mechanism amongst the software agents associated with each user (Change Agent) and the Resource Manager Agents (RMA). The competency matching consultation is initiated by one of the Change Agents when it recognises that its user should act as a consumer or supplier of some knowledge. When this happens, the Change Agent issues a distributed query asking respectively for suppliers or consumers of that knowledge. Each one of the agents taking part in the consultation is capable of deciding if the associated resource (whether human or not) could act as supplier or consumer in that knowledge exchange and responds to the request. Queries for competency matching may take two forms: (1) User X is looking for consumer of knowledge Y under constraints Z; or (2) User X is looking for producers of knowledge Y under constraints Z. The knowledge identifier Y may be, in the simplest instance a (set of) keyword(s). The constraints Z allow the querying agent to specify the type of producer / consumer it is looking for. Consider, for example the exchange of figure 2. If the agent recognises the need to situate its suggestion "Have you though about acquiring information outside the company?" it may issue the query "User *userid* is looking for producers of Knowledge about *Project Alpha* under constraint *external people*". Responses to competency matching queries may either indicate availability for production or consumption (depending on the original request) and take different formats when generated by Change Agents or Resource Manager Agents. In particular, Resource Manager Agents respond indicating the resource availability and the access instructions. For instance, by matching the query content against the resource model, a Resource Manager Agent may respond with: "External user *Mr.Black* is a supplier for knowledge about *Project Alpha* , 'Mr. Black is the director of Project Alpha for the University of Agag, he also collaborates in the EU standardization committee. He can be reached at 2233454 or email Black@ac.Agag.gr' ".

Change Agents are capable of supplying a more informative response to competence matching queries. For instance, responses to requests for suppliers include: the level of expertise of the supplier in the subject; the level of acquaintance of the supplier with the consumer, his preferred communication modes, his interests, his user profile, his social network, etc. After receiving the responses to its competency matching query, the change agent will select the consumers or suppliers best suited to engage in the knowledge sharing process and it will collate the responses

interested in the information you have found about product TK3. Paul works in the project Alpha and you seem to know him quite well. Leo shows a very high interest level for this product, he should be contacted by email at Wilter@company.com. You can access the profile of the above users by clicking on their name. You should also store information about product TK3 in the special products database which can be accessed […], rewards are given for certain types of contributions to this database see […]".

The dynamic elicitation of knowledge (e.g. user interests and expertise) built in the K-InCA system requires a maintenance mechanism which is partially automated. When users report their actions[ii], e.g. "I have talked to Mr. Smith about project Alpha" they may introduce elements unknown to the system. For example, the Change Agent may not know who Mr. Smith is, nor what the project Alpha is. A repository of classified known people and information objects is maintained by periodically collecting keywords and resource identifiers from Resource Managers and system administrators. Unknown objects are collected for classification. The classification system allows to specify facts such as object1 is the same as object2, or object3 is more specific than object4. This mechanism controls the system as it grows and learns about the environment.

5. Conclusions

This paper has introduced the functionalities and information used by K-InCA agents in order to support knowledge sharing. We believe that such agents, which are currently under development, can be particularly effective thanks to their ability to propose knowledge sharing practices within a context where such practices have been recognised to be relevant for the user as well for the organization. Furthermore K-InCA agents are able to supply users with the practical information necessary to efficiently implement knowledge sharing processes within an organization.

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[i] The work described in this paper was sponsored by Xerox Corporation.

[ii] For a more detailed description of the user interface of K-InCA see [Angehrn 2001]