# Knowledge Rich Intelligent Environments for Managerial Decision Support

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**Abstract.** The paper introduces into a recent research in the area of intelligent environments aiming to support managerial decision making using recently intensively investigated approaches based on so-called ambient intelligence. One of the most important problems in such an intelligent environment is interaction of the user with the environment surrounding her/him. There is a number of approaches developed by various authors, we briefly analyze the most interesting ones. In our research we accepted the approach based on so called ad hoc agent environments introduced in [7]. The approach is intended to be used further on as a basis for enabling multi-criteria decision making of the environment when choosing the supportive action aiming to help the user.

## 1 Introduction

The *Knowledge-based Society* should be enabled also by existence of such environments which are rich of knowledge and thus in a well defined sense able to support the people surrounded by the environments. Such environments have been particularly studied in the scope of the area of *Ambient Intelligence*, mainly from the enabling technologies point of view. A lot of related research activities have been performed and a lot of interesting results achieved also in the areas of so-called *smart spaces*, *pervasive* or *ubiquitous* computing. All of these activities work with ideas aiming to enhance human environment by more or less intelligent capabilities designed to help people in various, usually rather complicated situations.

The aim of this paper is to present some view on a possible knowledge-based solution in the area of intelligent environments. Based on some our recent research ([4] to [6], [8]) we wish to stress the role of knowledge and the management of knowledge in such intelligent environments. In the scope of our recent research an intelligent environment is designed as a smart workplace for top managers.

## 2 Smart Spaces and Other Intelligent Environments

The concept of a smart space in the sense of an intelligent environment has been studied and developed in different directions. The concept of *Smart Spaces for*

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*Learning*$^{TM}$ has been recently developed in the scope of the Elena project [3], oriented on professional learning in organizations. *Smart Spaces for Learning*$^{TM}$ has been introduced and developed further on mainly by Simon and others (see, e.g. [9] or [10]) as educational service mediators, which allow the consumption of heterogeneous learning services via assessment tools, learning management systems, educational (meta) repositories and live delivery systems. This line of development has evolved into a distributed system, which provides management support for the retrieval and consumption of heterogeneous learning resources. More precisely, a *Smart Spaces for Learning*$^{TM}$ is a system, which aims at managing the distribution and consumption of learning services via a personal learning assistant. The term "space" is used here as a synonym for "network", while "smart" refers to the smart mediation of learning services based on user profiling and artificial intelligence techniques [9].

Another and a bit older direction towards smart spaces was described firstly by Abowd and others at the GATECH (see [1] or [2]). They proposed the development of a unique experimental facility for the exploration of large-scale ubiquitous computing interfaces and applications that are aware of the context of their use and can capture salient memories of collaborative experiences. The proposed system provided several types of assistance for users: access to information, communication and collaboration support, capturing everyday experiences, environmental awareness, automatic receptionist and tour guide.

The research by Abowd and others research directions use the name smart space in the meaning of *"intelligent environment"*. Usually the intention behind is to design and deploy an intelligent environment capable to communicate with the user surrounded by the environment, and to support him/her in fulfilling of some rather complicated activities.

In the scope of our recent research ([4] to [6] and [8]) we focused on stressing the role of knowledge and the management of knowledge in intelligent environments of various kinds. Such environments inevitably need to be knowledge rich environments; therefore a synergy of approaches and techniques from ambient intelligence as well as from knowledge management is necessary. We have concentrated on an analysis of what are the basic common features of intelligent (and therefore knowledge rich) environments, what are they relations to ambient intelligence approaches, and what must be taken necessarily from the knowledge management area. Our ultimate aim in the future intend to be to specify the essential features of knowledge rich environments which we hope to find as typical for the future knowledge-based society.

## 3 Interaction in Intelligent Environments

One of the most important problems in an intelligent environment is *interaction* of the user with the environment surrounding her/him. There is a number of very interesting approaches developed by various authors. We shall briefly analyze the most interesting ones.

An *ad hoc agent environment* [7] is a way for users to interact with an ambient intelligent environment. Agents are associated with every device, service or content.

The user interacts with his environment as a whole, instead of interacting with individual applications on individual devices. Devices and services in the environment have to be more or less independent, which fits well with the notion that agents are autonomous. The research was oriented on how the user is able to interact with the environment in such a way that he/she would have the control over collaborating agents. Some experiments showed certain tension between the user being in control and the autonomy of agents. Therefore the notion of cooperating groups was introduced as a way for users to gain control over which agents collaborate. Users can then establish connections between devices and content that are meaningful to them, in the context of their task.

This approach is recently being used in the scope of our project *AmIMaDeS*, oriented on design and experimental development of an *intelligent environment for decision makers* (more precisely, for top managers in general). More about the motivation of this research is said, e.g., in [4] or [5]. Here we wish just to recall that the research is oriented on such an intelligent workplace design and development, which can be helpful in overcoming some barriers and stressful situations typical for managerial decision making. The workplace should (among other features):

- ensure broad but focused (and personalized) access to relevant information and knowledge resources, supporting thus both learning needs of the manager as well as creation of his/her decisions;
- offer as much relief from stress as possible by avoiding all the usual stressful situations (or more precisely their potential sources);
- ensure broad and up to date technical support for all technically based activities in the workplace.

Of course, there are a number of problems to solve in order to ensure the above mentioned control of users over the intelligent workplace. As the workplace architecture is modeled using the *multi-agent system* paradigm, when employing the ad hoc agent environment approach, the most important problem being solved recently is the problem of *multi-criteria decision making* of the environment. In other words, it is necessary to ensure that the action chosen by the environment will be the best possible action aiming to help the user. However, the research in this direction is still not completely finished.

## 4 Conclusions

Our approach based on rather wide employment of *ambient intelligence* technology opens also a number of related ethical and privacy questions which must be solved simultaneously with introducing of the technology. We have to analyze the most important from a big variety of such questions. Nevertheless, we believe that the approach chosen will lead eventually to creation of a modern and supporting working environment especially suitable for organizational learning (on workplace) and knowing (ensuring an access to all the organizational knowledge any time, when

necessary). On the other hand, it promises also a number of interesting theoretical results.

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