Virtual Workshops to Support Reflection in Action

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Position paper

In our experience of computer scientists, we cooperate in participatory projects to develop computer systems to be used by professional people, such us medical doctors, geologists, mechanical engineers. These professionals need to use computer systems for performing their work tasks exploiting all the communication and operation possibilities offered by these systems, but they are not and do not want to become computer experts. This has motivated the definition of a particular class of end-users, that we call *domain-expert users* (or *d-experts* for short) [4]: they are experts in a specific discipline (e.g. medicine, geology, etc.), not necessarily experts in computer science, who use computer environments to perform their daily tasks. These d-experts often complain about the systems they use, they feel frustrated because of the difficulties they encounters interacting with them.

In domains of their competence, communities of d-experts progressively developed documentation styles, notations and procedures to record the community's knowledge - abstract or concrete concepts, prescriptions, results of activities - as documents. This enabled the community's knowledge to be available to members when and where they require it and in the form required to perform their current activities. Notations developed by the communities of experts determine the layout and appearance of the document thus permitting the expression of tacit information – embedded and conveyed by the document shape as well as by images, icons, textual words, which are meaningful only for experts in the domain at hand. Documents expressed in these notations support reasoning based on implicit knowledge, namely the knowledge that people possess and currently use to carry out tasks and to solve problems but that they are unable to express in verbal terms and that they may even be unaware of. It is a common experience that in many application fields experts possess a large amount of implicit knowledge, since they are often more able to do than to explain what they do. Implicit knowledge depends on the specific work domain and is related to the d-experts "practical competence and professional artistry in achieving a task" [8]; it is exploited by users to interpret the documents and, nowadays, to interpret messages from the computer systems.

As designers, we are challenged to develop interactive software systems that a) support their users in exploiting their practical competence, and b) enables the practitioner to develop and extend the knowledge available to the profession [1]. To develop such systems, we recognize the importance of notations developed by d-expert communities as reasoning, communication, and documentation tools, and we adopt a methodology for developing virtual environments, in which users interact using languages that are a formal representation of their traditional notations and virtual tools that recall the real ones with which users are familiar. More specifically, the methodology takes into account the following observations:

1) We recognize user notations and 'semiotic systems' as tools to convey user tacit information. The notations developed by the user communities from their working practice are not defined according to computer science formalisms but they are concrete and situated in the specific context, in that they are based on icons, symbols and words that resemble and schematize the tools and the entities used in the working environment. Such notations emerge from users' practical experiences in their specific domain of activity. They highlight those kinds of information users consider important for achieving their tasks, even at the expense of obscuring other kinds, and facilitate the problem solving strategies, adopted in the specific user community [2].

2) We recognize that new computer-based reasoning and communication modalities created the possibility of new modalities of communication and of the development of completely new 'semiotic systems' and notations. We stress that d-experts, using systems that exploit these new semiotic systems and notations, must master them in order to maintain the interpretative expertise of the virtual world in which they operate. Sometimes, the new modalities diverged so radically from the past that large portions of the users' practical experience failed to generalize to the new situation [5]. The current phase of introducing digital media coupled with computerization poses yet a more fundamental

challenge to user work as a whole. The change in the material and technological mediation from traditional to electronic media suggests a drastic and through-going reorganization of everyday work practice.

3) We recognize the need of local categorization of knowledge. Our view refines the Schön observation that "the categorization of knowledge in terms of a category like 'tool', as distinct from the ordinary, familiar coherences of objects as they go together in our everyday life, is what I mean by the formal categorical character of knowledge. And it is one of the key features that separates schools from life. The ways in which things are grouped together, the way in which things are treated as similar and different, are not the way in which they are grouped and treated as similar and different in our ordinary life experiences" [9]. We stress that in ordinary life experience, experts use different categorizations of events and things according to the current activity they are developing. We observe that these categorizations are reflected in the experts' notations and semiotic systems; moreover, different categorizations of events and things linked to the specific culture of the expert and to the current context occur. These different categorizations lead to the existence of different notations and semiotic systems – mechanical engineers document their activities in a different way from physicians - and to the existence of dialects within notations and semiotic systems - mechanical engineers in Italy use different notations than their colleagues in other countries.

Starting from these observations, three principles are at the basis of our methodology to design interactive software systems: i) the language in which the interaction with systems is expressed must be based on notations and dialects traditionally adopted in the domain; ii) systems must present all and only the tools necessary to perform the user work, without overwhelming users by unnecessary tools and information; iii) systems must present a layout simulating the traditional layout of the tools employed in the domain, such as for example mechanical machines or paper-based tools.
Our approach to the design of a software system devoted to a specific community of domain-expert users is to organize the system as composed of various environments, each one for a specific sub-community. Such environments represent *virtual workshops* [3][4] since they are organized in analogy with the artisans workshops, where the artisans find all and only the tools necessary to carry out their activities. In a similar way, a d-expert using a virtual workshop finds available all and only all the tools required to develop his/her activities. These tools must be shaped and must behave so that to be usable by the d-expert in the current situation.

In each virtual workshop, d-experts of a sub-community interact using a computerized version of their traditional languages and tools; they get the feeling of simply manipulating the objects of interest in a way similar to what they might do in the real world. In other words, our approach provides each sub-community with a personalized workshop. In this way, d-experts of a sub-community work out data from a common knowledge base and produce new knowledge, which can be added to the common knowledge base, increasing the community knowledge.

Thus d-experts may work cooperatively to reach a common goal; in this sense, the computer system becomes a collaboratory, as defined in [10]: "a center without walls, in which researchers [in our case professionals] can perform their research [work] without regard to geographical location, interacting with colleagues, accessing instrumentation, sharing data and computational resources, and accessing information in digital libraries".

An important activity on which d-experts' collaboration is based is the annotation of documents [6][7]. In the workshop methodology, electronic annotation is a basic operator, on which the communication among different d-experts and the production of new knowledge are based. An expert has the possibility of performing annotations of a piece of text, of a portion of an image or of the same workshop in use in order to extend, make explicit his/her current insights - on the problem at hand or even on the features of the workshop. Annotations are added to the common knowledge base and become accessible by other d-experts, each one accessing the data through his/her own workshop and interacting in his/her own professional language. Such annotations provide further possibilities to support the d-expert to reflect on his/her activities, and to make his reflection available to the whole community. Indeed, the activity of a d-expert is influenced by the observations performed and annotated by a colleague, which are then visible to him/her.

To make an example of how these systems can allow cooperative work of professionals who perform a common task, and how the annotation is important for triggering user's reflections, let us briefly consider a scenario taken from the medical domain. The scenario refers to some physicians collaborating to achieve a diagnosis [4]. A pneumologist and a radiologist incrementally gain insight into a case by successive interpretations and annotations of chest radiographies, performed in (possibly) different places and at (possibly) different times. They work in two different workshops that share a knowledge repository. They achieve the diagnosis by updating the knowledge repository after each session of interpretation of the results and of annotation of their new findings. Working in his workshop, the radiologist is analyzing a chest radiography and recognizes an area of interest denoting a pleural effusion; he then selects from a toolbox the tool that allows him to draw a close curve around the area of interest, and adds to this area a textual annotation that describes its observations about a 'Pleural effusion' that he wants also to communicate to the pneumologist. The system is able to associate a widget to this annotation. This newly created widget will also appear to the pneumologist when he looks at the same radiography in his workshop. By clicking on this widget, the pneumologist may read the radiologist' annotation, that becomes a trigger for his reflective activity.

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