Locales for Requirements Engineering

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Abstract

This paper presents an approach to the social interaction in requirements engineering. Giddens' concept of a sociological locale, defined as the setting for interaction, is used in understanding the interaction of people negotiating requirements. The creation of requirements engineering locales in a physical environment and the implications for designing virtual requirements engineering locales are discussed. Lessons learned from an informal study of a virtual requirements engineering environment are presented and challenges for designing computer support to requirements engineering locales are addressed.

Introduction

Communication problems are considered a major factor in the delay and failure of software projects in general [4] and they are of special interest in requirements engineering [1]. The requirements engineering process is a difficult one as it involves the collaboration of a number of individuals with different perspectives on the system to be developed and with different levels of expertise. Many problems of communication are simply due to the lack of understanding [19]. One of the problems is how to recognize and handle the use of different terminologies by different people. Shaw and Gaines [18] point out that this is a difficult problem when combining contributions from many people: experts may legitimately have different terminologies for the same domain concept; they may describe it at different levels of abstraction; one expert may describe a concept in operational terms and another in descriptive terms; they may also legitimately use the same terminology for different domain concepts and they may be using the same term distinguished by different terminologies.

Another problem is that requirements negotiations are almost always influenced by organizational, political considerations as well as by the personalities of the people involved [19][1]. Specification of requirements is regarded as a knowledge acquisition task and the elicitation of this knowledge involves some form of interaction with the people who might have that knowledge [5]. Whichever methods are used, at some point the elicitation of requirements becomes a conversational activity. In this direction, a number of problems with collecting verbal data are identified: the experts have little experience in

verbalizing their thoughts; the knowledge may be hard to express verbally; there is no way of detecting whether the expert has omitted anything; and experts might not be motivated to reveal their inner thoughts [21]. However, conversation is the main vehicle for gathering, clarifying and validating the knowledge about requirements, and Easterbrook argues that any framework for the requirements engineering process should not only support this conversational aspect, but must also encourage it, to ensure that the various contributors actually participate [5].

Analyzing the interaction in requirements engineering

The research reported in this article addresses collaborative work in requirements engineering by discussing the interactional needs of the cooperating group. It is argued that solutions to interactional problems can be sought by building an understanding of the interaction involved in such a process. First, face-to-face interaction is modeled as taking place through a rich communication medium for tasks such as acquisition and presentation during requirements engineering process. Then, initial studies in designing support for requirements engineering virtual collaborative environments are presented.

Most requirements engineering activities are still meeting-based and communication in these meetings uses a variety of artifacts [13]. Studies reveal that communication patterns in meetings are influenced by (at least) the meeting type, the role of participants in the meeting, information needs of the participants, and the types of artifact in use [2]. Typical requirements meetings include artifacts such as: whiteboards, flip charts, projector slides and overhead projector transparencies. Empirical studies of requirements engineering meetings [14] report how usage of meetings artifacts is linked to the communication patterns involved.

A central notion in the research described has been that of a *locale*, drawn from the work of sociologist Giddens [8], and used here to deconstruct the interaction within requirements engineering meetings. Locales refer to the 'use of space to provide the *settings* of interaction, the settings of interaction in turn being essential to specifying its *contextuality*' (p. 118). Hence, the reason of using the term locale is to emphasize the properties of settings and move the focus away from the physical characteristics of the space itself. We recognize requirements engineering meetings as locales for the requirements specification interaction. The individuals in such meetings form a social network and the use of the artifacts is part of, and provides affordances for, their interaction. The study done by Bright, Maiden and Sutcliffe [3] reports on the affordances of the artifacts involved in a typical requirements

engineering meeting. However, there is more in a physical component of locale that affords collaboration: we relatively unconsciously use the inherent properties of space, such as body presence, movement and sensory mechanisms. These properties provide awareness of others in the shared workspace. As Giddens notes however, it is an error to consider locales just in terms of their physical properties; the human action is framed not only by spaces, but by the patterns of understandings, associations and expectations with which they are infused. It is the setting for the interaction and not the space itself that frames appropriate behavior in a locale. For example, a 'house' is something that keeps out the wind and the rain, but it becomes a 'home' where we live by its utilization in human activity.

In most interactions locales pre-exist as a combination of a physical environment, social conventions relating to behavior in that environment, cognitive models of the relevant features and artifacts in the environment, and mutual knowledge relevant to tasks to be performed in the environment. However, in requirements engineering the participants are typically unprepared for the processes involved and there is not natural locale in which they will be already predisposed to undertake the task of requirements engineering. The fundamental challenge in requirements engineering is creation of a locale for the requirements specification interaction as part of the requirements engineering task. In standard methodologies for requirements engineering, structured meetings (e.g. JAD sessions) facilitate this by arranging the artifacts in the room, by bringing a facilitator in the meeting and by establishing well-defined roles for the participants. All this can be seen as facilitating the creation of a locale for system specification which is then built through interactions involving the creation of artifacts, the development of understandings, and the learning of behaviors appropriate to, and supported by, the locale.

It is the lack of pre-existing locales, and the need to manage major group socio-cognitive processes in creating them that underlies the well-known difficulties that have characterized requirements engineering from its inception. Situations, such as the ongoing activities of an experienced information systems team in continuing the development of systems entirely under its control, correspond to interaction within a pre-existing locale and one would not expect them to typify the problems of requirements engineering. What we would regard as a typical and characteristic situation is one in which the participants have had little or no previous social interaction and come from a wide diversity of backgrounds having few or no relevant locales in common. The effort to build an appropriate locale

then dominates the requirements engineering process in terms of effort, costs, schedule and the ultimate quality of the outcome.

The NATURE framework

This section discusses the characteristics of the abstract requirements engineering locale that is inherent in the requirements engineering framework developed by the NATURE project [12]. In this framework, the requirements engineering process is perceived as proceeding along three dimensions proposed by Pohl [15] and illustrated in `Figure 1`.

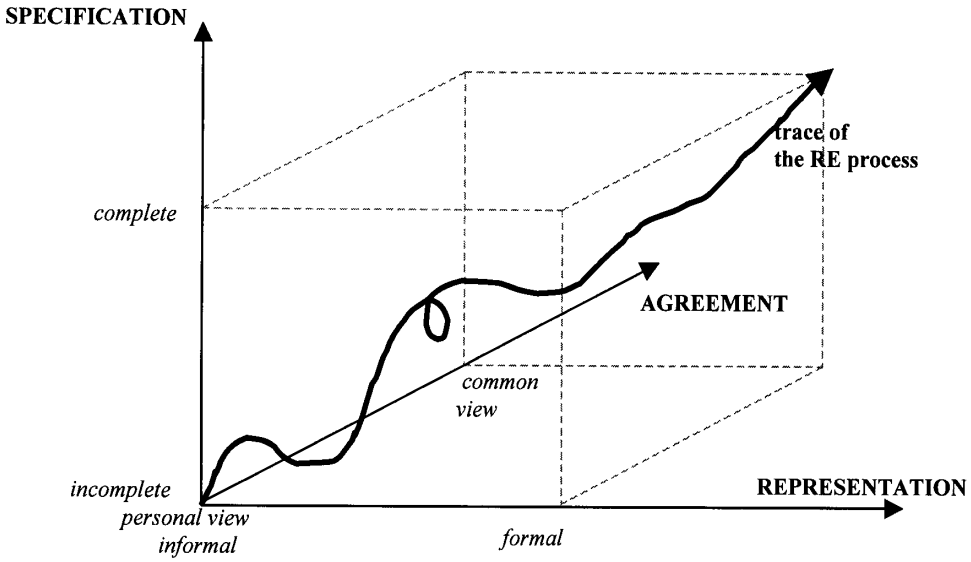


Figure 1. The NATURE framework

The interaction of such a process is regarded as taking place in a locale built within this three dimensional space. The collective goal of the human activity is to establish an agreed set of requirements which are complete and consistent. This means the evolution along the *specification* dimension. The requirements engineering locale develops as the social and cognitive process evolves along the *agreement* dimension.

Viewpoints [15] are defined as artifacts produced as part of the social requirements engineering process. Building the locale means in fact the creation of a setting in which the resolution of these viewpoints enables the determination of *conflicts* as well as the development of a *shared understanding*. They are considered key factors in requirements engineering from a social and cognitive perspective [6]. The knowledge gathered from these multiple perspectives is represented

using appropriate representation scheme [5]. This means evolution along the *representation* dimension. These representations, be they informal statements in natural language, semi-formal graphical notations such as DFDs and ER diagrams or formal notations, enrich the requirements engineering locale, enabling the interaction within it.

Locales in computer supported collaborative environments

Understanding how to create requirements engineering locales means understanding how to create a setting for the interaction that fosters a shared understanding and enables the creation of an agreed and complete requirements specification. However, the notion of virtual requirements engineering collaborative environments has arisen, as the number of software projects that involve distributed teams increases. In this case, how do we employ computer technologies to support the domain knowledge acquisition task in requirements engineering? Studies show that requirements engineering practices that barely worked in the past are unlikely to work in the new business and technological environment [16]. The first challenge is to better understand the collaboration work within requirements engineering meetings. Then, the next step is to design the technology that affords such model of interaction. However, how do we actually use the knowledge of the face-to-face requirements engineering model and map it to the virtual environment?

This section discusses recent research done in Computer Supported Collaborative Work (CSCW) in developing new approaches to collaborative environments and opportunities for supporting virtual requirements engineering interaction are presented.

Many collaborative and communicative environments use the notion of space and spatial organization to facilitate and structure interaction. Features of the "real world" which can be exploited as part of a spatial model for collaboration include relational orientation and reciprocity, proximity and action, and presence and awareness. However, recent studies [7][11] show that the focus on spatial models is misplaced.

Harrison and Dourish [11] discuss the re-*place*-ing of *space* in collaborative systems and argue that the property of appropriate behavioral framing which researchers are seeking in understanding collaboration is not rooted in the properties of space at all. It is actually the sense of *place* that provides sets of mutually-held, and mutually available, cultural understandings about behavior and action in collaborative work. Hence, the relationship between space and place is social and not technological; places are regarded as spaces invested with social meaning. The term *place* used by Harrison and

Dourish captures the same behavioral framing as the term *locale* does in social analysis. The distinction between space and place in CSCW is strongly shown by examples of places without notions of physical space: the USENET news groups and Internet mailing lists. They are computational spaces invested with social meaning; they are places. What is important in this case, is the tension between the connectedness and distinction which leads to placefulness [11].

Another approach that considers the notion of place, not space, as a metaphor for collaborative work support, has been developed by Fitzpatrick *et al.* [7]. This approach uses the term *social world* [20], defined as a group of individuals bonded by a collective goal, and develops a *locale framework* that also focuses on the centrality of interaction in human life. It frames collaboration as the interaction of individuals within social worlds regardless of whether that interaction is physical or virtual. In this framework, social worlds are not necessarily bounded by traditional social or organizational boundaries but instead by the limits of effective communication. Social worlds may be composed of sub-worlds which themselves may be composed of sub-worlds and so on. In this perspective, social worlds need 'site and means' [20] to facilitate their shared interactions and to provide shared context and resources. Here the term *locale* is used to denote the aggregation of site and means used in social world interactions.

The locale framework is defined by the following aspects.

1. *Locale foundations* define the basic locale structures that provide the affordances to support the work of social worlds.
2. *Mutuality* describes the way in which interactions between members of social worlds are supported through presence-awareness, and capability-choice mechanisms.
3. *Individual views* describe the way in which individuals construct personalized views of the multiple social worlds of which they are members based on their current level of participation in those worlds.
4. *Interaction trajectories* describe the temporal dimensions of interactions.
5. *Civic structures* define the relationship of locales into public spheres of interaction.

More detailed motivations and overview of this framework can be found in [7].

However, the question remains: how do we create virtual locales for requirements engineering interaction? Providing a virtual locale for the requirements engineering interaction is not about a simulation of the physical environment. Moreover, it is difficult to reconstruct the elements of face-to-face setting using the limited space of a computer monitor. It is about representing a collaboration place

driven by social worlds needs and the availability and appropriateness of different mechanisms to meet those needs [7].

Collaboration in virtual environments is often awkward and frustrating compared to face-to-face settings [10]. One issue that arises is of providing co-presence without physical proximity, in an environment where the richness of the face-to-face medium is lost. Part of the problem is that virtual collaboration environments provide very limited support for perceptual cues and workspace awareness. Workspace awareness, defined as the up-to-the-moment understanding of another person's interaction with the shared space [9], is an important factor in framing appropriate behavior and shared understanding in a physical requirements engineering locale.

In this case, there are many challenges when designing virtual requirements engineering locales. These include the identification of social worlds involved and their resources requirements, how these are related to the shared goal, what the ranges of possibilities are for the social worlds processes and so on.

An informal case study

This section discusses an informal case study and lessons learned from designing virtual requirements negotiation locales. The locale framework developed by Fitzpatrick *et al.* [7] lays the foundations of a bridge between the physical and virtual working environments. It provides a structure to analyze the group interaction in both environments. It has been used in designing this study of requirements engineering locales in the virtual environment.

The study uses a model of interaction in requirements engineering processes structured as illustrated in *Figure 2.*

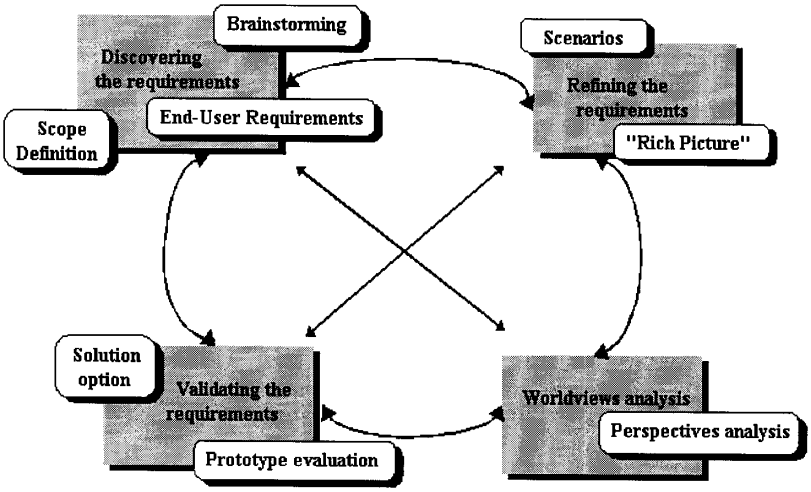


Figure 2. Locales for the requirements engineering process

This model regards the participants in the requirements engineering process as forming a social world with the collective goal of specifying requirements and that this social world's needs impose a structuring over the global process. The model is based on the assumption that the requirements engineering process can be defined in terms of four main activities: the requirements discovery, refinement, worldviews analysis and the validation of requirements, as illustrated in *Figure 2*. These parts of the process are drawn into sharper focus for its members at one moment in time. What is the focus becomes a locale for their work. Therefore, the model defines four locales corresponding to the interaction of these four activities. The interaction within and between these locales is the essence of the model.

The complexity and interdependencies of processes within the requirements negotiation involve the team members in interaction of multiple locales. The model defines varying levels of membership and involvement into these multiple locales, according to the participants' roles in the process. Individuals get their work done by becoming members with a high level of involvement in a particular locale. Meantime, the individuals are involved in other social worlds (e.g. organization, family), with different levels of involvement. Taking into account the participation in multiple social worlds and the participants' own view over multiples locales helps in understanding the emergence of conflicting perspectives over the system.

Designing for virtual requirements engineering locales

This model has been used in investigating computer support for the requirements negotiation process. A virtual environment has been created and informally evaluated for the support it gives to the requirements engineering locales. The study used the groupware system TeamWave [17] as the software platform. The reason for using this groupware component is that TeamWave is a place-based system that combines the rich applications and interfaces found in the existing real-time groupware applications, providing a persistent workspace filled with virtual rooms. It provides support for both synchronous and asynchronous requirements collaboration and allows the team members to work either co-located or at a distance.

The groupware system has been customized so that the requirements engineering process could follow the structure of the model in *Figure 2*. The main view in the system together with the list of the users of the system are illustrated in *Figure 3* and *Figure 4a* respectively.

Each icon in *Figure 3* represents a virtual room in which participants could meet and collaborate in the process. Each room contains a number of collaborative computer tools including concept map, note organizer, outliner, drawing tools, image tool and html viewer. The manipulation of these tools is visible to all inhabitants of the room in a real-time manner and the content of each room is fully persistent. The rooms have been grouped in four 'areas' in order to serve the interaction within the four stages of the model.

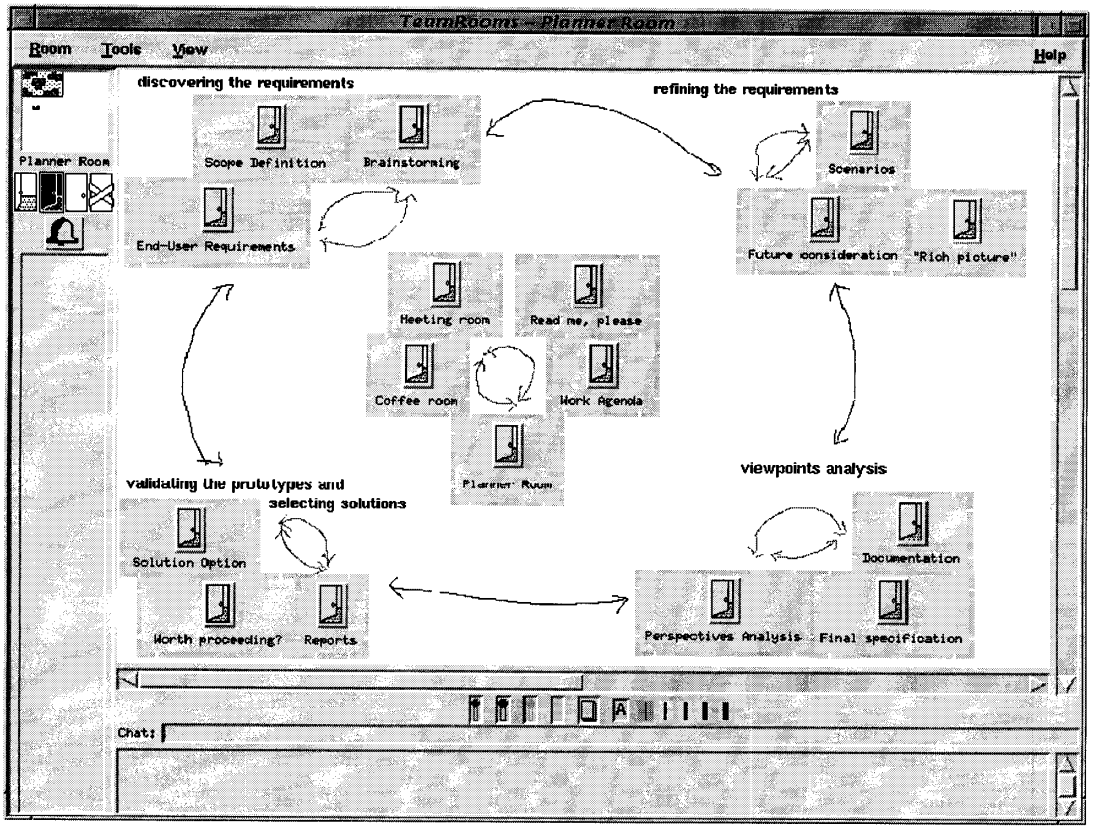


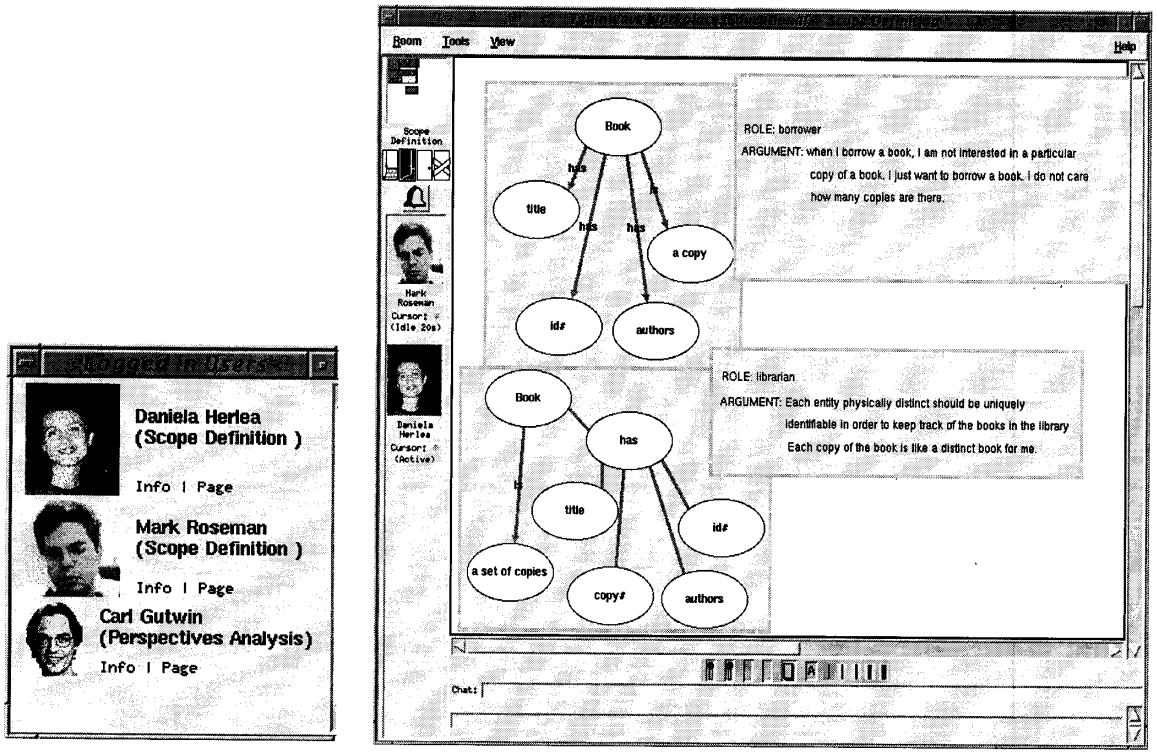
Figure 3. Virtual requirements engineering locales in TeamWave

The goal of the study was to identify to what extent these areas serve as virtual locales for the team interaction and to discuss the issues of concern when designing virtual requirements engineering locales. It involved a scenario of negotiating requirements for a library management system. The participants in the study played the roles of the librarian and the borrower; the study addressed the existence of multiple perspectives and the problem of requirements traceability. It consisted of two tasks. They addressed the following issues:

- the identification of different perspectives, based on the participants' roles in the process

- the ability to trace and validate requirements
- the accessibility of requirements documents

The rooms the participant used in their virtual collaboration are illustrated in Figure 4 and Figure 5.



(a) (b)

Figure 4. Analyzing different perspectives in TeamWave

Locales and the structuring of work in the virtual environment

The content of the Planner Room (*Figure 3*) represents the participants' view over the global structuring of the process. Once connected to a room, the interaction in the room becomes the focus for their activity and therefore part of a particular locale. Hence, becoming involved in the interaction of a particular locale is done by simply clicking on the icon of a room.

How the workspace is actually represented at the interface is of course technology dependent. However, our interest here is not the actual arrangement of the interface, but what are the choices and affordances the virtual environment offers and how the participants could make use of their environment. Lessons learned from this study are discussed and implications/challenges for designing requirements engineering virtual locales are addressed in the next paragraphs.

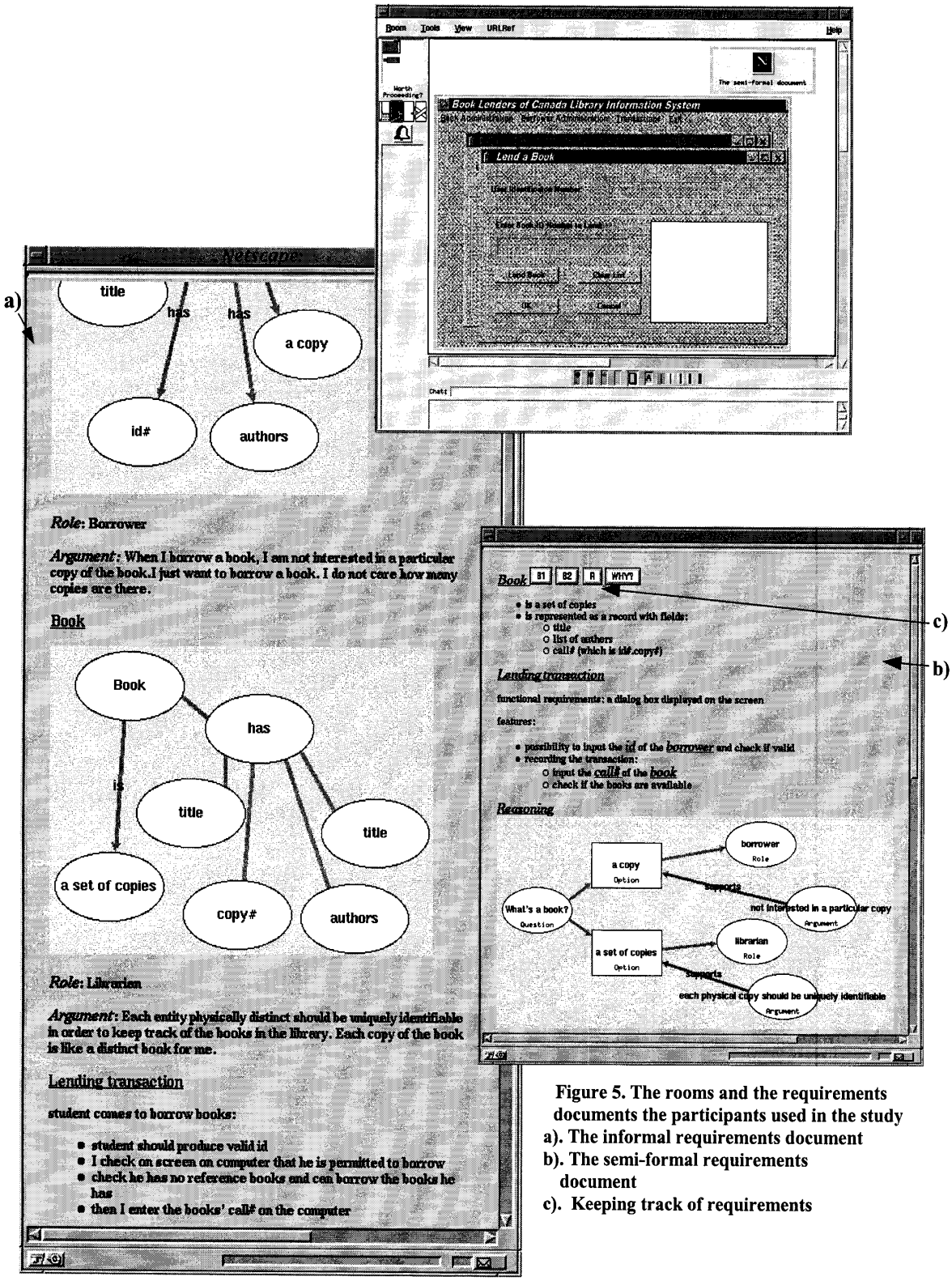


Figure 5. The rooms and the requirements documents the participants used in the study
a). The informal requirements document
b). The semi-formal requirements document
c). Keeping track of requirements

Awareness and presence

The virtual environment creates new mechanisms for awareness and presence in the workspace. The participants may be physically located at one workstation, in their own office, but can be virtually present in any room, any locale, collaborating on any task.

Seamless and fluid transitions between different social world activities are supported by the minimal, subtle effort required to move a cursor. However, when designing virtual locales for social world interactions, the spectrum of presence-awareness options may need to be defined in more explicit, discrete and manageable units [7]. Awareness information must be consciously and explicitly sought. In this case, the system provides *awareness widgets:* a list of the participants in the system meeting (see *Figure 4a*) and a list of the participants in each room (see *Figure 4b*).

The location of participants' actions in the shared workspace is provided by telepointers, which maintain an up-to-the-moment information about the focus of the participant in a particular room.

Designing for the awareness of current actions in virtual requirements engineering locales is another important issue to consider. In this study, the mechanisms to meet this need include the real-time access to collaborative tools and the visibility of the changes in a virtual room. The participants collaboratively constructed and analyzed several representations such as concept maps or notes (see *Figure 4)* that helped them in discussing different perspectives.

Artifacts manipulation

The virtual environment creates new affordances for manipulating the meeting artifacts. In a physical locale, the whiteboards, flip charts or overhead projector transparencies provide limited affordances for visibility, portability, duplication and persistence of information, and access to information in the artifact [14]. However, these weaknesses are overcome by the use of the electronic artifacts. In this study, the participants could synchronously and remotely access the electronic whiteboard, the concept map and the note organizer tools (see *Figure 4*) creating persistent representations of requirements. The spatial proximity of the work artifacts in the shared workspace could be used when annotating the requirements representations with information such as the roles of the participants in the process.

The information about requirements could also be stored in html documents which provides new possibilities as compared to paper documents. They include fast and synchronous access to information, persistent record of the information, support for requirements traceability and easy access to past actions and decisions in case of a new comer in the process (*Figure 5*).

However, the support for the awareness of actions with these artifacts is limited. The visible and tactile effects of actions are different in the virtual environment. The virtual workspace provides very limited support for the awareness of gesture, body presence, eye contact and gaze.

On the other hand, the virtual environment creates new possibilities for collaboration. The only observable activities participants engage at their keyboards are the movement of their fingers as they type or hold the mouse, and discussions with others during synchronous collaboration. But if their activities and conversations in the virtual were translated into the physical domain, they were a series of movements from one location to another in using physical artifacts such as whiteboards or flipcharts, in performing different tasks such as requirements elicitation or validation.

Individual view over multiple locales

From the locales they are interested in, individuals draw the resources they need to meaningfully engage in their work activities. This defines the individual view over multiple locales. Once connected to a room, participants in the study could create shortcuts to other rooms in the same locale or bring artifacts from different locales making them visible on their screen (the current room). The choice of bringing different artifacts from different locales is based on the personal simultaneous participation and involvement in those social world locales. The location of the participants in the system at one moment in time reflected their participation in the social world's locales. It is very important that the virtual locale provides awareness of current action on these artifacts. Support for effective communication is lost otherwise. For example, participants may choose to analyze a particular concept map developed as part of the 'requirements elicitation' locale, when validating requirements; that means access to that concept map while interacting in another locale. In our study, the system provided limited support to the individual view over multiple locales because of the limited information about current actions in other rooms of the system.

'Areas' versus locales

This study emphasized the importance of designing virtual locales as centres for the social worlds' interactions, as opposed to bounded spaces. However, when connected to a room in TeamWave, participants' interaction was bounded by its hard walls. That means that support for the mutuality within and across locales was limited. There was no awareness of the interaction in a whole locale. Hence, the 'areas' lost the battle against locales in this study, in the perspective discussed in this paper.

Therefore, this is a crucial domain CSCW designers should consider when designing requirements engineering virtual locales.

Conclusions

This paper presented an approach to Requirements Engineering that addresses the interactional needs of its process. The model of interaction we developed has been used in conducting an informal study of the requirements engineering process in the virtual environment. However, we consider this research just a start in understanding the intricacies of the requirements engineering interaction and of the implications for requirements engineering virtual environments.

There are still many issues to consider when designing virtual requirements engineering locales. For example, how much mutuality is optional vs. mandatory to afford shared understanding in the virtual? Or, what are in fact the requirements for a virtual environment to enable social interaction in requirements engineering locales and mitigate the communication problems in requirements engineering?

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