Extending the Services and the Accessibility of Community Networks

Antonietta Grasso*, Dave Snowdon* and Michael Koch^

*Xerox Research Centre Europe, Grenoble Laboratory, France
^Technische Universität München, Munich, Germany

Abstract. Community networks are community-oriented information and communication systems that are generally patterned after the public library's model of free, inclusive service and commitment to universal access. To serve the community network objectives it is therefore important to have easy and widespread information access. In this paper we present the Campiello system that proposes both enhanced information services and complementary user interfaces to better serve the community network objectives. Enhancement of the services is obtained by introducing collaborative filtering functions to support easier navigation in the information space of the community. To extend access to the community network, a paper-based interface is used, that supports exchange of information with the network, from physical locations spread in town. A large screen based interface is also used, which provides collective easy entry points to the most recent and relevant community information.

1 Introduction

In the last few years there has been much work on virtual communities and how they can be supported with technology ranging from text-based MUDs [8] to 3D collaborative virtual environments (CVEs) [7]. However, there has also been work on community networks in which the aim is to provide support for existing communities situated in specific physical locales such as towns and cities (e.g. [6]). In this second case, since the community already exists, the aim of technology is not to support the existence of the community itself but to provide tools which can augment the existing communication channels in the community, provide awareness of current activities and support a collective memory. The work presented shares the same social motivations driving the community networks, and is based on the assumption that technology advancements can help in better serving the above objectives. In the last two years we have been working on a project that has the goal to explore how technology can be used and enhanced to support both the communities living in cultural towns and the encounter between them and the visitors. The principal project guideline has been to focus not in providing a better virtual environment, but in better connecting activities happening in the real world with the digital representation of the community.

In this paper we first introduce in Section 2 the community networks and where

technology can be improved. Then we present the Campiello project and its main technology advancements both on the information services and on the user interfaces. In Section 6 we discuss future research.

2 Community Networks

Community networks are community-oriented information and communication systems that are generally patterned after the public library's model of free, inclusive service and commitment to universal access. Community networks, some with user populations in the tens of thousands, are intended to advance social goals such as building community awareness, encouraging involvement in local decision making, or developing economic opportunities in disadvantaged communities [15]; they are inherently addressing co-located communities. An example of community network is the Rete Civica Milanese (RCM) [6]. RCM is a community network created five years ago to promote a stronger community sense of belonging in the city of Milan (Italy). To achieve this purpose it offers a free registration service to a network where both private and public communication can occur. The basic information unit of the system is the email message, which can be posted either in public or semi-public discussion areas or exchanged among participants; synchronous communication can occur too, through chatting facilities. This basic set of functionality is used to provide an encounter place to virtually all the actors active in town (municipality, associations, commercial entities, etc.). The core of the project is to offer a new kind of *piazza* inhabited by the members of the local community, people sharing history, experiences, and problems connected with Milan.

On the same line, even if sometimes with less explicit emphasis on the civic aspects, are the efforts related to several digital cities. Experiences of this kind are the digital cities of Amsterdam [4] and Bristol [5].

In general these networks, to fulfill their objectives of increasing the sense of belonging to the community, put a high priority in having a system that is easy to use and widely available. The availability and modality of access can be considered a major issue, because only a broad participation in a community network can sustain its growth and wealth. This is true for any kind of community, not only local communities of town inhabitants: the more the network is the image of the real community, the more it encourages community newcomers to participate in it and the risk of drying out diminishes.

2.1 Advanced information services and user interfaces for community networks

Community networks are usually based on easy to use software. However we have observed, in our experience of users of such community networks, that technology can improve along two main directions:

- information navigation;
- information access.

From the point of view of information access, we have experienced that when successful, the number of discussion topics can become very large and locating information matching the users' interests can be a complex task. In the same way the location of people sharing the same interests can become very difficult when users are in the order of thousands like in the RCM case. To an extent a user of a community network can suffer from the same information overload problems that a Web user experience. However in the case of the community network it is even more crucial to its growth the possibility to easily benefit from the community generated information. On the side of accessibility, the provision of common access points is part of the agenda of almost every community network. However, up to now all user interfaces to community networks are based on desktop computers. The problem with this approach is that firstly it is not possible to reach all possible users, and secondly, it forces the users to access the network in isolation (alone sitting in front of the personal computer). In the work presented here we argue that it would be an improvement if the community information could be accessed without using a computer and while being with other members from the community.

In the rest of the paper we describe the approach that the Campiello[1] [1, 2, 9] system has adopted to enhance the information services and the user interfaces to community networks.

3 Overview of the functionality of Campiello

On the basic level, the Campiello system acts as a repository of information that is related to places and events in the city. This information mainly consists of descriptions and comments. Every user of the system can contribute to the information space, but there will be some main actors that provide an initial set of descriptions and continue to feed the system with descriptive information.

For structuring the information space and designing the access to it, we were faced with the well-known tradeoff between structured information system and unstructured 'communication area'. If the system is designed in a structured way it is easy for users to find information. On the other hand if you give users a lot of freedom in creating new information they are more likely to contribute, but this usually leads to a loss in structure and so can frustrate people when they try to find something in the network. For this reason we have decided to model the information services primarily around the recommendation function, while leaving the search and browsing capabilities still available if desired.

The information space consists of a set of items. The major types of items are physical places (e.g. (cultural) buildings, restaurants, and museums), events (e.g. concerts, festivals), and more abstract topics of interest like 'food' or 'parenting'. For search and recommendation issues the items can be related to one or more categories. Additionally, the descriptions or comments of the items can contain links to other items. The system collects explicit and implicit feedback of the user and combines this with a given profile of interests to select information items that might be

[1] Campiello is a project funded by the European Union's (ESPRIT LTR #25572, i^3 framework) which is aimed at providing intelligent information interfaces for connected communities.

interesting for the user. This works in a proactive way (i.e. without action by the user) and in a reactive way (i.e. the user tells the system to give him items that match some attributes). More information about collaborative filtering can be found in [15]; Knowledge Pump, an existing collaborative filtering system from Xerox used as recommender engine in Campiello, is described in [11, 12].

On top of the information services devoted to improve the flow of information inside and among the different communities, Campiello offers a layer of functionality to support improved communication and contact facilitation. This layer includes services for finding people with similar attributes (e.g. interests) that one could contact for preparing a visit to the town or for whatever.

3.1 Improved information services

The goal of Campiello is to provide more than just an asynchronous messages service (although we may well integrate synchronous communications support) – we aim to provide a dynamic community memory and actively push information to people who might be interested in it. To this end we have been developing two novel interfaces and also working on supporting services for managing the information contained in the community memory.

This section will describe the internal services of the Campiello system and subsequent sections will describe the user interfaces that use these services.

3.2 Contexts, items, people traces

There are four important types of information stored by Campiello, these are:

1. *Contexts* – A hierarchical classification scheme that can be used to group related *items*. Each context has a title in one or more languages and one or more description in one or more languages. Contexts can also have context specific information associated with any items related to them allowing the knowledge base to be extended. A fragment of contexts hierarchy is presented in Figure 1.
2. *Items* – An item represents a concrete or abstract entity about which information can be collected. Items can be buildings, museum exhibits, cultural events, associations or any "thing" about which people might wish to collect information. Items have a title on one or more languages and one or more descriptions in one or more languages. Items are classified into any number of contexts – for example an Italian restaurant might be classified under:
   - restaurants/italian – it's a restaurant!
   - architecture – the building containing the restaurant might be of architectural significance
   - cuisine/italian/venice – the restaurant might service particular examples of local cuisine.
3. *People* – The users of the system. Campiello stores some basic demographic information about people and a user profile which is composed of 1) a static

part indicating a user's preferences such as which contexts they are interested in and 2) a dynamic part composed of the *traces* the user has generated in the course of their interaction with Campiello.

4. *Traces* – As people interact with the system they leave traces of these interactions, which are then used to find correlations between users, and as implicit indications of a user's preferences and interests. Traces can be both implicit and explicit. Implicit traces are generated by actions such as requesting information on an item, sending a message to another user, or a record of a visit to a particular place. Explicit traces are generated when a person explicitly wants to communicate information to the system and other people. Examples of explicit traces include a rating of an item (a score awarded on a linear numeric scale indicating like-dislike) and comments (a text or hand-written comment indicating the users opinion and intended to be communicated to other users, e.g. the hand-written comment in Figure 2).

These four types of information allow Campiello to provide a flexible knowledge base and to allow users to share their opinions of items with others by the medium of comments and ratings.

Rather than relying on users performing searches of the knowledge base or browsing it looking for items of interest, Campiello actively tries to push information to users. The next section will present the architecture of the system and explain how this "information push" is achieved.

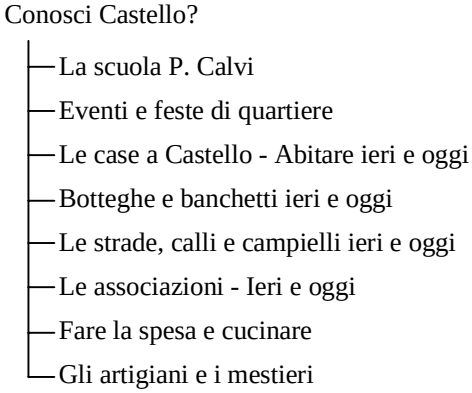

Fig. 1. A fragment of the context hierarchy related to the Castello quarter of Venice

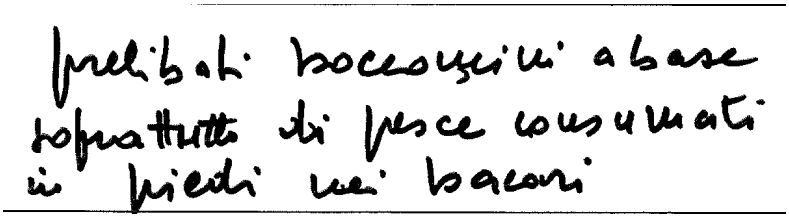

Fig. 2. An example of a hand-written comment.

3.3 The Campiello architecture

The Campiello system contains a number of components (see Figure 3):

- storage agents – these provide access to and specialised functions on the information stored in the Campiello knowledge base. Internally the information is stored in an SQL database but these modules provide a more convenient API hiding this fact.
- service providing agents – these agents use the knowledge base to provide services to the user interfaces. Currently the most important of these modules is the recommender agent.
- user interfaces – Campiello provides a number of user interfaces which use the storage and service providing modules.

These modules are implemented as Java-based agents and can either run on the same machine or several different machines allowing for some flexibility of deployment and the ability to provide multiple instances of each user interface geographically dispersed throughout a city.

The recommender agent has two main functions:

1. Finding users with similar profiles (matchmaking)
2. Recommending items to users which they should be interested in, based on their profiles

These two functions are interrelated. The recommender uses a technique called *community centred collaborative filtering* [10, 14] in which correlations are found between people in each context (community) and then these correlations are used to predict a given person's interest in a given item based on the ratings of the users with which a person is correlated. These correlations are done on a context by context basis since while two people might agree in one subject area (e.g. films) they might violently disagree in another (e.g. restaurants). By restricting correlations to individual contexts we can provide better correlations of interest than by attempting to find overall similarities between users.

For example, suppose a number of users have eaten at several restaurants in Venice. These users have then rated the restaurants and left comments on them that can be seen by other users. The recommender then compares the ratings of the users for each restaurant and derives a value for the correlation between users using the Pearson algorithm [14]. Given the correlations between users the recommender can

now predict the users' interests in items that they have not yet seen. If two users tend to agree on their ratings of restaurants and one has rated a restaurant that the other has not then the recommender can use the rating and the correlation factor to predict the other user's interest in this restaurant. If the result of this computation is a score above a given threshold the system might recommend the restaurant to the user when they next interact with the system or it might directly send them information, perhaps by fax or email.

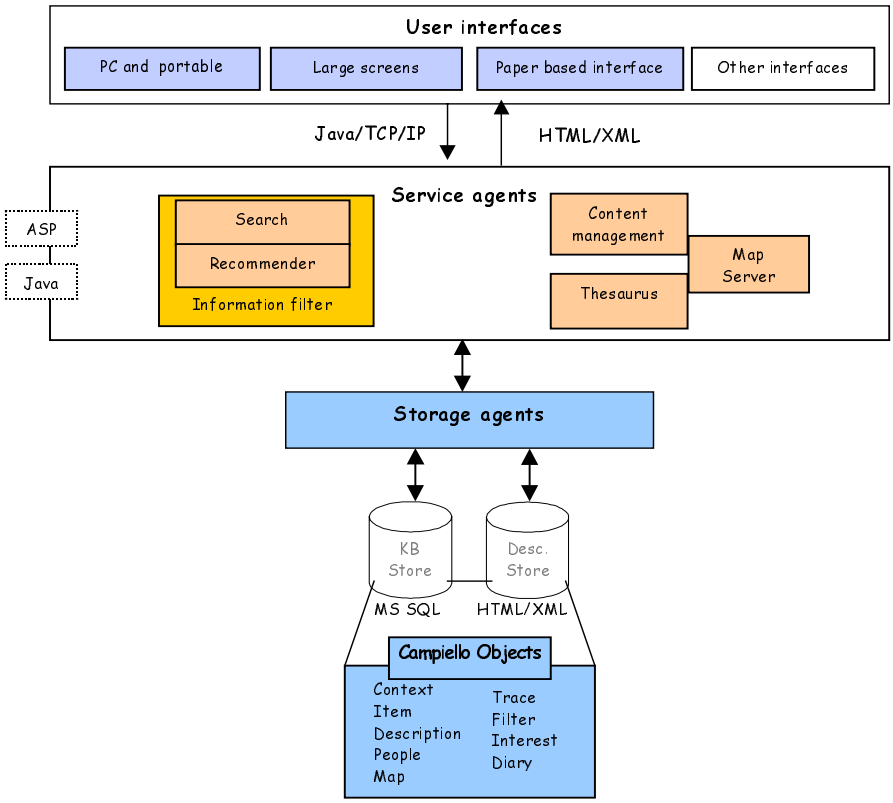

Fig. 3. The system architecture

As stated earlier, one of the goals of community networks is to offer widespread access in order to encourage the maximum possible participation and to ensure that sections of the community are not excluded due to lack of access. For this reason Campiello has chosen to focus on novel user interfaces in addition to using a PC based user interface. The sections below describe these new user interfaces: paper and large screen displays.

4 Using paper to interact with the community network

The paper interface was chosen as an interaction tool for the various advantages it presents (e.g. it is cheap, paper artefacts are easily shareable, and it can be easily annotated) and especially the fact that it is mobile and doesn't require acquiring new skills to interact with computers.

However, a simple means of interaction was needed for the paper interface. The users should be able to navigate through the data and be able to comment and rate on items and be identified. We used a very generic interaction scheme similar to dialog boxes in current computer interfaces. It is based on checkboxes and comment boxes as the basic means of interaction and it is described in the Section 3.4.4. Using this simple interface we aimed to achieve two objectives [10]:

- close the gap between the moment where an experience happen and the moment where an evaluation or comment about it can be given;
- take advantage of existing information collection and feedback generation activities.

Regarding the implementation, in Campiello we make use of some Xerox technology [13, 18] for processing paper-based forms. In this paper however we do not focus on the implementation architecture of this interface, but rather on the user functions addressing the two above objectives.

4.1 Applying the Paper Based Interfaces in Campiello

With the possibility to link the real world and the electronic space through paper, dynamic information can become a real support to local communities, both enhancing the effectiveness of current paper based media, from newspapers and magazines to wall postings and restaurant tickets, and opening the way to a new set of paper artefacts that can exploit completely the potential of this link.

In our work on the project Campiello we are currently dealing with support for connected communities in towns which have a rich culture and hence large numbers of tourists. The major objective of the project is to better connect the local inhabitants of the towns, to make them active participants in the construction of the cultural information and also to support new and improved connections with cultural managers and tourists.

The goals are achieved by creating a bi-directional exchange of information about the town, its places and events.

As described before, the Campiello system acts as a repository of information that is related to places and events in the city. Every user of the system can contribute to the information space but there will be some main actors that provide an initial set of descriptions and continue to feed the system with descriptive information.

Access to the information space is provided through collaborative filtering. Therefore, the system collects explicit and implicit feedback from the users and combines this with a given profile of interests.

Looking at what paper artefacts were already available in the field we identified postcards announcing events which are distributed in a lot of places, and local, topic

specific newspaper like information brochures as examples. We planned to enhance these artefacts in a way that they could easily be used for collecting feedback.

4.1.1 Take advantage of existing information and feedback generation tasks

People already collect a lot of information on paper and use paper quite naturally for marking feedback on items for themselves or for friends. If we make this information gathered in paper form and written on paper artefacts available to electronic information systems, the users do no longer have to make an extra effort and much more material and feedback will be available to the recommender system.

There are two ways to tackle the topic of using already established activities:

1) Firstly one could use the forms which are produced by the recommender system but design them in a way that makes them useful for different tasks. For example these forms can be nice information carriers with room for giving feedback that are worth collecting for a personal diary. One problem here is that it cannot be used to collect new information.
2) Secondly one could provide means for extracting information from existing paper artefacts which have not been produced by the system. Possibilities are to extract text from the given paper artefacts and try to relate them to existing items or define new items based on the information.

The general set-up for recommender systems with paper based interfaces is the following: A computer based recommendation systems prints its recommendations on paper and then receives feedback and new items from the user through traditional desktop interfaces *and* scanned paper forms.

Central issues when implementing this setup are where and when the data leaves the information system and how the data comes back to the system.

For processing forms we support two complementary approaches: delayed processing (the user drops the form in a box and it is collected later) and immediate processing (the user does the processing himself – and perhaps gets immediate response).

4.1.2 Active NewsCards

One outcome of our work was what we call an Active NewsCard.

Active NewsCards are flyers (DIN A4) or small (DIN A5 or DIN A6) postcards that show information on one or more items from the information space, enhanced with visible checkboxes and active blank areas. Ticking any of the checkboxes distributed in the content allows the user to:

- express interest in more detailed or related pieces of information or
- give feedback (rating) for an item.

Checkboxes can have different shapes or can be attributed with attached icons to express the different functionality. Blank areas are used to give the possibility to add free comments, which are scanned and saved. Additionally, we are considering using highlighting of text on the NewsCards for input purposes

4.1.2.1 Different types of Active NewsCards

According to the basic ideas mentioned in the section on paper-based interfaces for collaborative filtering, there are two basic types of Active NewsCards:

- Static NewsCards: These are Active NewsCards edited explicitly by cultural managers and distributed in large numbers in the town. These resemble the information cards already found in several towns. According to the main usage of the feedback elements we distinguish two main subclasses:
  - Information NewsCards: Main goal of the NewsCard is to give information on one of the several items. Therefore, the NewsCard contains a lot of text and images. Feedback elements are mainly used for expressing interest in more information or for giving feedback (ratings and free text). An example is visible in Figure 4.
  - Comment NewsCards: Main goal of this kind of NewsCard is to collect comments and ratings on a specific event/place. It is assumed that the user already knows about the item, so there is little extra information but large areas for writing comments or for giving ratings. Examples for such NewsCards can be feedback NewsCards in restaurants.
- Dynamically created NewsCards: While static NewsCards are created in large numbers for generic users, there is also the possibility to get a personalised printout of information (e.g. in response to submitting a filled out static NewsCard). These NewsCards usually contain more information and are larger in size. That is why we also use the term Active Newspaper for them.

Fig. 4. An Active NewsCard about Vienna

4.1.2.2 Processing of Active NewsCards and new information

Two possibilities for processing paper input have been implemented in Campiello:

For synchronous processing scan/print stations are available at semi-public places where people can process their NewsCards and immediately receive the results, which can be a personalised NewsCard with requested information. Such places are tourist offices, libraries, hotels and schools. Additionally, synchronous access is available through a fax server.

Alternatively, the users can drop the NewsCard in collection boxes that are mounted at several places (e.g. in restaurants and hotels or at public events) or send them by mail.

Both for comments on existing items and for new items we make use of the fact, that the information we collect is mainly to be presented to users again. Therefore, we do not have to fully transfer it into digital information (e.g. do recognition of handwriting etc) but mainly store the image and relate it to some basic contexts and/or users.

Each Active NewsCard can be associated with another paper "tool" called PID Stickers (see Figure 5), which work as personal identifications. Such a sticker contains a machine-readable id of the user. Attaching a PID sticker to an Active NewsCard makes the system associate content and actions with the user, creating conditions to produce useful information for the recommending and the collaborative systems, which are essential to give valuable services back to the user.

Fig. 5. Example of Personal Identifier (PID) Stickers

5 Using large screens to interact with the community network

As described above, the paper user interface allows us to provide information on specific topics and allows users to request more information and provide feedback. What is lacking in this interface is a general overview of the contents of the community memory and information about the topics that are currently interesting to members of the community. This information could be distributed via the paper user interface by providing forms which users can scan to receive updates or by

automatically mailing or faxing information to registered users – indeed this is something that we may try at a later date. However, our current approach is to use large screen displays to display broad coverage of topical information in a way that complements the focussed presentation of the paper user interface.

The purpose of our large screen display, the CommunityWall, is to create an environment that fosters social encounters (conversation) using topical information and/or news as a trigger. It provides a focus for social activity in a similar way to existing notice-boards which display notices (ranging from formal printed notices to hand written scraps of paper) concerning current community activities. Using the CommunityWall, we aim to provide information on what are the interesting activities or topics of conversation, who is actively interested and what they are saying. If a topic displayed on the CommunityWall catches attracts someone's attention they can then request that more information be displayed on that item by touching the screen (or using some other means if a touch-sensitive display is not available) or that a NewsCard be printed on that topic on a printer/scanner situated near the display. Once the NewsCard is printed it can be used to comment on the topic. In this way the CommunityWall supports information discovery and an asynchronous communication among members of the community. Furthermore, we hope that if multiple people simultaneously use the display it will help trigger conversations and allow people to meet others with similar interests (since it will be obvious what topics people are looking at).

Given the contexts, items, and traces present in the knowledge base, the task of the CommunityWall is to select the topics that are most representative of the community at the current time and to display information about these topics in such a way that onlookers can see which are the items of current interest to the community. Topics are selected for one of two reasons. Firstly, privileged users, referred to as cultural managers (editors), can mark some items as being of particular interest. Secondly, the CommunityWall monitors additions to the database in order to see which contexts and items are receiving most comments and ratings – these are assumed to be the items that are of current interest and therefore generating lots of "traffic". A set of customisable rules is invoked to prioritise items and decide which are the most interesting at the current moment. Items can be viewed as competing for screen real-estate and those that win are the ones that are generating the most interest, belong to contexts of other items of high interest, or have been marked by a cultural manager as being of particular interest.

Once selected, items displayed are grouped by contexts so that the display has some coherence. Items are represented by a title, a brief description, and comments on the items and pictures of the users who have commented on that item. Onlookers can therefore see what is interesting, who is interested in it and what these people are saying about the item. In order to maximise screen usage while preserving context, older comments (and the associated images of the commenter) are gradually shrunk and thereby progress from being full-size, to being small but legible, to being illegible but still visible, to finally vanishing altogether. The motivation for this is to provide some indication of the volume of comments even if people cannot actually read them all. Optionally, ratings can be displayed alongside particular items to give another form of feedback.

We deliberately chose to display images of people who make comments, which were captured as part of the registration process. Although this might seem to raise privacy concerns we believe that there are good reasons for identifying people in this way. Firstly, people are aware that the comments they are entering are intended to be seen by others. Secondly, we believe that some form of identification may help to encourage responsible comments and avoid obscenity. Thirdly, we hope that people standing in front of the CommunityWall will be able to recognise people who have commented on a topic that is of interest to them and perhaps identify these people if they are also nearby. In this way the CommunityWall can help to facilitate contact between members of a community.

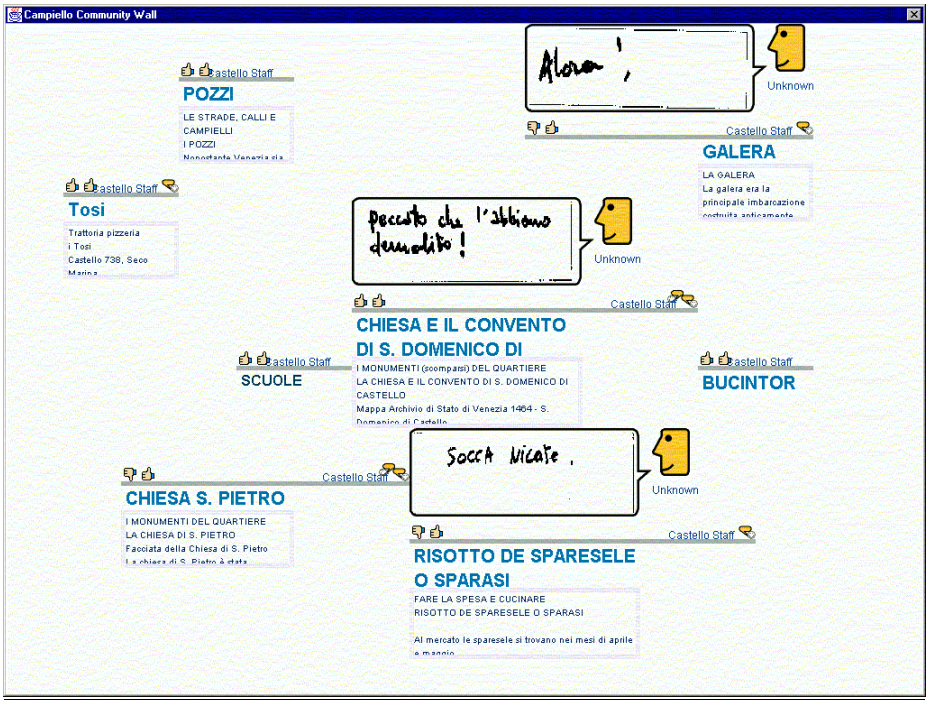

Fig. 6. The CommunityWall on real content from a Venice neighbourhood

We are currently experimenting with a number of different display and layout styles for the CommunityWall and also working to provide an interface that can be adapted for a number of different settings. Figure 6 shows the current CommunityWall display and Figure 7 shows an earlier prototype of the CommunityWall used for a demonstration at a conference of European projects (IST'98).

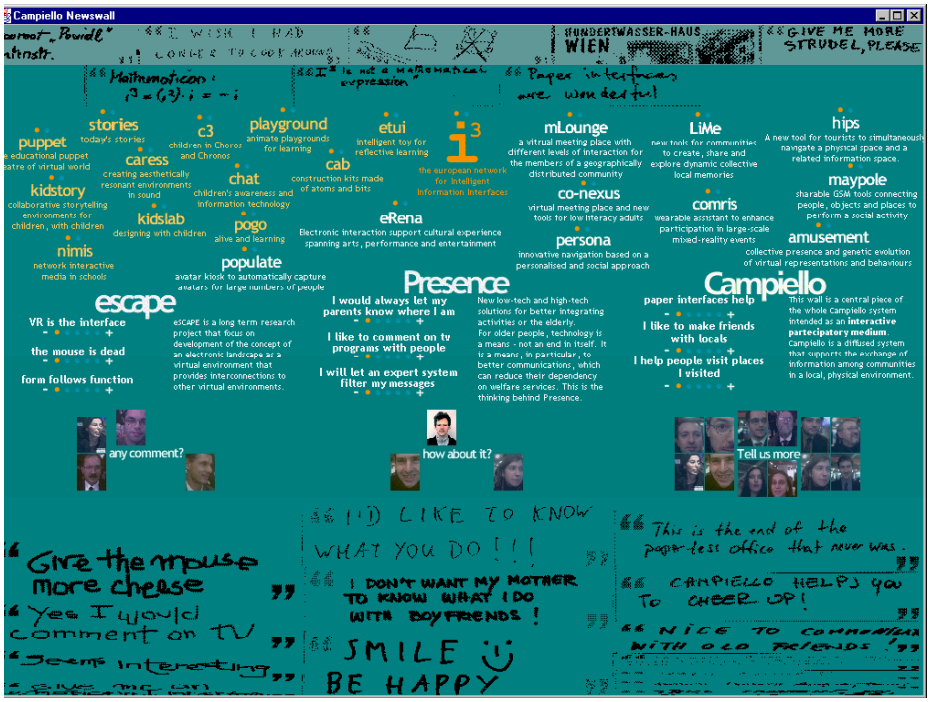

Fig. 7. The first CommunityWall produced for a conference dedicated to i3 projects.

6 Conclusion

Campiello is a project based on a multidisciplinary approach supported by different partners with different skills: computer engineers, industrial designers and social observers [1]. Input from these three converging perspectives continuously gets compared and influences the work of the others. In this paper we have focused on the technology as it has been designed on the basis of the industrial designers vision and of the first insights from the social observation in the two towns of Venice (Italy) and Chania (Greece). The next steps of this work will be the refinement and testing of the ideas in real communities with the support of the social observers participating in the project.

Acknowledgements

The work described in this paper is partly supported by the European Community via the Campiello project (ESPRIT LTR #25572). The design of the CommunityWall

and of the Active NewsCards originated from the Domus Academy Research Centre, XRCE, and the University of Milan, in conjunction with the project consortium.

References

[1] A. Agostini, G. De Michelis, M. Susani. A methodology for the design of innovative user oriented systems. In *i³ Magazine*, 2, March 1998.

[2] A. Agostini, V. Giannella, A. Grasso, and R. Tinini. Memories and Local Communities: An Experience in Venice. In *Proc. Designing Collective Memories, 7th Le Travail Humain Workshop*, Paris, Sept. 1998.

[3] S. Benford, D. Snowdon, C. Brown, G. Reynard, and R. Ingram. Visualising and Populating the Web: Collaborative virtual environments for browsing, searching and inhabiting Webspace. *Computer Networks and ISDN Systems* 29, pages 1751-1761, 1997.

[4] P. van de Besselaar, I. Melis, D. Beckers. Digital cities: design, organization, and use. Lecture Notes in Computer Science (in this volume), Springer-Verlag, 2000.

[5] A. de Bruine. Digital City Bristol: A Case Study. Lecture Notes in Computer Science (in this volume), Springer-Verlag, 2000.

[6] G. Casapulla, F. De Cindio, and O. Gentile. The Milan Civic Network Experience and its Roots in the Town. In *Proc. 2nd International Workshop on Community Networking*, IEEE Comm. Soc., ACM SIGCOMM, Princeton (NJ), 1995.

[7] E. Churchill, and D. Snowdon. Collaborative Virtual Environments: an introductory review of issues and systems. *Virtual Reality: Research, Development and Application*, Springer-Verlag, 1998.

[8] P. Curtis, and D.A. Nichols. MUDs grow up: Social virtual reality in the real world. In *Proc. IEEE Computer Conference*, IEEE Press, 1994.

[9] N. Glance, D. Arregui, M. Dardenne. Knowledge Pump: Supporting the Flow and Use of Knowledge in Networked Organizations. In U. Borghoff, R. Pareschi (eds), *Information Technology for Knowledge Management*, Springer Verlag, Berlin, 1998.

[10] N. Glance, D. Arregui, M. Dardenne. Making Recommender Systems Work for Organizations. In *Proceedings of PAAM'99*, 1999.

[11] A. Grasso, A., M. Koch, and D. Snowdon. Campiello – New user interface approaches for community networks. In *Proceedings of Workshop on Designing Across Borders: The Community Design of Community Networks*, Seattle, WA, Nov. 1998.

[12] Grasso, A., M. Koch, and A. Rancati. Augmenting Recommender Systems by Embedding Interfaces into Practices. To appear in *Proc. GROUP '99*, Phoenix, Arizona, ACM Press, 1999.

[13] W. Johnson, W., S.K. Card, S.K., H. Jellinek, H., L. Klotz, and R. Rao. Bridging the paper and electronic worlds: The paper user interface. In *Proc. INTERCHI*, ACM Press, 1993.

[14] P. Resnick, N. Iacovou, M. Suchak, P. Bergstrom, and J. Riedl. GroupLens: An Open Architecture for Collaborative Filtering of Netnews. In *Proc. of CSCW'94*, October 22-26, Chapel Hill, NC, ACM Press, 1994.

[15] D. Schuler. Community Networks: Building a New Participatory Medium. *Communications of the ACM*, **37**(1), 1994.

[16] A. Sellen, and R. Harper. Paper as an Analytic Resource for the Design of New Technologies. In *Proc. CHI'97*, Atlanta, GA, 1997.

[17] U. Shardanand, P. Maes. Social information filtering: Algorithms for automating word of mouth". In *Proc. CHI'95*, Denver CO, May 1995, ACM Press, pp. 210-217, 1995.

[18] Xerox (1998): Information on PaperWare and multifunctional devices from http://www.xerox.com/paperware/