

Supporting Wards with Interactive Resources and Logic-based Systems

Federico Cabitza, Marco Loregian and Marcello Sarini

Università degli Studi di Milano Bicocca,
via Bicocca degli Arcimboldi 8,
20126 Milano (Italy),
{cabitza,loregian,sarini}@disco.unimib.it

Abstract. In this position paper we outline the visions of the SWIRLS project, focusing on the aspects more closely related to ubiquitous computing. In order to support practitioners in coordinating care-giving in hospital wards without disrupting the practices they have established within their work, we present a solution that augments the natural interaction with pre-printed paper-based forms through context-adaptivity of situated whiteboards. Information flows coming from these heterogeneous artifacts are elaborated by a rule-based layer in order to provide practitioners with awareness information on the status of work.

1 Visions in Ubiquitous Hospital Ward Support

Our research is based on literature regarding observations of real practices that workers have established in order to deal with the complexity of coordination [1] [2] [3] [4] [5].

The majority of these practices involve at various degrees the use of artifacts that for historical reasons and for convenience of means are paper-based. Information Technology has till now tried to provide support to these practices by substituting the paper artifacts with digital counterparts. These endeavors seem to underestimate the pivotal role and often implicit value of paper affordances. On the contrary, we consider a benefit not to change the way users interact with traditional artifacts. This opinion relies also on studies that reveal how critical is the hospital domain about the introduction of technologies that could disrupt work practices consolidated in years: people tend to react either not using the digital counterparts or limiting their use so that their actual utility can be questioned [6] [7]. We are focusing on technologies that enable the design of systems that can involve traditional artifacts almost unchanged but augmented by computation. In fact we also think that digital enhancement is a feasible way to support coordination, either by improving performances of tools that deal directly with it or by enabling reliable communication among actors. In particular, in domains characterized by mobility and spread of involved actors, like hospital healthcare is, computation can provide artifacts with context-adaptivity and can also make information spanning across heterogeneous and distributed

actors possible. Computation can thus enable a support that can fast align to actors needs and follow them to be ready-at-hand wherever and whenever they need it: in other words computation can enable ubiquitous support. From the Weiser seminal definition [8], we stress the vision of an ubiquitous computing where the information is depending on context, available throughout the physical environment and where computation on this information is effectively invisible to the user. Ubiquity can be achieved not necessarily by scattering digital devices in the environment but rather by strengthening relationships among the heterogeneous artifacts spread in the work-setting and by linking and correlating the various information they objectify. Ubiquity can then be seen as an emerging property of the overall system regarding high level functionalities. Therefore we conceive a system that is ubiquitous in the sense that it facilitates the sharing throughout the work-setting of information regarding work status and planned activities and makes computation invisible. Such a system thus aims at facilitating an information flow that promotes awareness about the status of work in a coherent way. Involved artifacts can also be seen as a “web of artifacts” [9]; by which we mean to stress that any node of this net may influence all other nodes at some extent while carrying within itself the twofold and primary goal it has been designed for: accumulating inscriptions and coordinating activities [10].

This paper presents an application of ubiquitous computing aiming to support practitioners in caregiving process within hospital wards. Our web of artifacts encompasses some of the most common resources practitioners use in their ward practices: pre-printed paper forms where data are annotated by actors during their everyday work, and wall-mounted whiteboards where information about planned activities and status of the work is displayed and hence shared by all practitioners. The formers represent a highly flexible, convenient and mobile support to assigning and reporting activities; the latter ones provide actors with a highly interactive and timely support. This application will be illustrated in the following by describing the current work concerning the SWIRLS (Supporting Wards with Interactive Resources and Logic-Based Systems) project.

2 Current Work

In designing the SWIRLS architecture we have conceived artifacts as terminal nodes of a net whose information can influence all other nodes at some extent. In other words the paper forms and the whiteboards are not to be seen as separated artifacts; to express this strong but somehow implicit correlation we conceive them as quite tightly connected by sharing the same logical core. Each SWIRLS artifact then may be seen as the combination of a interactional side (with its physical affordances and features) and a computational “back-end” where some kind of logical processing — inference on facts — is accomplished. The former side — what we called Interaction Layer — is spread in the environment: whiteboards are placed where coordination needs are stronger and paper-forms are lightweight and mobile supports that follow the practitioners in their rounds. The latter side — the Logic Layer — is where the information coming from the

physical interfaces is elaborated according to the context of work. In the following we shall outline both the Interactional Layer, constituted by paper-forms and whiteboards and the Logical Layer that aims to provide these artifacts with such computation power.

Paper based interactions - Several technologies (e.g. Anoto, DataGlyphs) are already available for enhancing regular paper and some projects [13] [14] [15] have already explored some of their possibilities. We have designed two kinds of paper-forms that include the Anoto features: schedule-forms and data-entry forms. These artifacts embody three main functionalities: 1) supporting work as convenient handheld reminders since they are functionally equivalent to to-do-lists and work-schedules; 2) providing the “data-entry” layer of our system, in a twofold sense: on the one hand they allow feeding into the Hospital Information System (HIS) of data that relate to caring and patients without ambiguity and through well-structured forms; on the other hand they also provide the system with a quite precise account of the status of the work as box-checking follows quite tightly the tasks completion; 3) providing the lightweight, distributed and mobile interfaces to some commands and functionalities of the artifact as a whole. Commands are available simply by checking proper boxes and printed widgets. In other words these forms represent a paper-printed distributed and mobile GUI to some system functionalities.

Whiteboard based interactions - In generic office settings it has been observed [16] that people tend to use whiteboards as informal information gathering points, in contrast to their desktop workstations where they tend to organize their activities. Whiteboard surface is generally divided into smaller areas (regions) on which different activities, different kinds of interaction and different behaviors take place. Regular whiteboards used in hospital ward context, as described in [17] [9], are conceived for “storing status and scheduling information, communicating tasks, updates, notes about work” and to support face-to-face discussions. To support whiteboard based interactions we adopt touch sensitive smartboards by Smart Technologies. As a starting point we pinpointed some common activities taking place in front of the whiteboard and envisioned how to map them into regions: 1) a Beds Table symbolically represent bed placement with additional patient information; 2) a Ward Map is introduced for supporting actor localization: it is not only a mere representation of the physical environment but also a sort of graphical representation of the semantic relationships between activities and space; 3) a Faculty Region where each practitioner is represented by a virtual magnet whose absolute position is meaningful for representing the status of the corresponding actor (e.g. off-duty and on-duty) and its relative position indicates relationships in team composition and tasks assignment; 4) a Bulletin Board supports asynchronous communication. Besides, mechanisms to detect proximity to the whiteboard (e.g. Bluetooth, RFID)[19] may be employed for supporting face-to-face conversations and for information filtering according to the different identities and roles of actors currently standing in front of it.

Logic-based Support - The computational back-end of our web of artifacts is designed as a Rule-Based System. Objects in the field of work (patients, nurses, patient records, forms, whiteboard elements, etc. . .) and events due to practitioners' interaction with the artifacts correspond to proper facts in a Facts Base. An Inferential Engine matches these facts against rules that represent protocols or conventions shared within ward practice as well as apt mechanisms by which the system aligns timely with a more physical ward context (e.g. time, proximity, localization). For instance an action performed on a whiteboard magnet, if this is intended to change some characteristic of the referenced entity, will affect the magnet affordance due to some inference carried out on the corresponding facts. The RBS is implemented in Jess which provides an inferential engine integrated with Java [20]. The "rule based approach" is mainly motivated for its ability to easily extend the policies governing the system behavior in terms of new rules added to the knowledge bases as the use of the application evolves. This helps designers follow an user-centered and "evolutionary design" [21] approach that could capture and hence favor the adoption of new working practices based on SWIRLS augmented artifacts.

3 Issues for Discussion

We currently are in an early stage of our project: we designed our architecture and are about to undertake more thorough field studies about ward practices. To our knowledge, the innovativeness of our system is based on its ability to elaborate coherently information coming from different places and at different time in order to promote among actors awareness about the overall status of work accordingly with their current needs. We have taken the position that ubiquity is rather a property emerging from the system as a whole, relaxing the requirement of computational power spread throughout the environment: is it then an acceptable trade-off to exchange computational power in any single device in return for a more natural interaction with traditional artifacts? We should also consider how to manage coherently information according to the artifact affording it. Bearing in mind EPR tradition, at which extent is our proposal a step towards a full coexistence of paper-based patient records with digital support to caring activities? Questions are open for discussion.

About the Authors

Federico Cabitza is a PhD student in Computer Science at the University of Milano-Bicocca. His research concerns the development of Information Systems and CSCW systems with a specific interest on Health Care and Hospital Ward contexts.

Marco Loregian is a Computer Science PhD student at the University of Milano Bicocca. His research focuses on CSCW, UbiCom and HCI.

Marcello Sarini, PhD, is a researcher at the University of Milano-Bicocca. His main research areas concern the development of CSCW systems with a specific interest on semantic interoperability, multi-agent systems and context-aware computing.

References

1. Luff, P., Heath, C., Greatbatch, D.: Tasks-in-interaction: Paper and screen based documentation in collaborative activity. In: Proceedings of ACM CSCW'92 Conference on Computer-Supported Cooperative Work. Conversational Props (1992) 163–170
2. Symon, G., Long, K., Ellis, J.: The coordination of work activities: cooperation and conflict in a hospital context. *Comput. Supported Coop. Work* **5** (1996) 1–31
3. Heath, C., Luff, P.: Documents and professional practice: 'bad' organizational reasons for 'good' clinical records. In: Proceedings of ACM CSCW'96 Conference on Computer-Supported Cooperative Work. *Work & Records* (1996) 354–363
4. Pratt, A., Reddy, M.C., Dourish, P.: Coordinating heterogeneous work: Information and representation in medical care. (2001)
5. Reddy, M., Dourish, P.: A finger on the pulse: Temporal rhythms and information seeking in medical work. (2002)
6. Fitzpatrick, G.: Understanding the paper health record in practice: Implications for ehrs. In: Health Informatics Conference (HIC2000), Adelaide (2000)
7. Bardram, J.E.: I love the system - i just don't use it. In: Conf. on Group Work (GROUP'97), New York, ACM Press (1997) 251–260
8. Weiser, M.: Some Computer Science issues in ubiquitous computing. *Communications of the ACM* **36** (1993) 74–84
9. Bardram, J.E., Bossen, C.: Moving to get ahead: Local mobility and collaborative work. In: Ninth European Conference on Computer Supported Cooperative Work ECSCW'03, Helsinki, FI, ACM Press (2003)
10. Berg, M.: Accumulating and coordinating: Occasions for information technologies in medical work. *Computer Supported Cooperative Work* **8** (1999) 373–401
11. Anoto. (<http://www.anoto.com/>)
12. DataGlyphs. (<http://www.parc.com/research/asd/projects/dataglyphs/>)
13. Grasso, A., Karsenty, A., Susani, M.: Augmenting paper to enhance community information sharing. In: Proceedings of DARE 2000 on Designing augmented reality environments, ACM Press (2000) 51–62
14. Bang, M., Larsson, A., Eriksson, H.: NOSTOS: A paper-based ubiquitous computing healthcare environment to support data capture and collaboration. In: 2003 AMIA Annual Symposium, Washington DC (2003) 46–50
15. Paper++. (<http://www.paperplusplus.net/>)
16. Mynatt, E.D., Edwards, W.K., LaMarca, A., Igarashi, T.: Flatland: New dimensions in office whiteboards. In: Proceedings of ACM CHI 99 Conference on Human Factors in Computing Systems. Volume 1 of Profiles, Notes, and Surfaces. (1999) 346–353
17. Xiao, Y., Lasome, C., Moss, J., Mackenzie, C.F., Faraj, S.: Cognitive properties of a whiteboard: A case study in a trauma centre. In Prinz, W., Jarke, M., Rogers, Y., eds.: Seventh European Conference on Computer-Supported Cooperative Work (ECSCW01), Bonn (2001) 259–278
18. SmartTechnologies. (<http://www.smarttech.com/>)
19. Bardram, J.E., Kjaer, R.E., Pedersen, M.: Context-aware user authentication - supporting proximity-based login in pervasive computing. In Dey, A., McCarthy, J., Schmidt, A., eds.: Ubicomp 2003. Volume 2864., Seattle, WA, Springer Verlag (2003) 107–123
20. Friedman-Hill, E.J.: (Jess, the rule engine for the java platform)
21. Fayard, A., Mackay, W.E.: Designing interactive paper: Lessons from three augmented reality projects. (2000)