Towards Cooperative Surface Media Spaces

Tom Gross
Human-Computer Interaction Group
University of Bamberg
96045 Bamberg
tom.gross(at)uni-bamberg.de

Abstract
In this paper we introduce work-in-progress on the concept and implementation of a cooperative media space that connects two remote labs via a permanent audio-video channel and supports group-to-group interaction on synchronised large displays.

Author Keywords
Computer-Supported Cooperative Work; Media Space; Interactive Tabletops and Surfaces.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces — Graphical User Interfaces, User-Centred Design; H.5.3 [Information Interfaces and Presentation]: Group and Organisation Interfaces — Computer-Supported Cooperative Work.

Introduction
We have been developing the Cooperative Media Space CMS that aims to provide a flexible environment supporting easy communication and cooperation within collocated groups, and among distributed groups. It combines concepts for easy interaction among remote users based on permanent audio or video connections, and for easy interaction among collocated users based on shared hardware and software.

The CMS so far leverages on and combines technology and experience from computer-supported cooperative work and computer-mediated communication and human-computer interaction.

In Computer-Supported Cooperative Work (CSCW) and Computer-Mediated Communication (CMC) several concepts and systems for remote interaction have been developed within the last decades. For instance, *Media Spaces* are systems that 'support distributed work groups through access to information that supports general awareness', which 'may lead to informal interactions, spontaneous connections…' [2]. Some classical examples of media spaces are Portholes [2] and RAVE [3]. Since 2009 Media Spaces are witnessing a revival [9], and broaden the scope to include full imerson [e.g., 12] or mobile users [e.g., 10].

In Human-Computer Interaction (HCI) several styles of single-user and cooperative interaction have been developed based on widespread interactive surfaces and devices 'ranging from large-scale walls, touch surfaces to wearable computing devices' [1]. An early predecessor was i–LAND that consisted of several *Roomware* components that were 'computer-augmented objects integrating room elements with information technology' [18]. Two prominent components were the DynaWall: a very large display that can be shared among users and that features some novel interaction styles, and the InteracTable: a tabletop that can be used cooperatively. Overall, the Interactive Tabletop and Surfaces community has witnessed great progress of concepts and base technology, where unprecedented environments can now be realised [e.g., the very large space interactive engagement space by 15].

In this position paper we first report on the current state of the Cooperative Media Space CMS, and then discuss design dimensions. We conclude with a discussion on an outlook towards surface interaction.

The Cooperative Media Space CMS

The CMS aims to meet requirements for general awareness and informal communication from traditional media spaces and additional requirements for enhanced cooperation support. First, it should provide general awareness among distributed groups in order to support informal and spontaneous interaction. Secondly, it should also provide easy and intuitive single-user and cooperative interaction based on large displays. Thirdly, it should support distributed cooperation among distant sub-groups based on large displays.

Together with a group of designers with backgrounds in media systems, media design and in architecture we envisioned concept for the CMS. The point of departure was to virtually connect the two rooms of our lab in two different buildings. The concept should allow for seamless awareness, communication, and cooperative group interaction among the users of each room and also between the users of the two rooms. Figure 1 shows a first sketch of this basic idea.

The design of the CMS supports three core concepts: *(1) Pervasive Presence and Communication*: to facilitate chance encounters and ad-hoc conversations over distance the CMS can identify users who enter either location of the CMS and notifies users on the other side. *(2) Smart Roomstates*: to provide upfront information on the current use of the CMS we provide users in front of either room with a an roomstate display. For this purpose various sensors capture data from the computers (e.g., running applications and open documents) and the real world (e.g., noise and movement) and make a heuristic inference of the roomstate. For instance, if the sensors detect that on one computer presentation software is running in presentation mode and that there is movement and noise in the area of this computer, then we assume that a presentation is going on. *(3) Seamless Group Interaction*: to facilitate cooperation across all computers and displays of either room, we introduced a concept of a continuous surface. When users move their cursors out of a surface their cursor is teleported to the neighbour surface.

For (1) we use our own PRIMI instant messaging platform [7], and for (2) we use our own SensBution platform [8]. SensBution has a suite of sensors on computers (e.g., Mac OS X sensors in AppleScript and UNIX shell scripts) and in the real world (e.g., the ESB sensor board to capture temperature, movement, vibration, light, sound). They were extended by the CoLocScribe [5]. For (3) we use the Multi-Cursor Window Manager (MCWM) from Wallace et al. [19]. MCWM is an X window manager for the UNIX operating system, which can easily be installed on Mac OS X via the X11 environment that is part of the Mac OS X operating system.

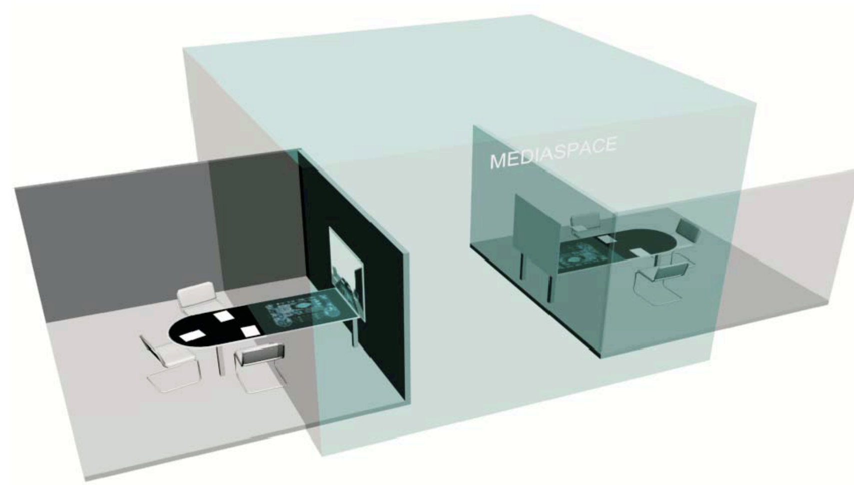

Figure 1. First sketch of the basic idea of the CMS.

Back to the Roots—Social, Spatial, Temporal, and Task Design Dimensions

The CMS aims to facilitate spontaneous interaction among co-present users. Like classical media spaces it reduces the friction between users at remote locations. It supports various usage scenarios of the rooms and the transitions between them. It connects computers, displays, and surfaces for easy and fast cooperative interactions. In order to provide adequate combinations of functionality four basic design dimensions are identified: the social setting; the spatial setting; the temporal setting; and task setting (cf. Table 1):

- The *social setting dimension* addresses the number of users involved—ranging from individual users to dyads of two users, to groups of typically up to 15 users to individuals or sub-groups within groups of users when different team are working in parallel within the CMS. Larger communities of above 15 users are very rare.
- The *spatial setting dimension* can either refer to the absolute geographical position of the users or to the relative co-presence of users [11]. The absolute position can be a static place or a location of a mobile user. The co-presence refers to the distance between users: they are either co-located at the same location, or remote at different locations. Rodden and Blair [16] have early on identified two additional hybrid forms of co-location, where virtually co-located means that users are at different places and connected through low-fidelity information and communication technology, and locally remote means that users have some high-bandwidth conferencing systems.
- The *temporal setting dimension* relates to the use of the CMS. The interactions of users is either asynchronous where the users use the CMS at different times, or synchronous where they use it at the same time. Furthermore, systems can be of a mixed nature—according to Rodden and Blair [16, p.

<table>
<tr><td>Social settings: size
(cf. [13, 14])</td><td>Individuals</td><td colspan="2">Dyads</td><td>Groups</td><td>Sub-Groups</td><td>Communities</td></tr>
<tr><td>Spatial settings: absolute
(cf. [11])</td><td colspan="3">Static</td><td colspan="3">Mobile</td></tr>
<tr><td>Spatial settings: relative:
(cf. [11, 16])</td><td>Co-located</td><td colspan="2">Remote</td><td>Virtually co-located</td><td colspan="2">Locally remote</td></tr>
<tr><td>Temporal settings: spectators
(cf. [16])</td><td colspan="2">Asynchronous</td><td colspan="2">Synchronous</td><td colspan="2">Mixed</td></tr>
<tr><td>Task settings: complexity
[4, 17]</td><td colspan="2">Low</td><td colspan="2">Medium</td><td colspan="2">High</td></tr>
<tr><td>Task settings: coordination
[4, 17]</td><td colspan="2">Easy articulation work</td><td colspan="2">Some coordinative protocol</td><td colspan="2">Specialised artefacts for articulation</td></tr>
</table>

Table 1. Design dimensions. Source: adapted and extended from: [6, p. 164].

51] mixed cooperative systems ‘contain elements of support for both synchronous and asynchronous cooperation’.

- The *task setting dimension* refers to the complexity of the tasks of the users at hand as well as the coordination mechanism that is required respectively. If users perform a solitary activity in a shared space, they need to coordinate the use of the ressources with each other. Here the complexity is typically low. However, when users cooperate with each other, they need to exchange with their cooperation partners. Schmidt writes [17, p. 10]: ‘We also distinguish the work itself, the work of moving the table set, from the secondary interactions required to coordinate and integrate the contributions of multiple individuals, for which I have adopted the term … articulation work’. And later in his book he continues [17, pp. 97, 100]: ‘With low degrees of complexity, the articulation of cooperative work can be achieved by means of the modes of interaction of everyday social life. … In cooperative work settings characterised by complex task interdependencies, the articulation of the distributed activities requires specialised artefacts…’. Research into mutual awareness of actors has tried to reduce this coordination effort [4].

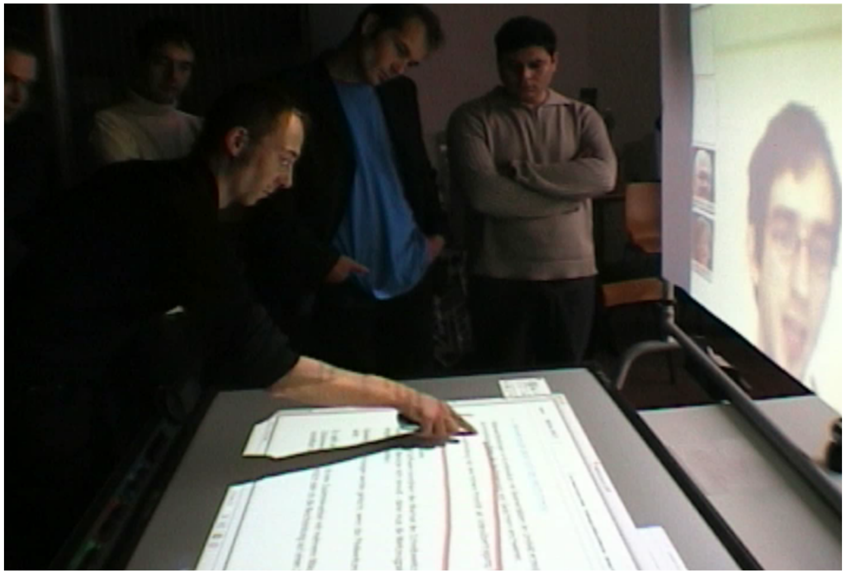

Figure 2. Early CMS prototype with vertical audio-video link and horizontal SmartBoard on a table.

Conclusions and Future Work

In this position paper we have reported on the Cooperative Media Space CMS. We have presented its concept and implementation providing support for pervasive presence and communication, for smart room states, and for seamless group interaction.

So far, CMS is mainly based on traditional hardware and software. User interaction is currently done via keyboard and mouse. Figure 2 shows an early version of the CMS where we combined an audio-video link on the wall with a SmartBoard that we fixed horizontally on a table. This mockup only allows single-user single-touch. Yet, it allows us to explore specific affordances of horizontal and vertical surfaces.

In the Workshop on Collaboration Meets Interactive Surfaces: Walls, Tabletops, Mobiles, and Wearables - CMIS 2015 - at the ACM International Conference on Interactive Tabletops and Surfaces - ITS 2015 I would love to discuss ideas and concepts for future work to integrate novel interactive tabletops and surfaces.

Acknowledgements

I would like to thank the members of the Cooperative Media Lab—especially Tareg Egla, Mirko Fetter, and Christoph Oemig—for inspiring discussions on the concepts and implementation of the cooperative surface media space.

References

1. Anslow, C., Campos, P., Grisoni, L. and Lucero, A. Workshop on Collaboration Meets Interactive Surfaces: Walls, Tabletops, Mobiles, and Wearables - CMIS 2015 - at the ACM International Conference on Interactive Tabletops and Surfaces - ITS 2015. https://sites.google.com/site/collaborationsurfaces/home, 2015. (Accessed 29/9/2015).
2. Dourish, P. and Bly, S. Portholes: Supporting Awareness in a Distributed Work Group. In Proceedings of the Conference on Human Factors in Computing Systems - CHI'92 (May 3-7, Monterey, CA). ACM, N.Y., 1992. pp. 541-547.
3. Gaver, W.W., Moran, T., MacLean, A., Lövstrand, L., Dourish, P., Carter, K.A. and Buxton, W. Realising a Video Environment: EUROPARC's RAVE System. In Proceedings of the Conference on Human Factors in Computing Systems - CHI'92 (May 3-7, Monterey, CA). ACM, N.Y., 1992. pp. 27-35.
4. Gross, T. Supporting Effortless Coordination: 25 Years of Awareness Research. Computer Supported Cooperative Work: The Journal of Collaborative Computing 22, 4-6 (Aug.-Dec. 2013). pp. 425-474.
5. Gross, T. and Beckmann, C. Advanced Publish and Subscribe for Distributed Sensor-Based Infrastructures: The CoLocScribe Cooperative Media Space. In Proceedings of the Seventeenth Euromicro Conference on Parallel, Distributed, and Network-Based Processing - PDP 2009 (Feb. 18-20, Weimar, Germany). IEEE Computer Society Press, Los Alamitos, 2009. pp. 333-340.
6. Gross, T., Fetter, M. and Paul-Stueve, T. Towards Advanced Social TV in a Cooperative Media Space. International Journal of Human-Computer Interaction (IJHCI) 24, 2 (Feb. 2008). pp. 155-173.
7. Gross, T. and Oemig, C. PRIMI: An Open Platform for the Rapid and Easy Development of Instant Messaging Infrastructures. In Proceedings of the 31st EUROMICRO Conference on Software Engineering and Advanced Applications - SEAA 2005 (Aug. 30-Sept. 3, Oporto, Portugal). IEEE

Computer Society Press, Los Alamitos, 2005. pp. 460-467.

8. Gross, T., Paul-Stueve, T. and Palakarska, T. SensBution: A Rule-Based Peer-to-Peer Approach for Sensor-Based Infrastructures. In Proceedings of the 33rd EUROMICRO Conference on Software Engineering and Advanced Applications - SEAA 2007 (Aug. 27-31, Luebeck, Germany). IEEE Computer Society Press, Los Alamitos, 2007. pp. 333-340.

9. Harrison, S., ed. Media Space 20+ Years of Mediated Life. Springer-Verlag, Heidelberg, 2009.

10. Jones, B., Witcraft, A., Bateman, S., Neustaedter, C. and Tang, A. Mechanisms of Camera Work in Mobile Video Collaboration. In Proceedings of the Conference on Human Factors in Computing Systems - CHI 2015 (Apr. 18-23, Seoul, Republic of Korea). ACM, N.Y., 2015. pp. 957-966.

11. Jones, Q., Grandhi, S.A., Terveen, L. and Whittaker, S. People-To-People-to-Geographical-Places: The P3 Framework for Location-Based Community Systems. Computer Supported Cooperative Work: The Journal of Collaborative Computing 13, 3-4 (Aug. 2004). pp. 249-282.

12. Luff, P.K., Yamashita, N., Kuzuoka, H. and Heath, C. Flexible Ecologies and Incongruent Locations. In Proceedings of the Conference on Human Factors in Computing Systems - CHI 2015 (Apr. 18-23, Seoul, Republic of Korea). ACM, N.Y., 2015. pp. 877-886.

13. Marca, D. and Bock, G., eds. Groupware: Software for Computer-Supported Cooperative Work. IEEE Computer Society Press, Los Alamitos, 1992.

14. Preece, J. Online Communities: Designing Usability, Supporting Sociability. Wiley, N.Y., 2000.

15. Rittenbruch, M., Sorensen, C., Donovan, J., Polson, D., Docherty, M. and Jones, J. The Cube: A Very Large-Scale Interactive Engagement Space. In Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces - ITS 2013 (Oct. 6-9, St. Andrews, UK). ACM, N.Y., 2013. pp. 1-10.

16. Rodden, T. and Blair, G. CSCW and Distributed Systems: The Problem of Control. In Proceedings of the Second European Conference on Computer-Supported Cooperative Work - ECSCW'91 (Sept. 24-27, Amsterdam, NL). Kluwer Academic Publishers, Dordrecht, 1991. pp. 49-64.

17. Schmidt, K. Cooperative Work and Coordinative Practices - Contributions to the Conceptual Foundations of Computer-Supported Cooperative Work (CSCW). Springer-Verlag, Heidelberg, 2011.

18. Streitz, N., Geissler, J., Holmer, T., Konomi, S.i., Mueller-Tomfelde, C., Reischl, W., Rexroth, P., Seitz, P. and Steinmetz, R. i-LAND: An Interactive Landscape for Creativity and Innovation. In Proceedings of the Conference on Human Factors in Computing Systems - CHI'99 (May 15-20, Philadelphia, PE). ACM, N.Y., 1999. pp. 120-127.

19. Wallace, G., Bi, P., Li, K. and Anshus, O. A Multi-Cursor X Window Manager Supporting Control Room Collaboration. Department of Computer Science, Princeton University, ftp://ftp.cs.princeton.edu/techreports/2004/707.pdf, 2004. (Accessed 29/9/2015).