In: Proceedings of DIS´2002 (Designing Interactive Systems). June 2002, London. ACM. In press. Accepted as exhibit (Preprint version)

Multilevel Design and Role Play:
Experiences in Assessing Support for Neighborhood Participation in Design

Hal Eden
Center for LifeLong Learning & Design
University of Colorado at Boulder

Eva Hornecker
research centre artec
University of Bremen

Eric Scharff
Center for LifeLong Learning & Design
University of Colorado at Boulder

ABSTRACT
Designing and assessing systems to support neighborhood participation in design is difficult due to the challenges of involving real participants and the fragile nature of early instantiations of technologies aimed at supporting open-ended and ill-structured design tasks. We report on a scenario-based, semi-realistic field trial of two prototypes of the Envisionment and Discovery Collaboratory, an environment for supporting community involvement in design activities. By engaging subjects in playing participant roles, we have been able to gain some crucial insights into the facets of the design at multiple levels as part of an ongoing design process.

Keywords
Graspable Interfaces, Computer-Augmented Environments, Communities of Interest, Participatory Planning, Role Play, Evaluation Methods, Group Interaction, Interaction Design

INTRODUCTION
The Center for LifeLong Learning & Design (L^3D) has worked for several years in the area of community participation support, building upon the notion of "physical language of pieces" and game-like interaction [2]. The systems envisioned and developed, which couple physical game elements and computerized support, fall under the category of "graspable" [4,10] or "tangible" [5,17] user interfaces. A research visit provided an opportunity for the authors to cooperate on the assessment of two variants of the Envisionment and Discovery Collaboratory (EDC) [3], an example of such systems. The goal of the assessment was to improve the design of the EDC by studying group interaction with the systems in scenarios with real-world relevance.

SUPPORTING COMMUNITY DESIGN: THE EDC
Individuals using the EDC convene around a computationally enhanced table, such as those shown in Figures 1 and 2. This table serves as an *action space,* where constructive design activities take place. Building upon the experience of using physical, game-like methods in participatory neighborhood development, the system is inspired by the game board of physical design games [1], but augments the tactile aspects of physical game pieces with the dynamic capabilities of computational simulation [2]. Participants use the action space to create and manipulate the computational simulation projected onto the surface by interacting with physical objects on the table.

Underlying Technologies
This study focuses on two different implementations of the EDC. The first, which we will call the SB_{EDC}, uses a horizontally mounted, touch-sensitive SmartBoard™ electronic whiteboard, as shown in Figure 1. The other, which we will refer to as the PB_{EDC}, uses the Participate-in-the-Action Board (PitA-Board [6], see Figure 2).

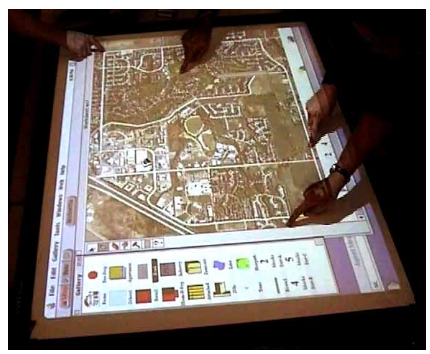

Figure 1: The SmartBoard version of the EDC

The SmartBoard provides an interface similar to a high-resolution mouse or touch screen along with multiple sketching pens and a fine-grained sketching mechanism. However, it does not support the truly parallel interaction needed for group interaction because it can only detect one touch point at a time. The modal interaction provided by the underlying simulation software, although typical of single-cursor systems, presents limitations for group interaction. The PitA-Board was developed as an alternative interface to overcome these limitations. Its underlying technology consists of a grid of 2-inch-square antennas that can sense the location and identity of 15 distinct transducer coils that can be imbedded in physical objects (see Figure 3). The PitA-Board uses a 16 x 8 antenna grid to track multiple transducers, allowing for multiple cursors and simultaneous

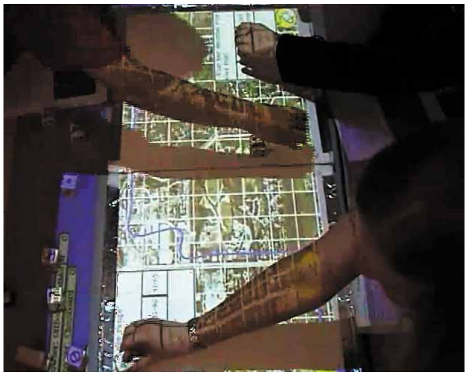

Figure 2: PitA-Board version of the EDC (showing parallel interaction with kiosk menus)

interactions. Because the PitA-Board is able to track the tokens themselves, it comes much closer to the concept of graspable interfaces [17] than does the SmartBoard.

A Context for Design and Challenges for Assessment

Bringing together stakeholders from different backgrounds to resolve issues in reaction to problems or based on shared interests often results in groups that are heterogeneous and temporary. The diversity of backgrounds means that participants need to learn about each other's points of view, resolve conflicts of interest and perspective, and find a way to work together. This is an example of what Fischer [9] terms *communities of interest* (CoIs). However, the specificity and concreteness of tasks, such as we have experienced in building systems for citizen participation in urban planning, often result in transitory groups, which we term *knots* [7] *of interest* (KoIs).

Although it is our desire to involve future users in our design process, a conflict exists when simultaneously studying real communities and developing evolving prototypes. Several issues obviate involving real participants: KoIs are virtually inseparable from the problem context they address. A KoI has its own (tight) timeline and a focus on short-term goals, not on helping the research process or on designing general support tools. Nevertheless, we have profited from the observation of previous design activities in participatory neighborhood development [2] and from cooperation with domain experts, whose interest in the problem is more general. The nature of research software development has an impact as well, making real field trials impractical. The technologies are not ready for real situations, because research prototypes generally "lag behind" in terms of capabilities, depth, usability, and stability. As a result, it is likely that systems deployed too soon would get in the way of *real*

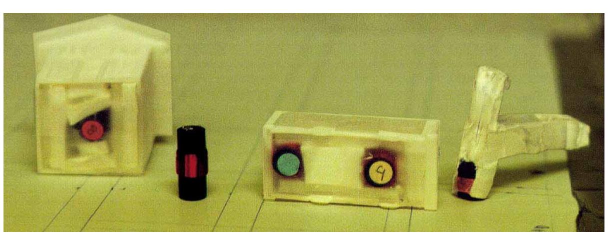

Figure 3: Using coils to identify objects on the PitA-Board

tasks, negating any benefit.

In designing a face-to-face group interface, multiple levels of interaction come into play, and therefore multiple (interacting) levels of design and assessment need to take place**.** Whereas standard usability testing concentrates on individual interaction and clearly defined tasks, in collaborative interaction there is a need to look at (1) social and organizational aspects at the interaction and task levels and (2) factors that span multiple levels of interaction.

DESIGN OF THE STUDY

To understand design issues raised by the two EDC versions, we developed an assessment study with the objectives of observing groups interacting with the systems while doing realistic activities, gathering concrete ideas for further development, and collecting user feedback. The study investigated how usefulness, usability [8], and group interaction related to issues spanning several levels: interface concept evaluation, interaction design (tangible/graspable interfaces, augmented environments), task design, and use of facilitation.

Several considerations led to our decision to engage subjects in role play as a means of assessment. We wanted to avoid the abstract, rational-problem-solving behavior that often occurs when subjects are given decontextualized tasks. To evaluate the prototypes in settings that bring out the ill-structured, multilevel, and conflict-filled nature of real problems along with the emotions, context, and perspectives that real participants would bring to the table, we wanted to approximate real situations and allow participants to behave *as if* the problems were real and relevant. Also, given that usability in a group interaction context is likely to differ from single-user usability, we wanted to begin by understanding aspects critical to group interaction. Role play based on concrete scenarios provided a promising approach to meet these concerns.

Scenario and Process Design

We decided upon a subset of an existing scenario on transportation planning and fleshed it out with details and additional system functionality. The scenario is that transportation planners have decided to redesign an under-used bus route through a local neighborhood to better serve the needs of residents and to encourage bus ridership. The bus route may be expanded or re-routed by using an extra five minutes of time available in the bus schedule.

Participants were given role cards with descriptions of their personae. The roles were chosen to span diverse population groups with different needs, including, as examples, a college student, a working mother, and a senior-aged couple. The session was patterned into different phases to provide a degree of structure to the process and to overcome limits of some of the technology. These phases were:

1. Familiarization: give participants an opportunity to experiment, interact, and become familiar with the task, the map, and the technology.
2. Introductions: solicit information from players by having them fill out surveys about their persona while introducing themselves to each other and placing their houses on the map.

3 Discussion: initiate open-ended discussion of issues and perspectives of the participants to lessen effects of facilitation interventions and give group process a chance to evolve.

4 Develop preferences: explore walking-distance preferences (between home and the bus stop) under good conditions using simulation features..

5 Expand preferences: explore walking-distance preferences under poor conditions

6 Planning: plan the final bus route and place a maximum of eight bus stops. Discuss and summarize results.

Exact details of interaction with the system were different across systems, in part due to different capabilities of hardware and software and in part due to deliberate design experimentation. The only graspable objects or tokens used during the SB_{EDC} session were foam-core squares used to represent the subjects' houses and paper squares used to choose walking distance. The PB_{EDC} session used wooden block tokens for the houses, bus-route drawing, bus-route deletion, bus-stop drawing, bus creation, and bus deletion.

Subject Selection, Videotaping, and Analysis

We recruited one set of subjects for each system, seeking people who were not well versed in the computing, public-transportation, or urban-planning domains to play roles within the scenario. The first experiment drew from an older audience (four Ph.D. or postdoctoral students ranging from early 20s to late 30s, plus a mother of teens in her late 40s), and the second included three undergraduates and a 50-year-old single mother. Thus each group included one participant from outside the academic community.

We held two design sessions staged as neighborhood meetings, with the research team acting as technical and process facilitators. The role play, along with a follow-up discussion by the participants regarding their ideas and impressions, was videotaped for subsequent analysis with the consent of the subjects. A single camera was mounted high on a table next to the systems, approximating a bird's-eye view. Due to differences in light levels, only the immediate surroundings of the action space could be recorded. We expected this to be the focus of the groups' interactions, however, so it did not present a problem. Previous single-camera studies under similar conditions (e.g., [11]) showed analysis of task-focused interaction to be feasible and useful. Both videos were viewed several times by all authors together. Part of future work will be to transcribe segments for additional study.

OBSERVATIONS, ASSESSMENT, AND PRESCRIPTIONS FOR DESIGN OF THE EDC

The assessment sessions provided us with a wealth of observations. These inspired us with many ideas for improvement, which have in part already been realized. Results confirmed our decision to search for alternative basic technology, but also reminded us that the details make the difference.

Following an interaction analysis approach [13], our observations were not narrowly focused on predetermined categories, but were more exploratory and open to themes that emerged as we repeatedly reviewed the videos. The result was a variety of aspects that span multiple levels of design, including the underlying technology, interaction, simulation, and our facilitation approach.

Sketching

Review of the videos showed that an important facility of the SB_{EDC} was the sketching feature, which gave participants an opportunity to interact with the map while exploring and visualizing ideas. It was used heavily during phase 3 (open-ended discussion) and phase 6 (bus-stop placement). This resonates with other research (e.g., [11,16]) which indicates that sketching and manipulating objects aid in expressing ideas and augmenting talk.

Even though sketching stopped the application, and sketches subsequently disappeared, this was not experienced as a major disruption. In fact, redoing sketches helped participants build a shared mental image, as evidenced by the fluency of interaction and cooperative drawing. Redrawing usually involved discussion and evaluation. Only when the group was ready to move on did repeating a sketch disrupt the process. Participants mentioned that being able to save and recover sketches would have been advantageous.

There was no sketching capability available in the PB_{EDC}. The group relied on the map, verbal discussions, and gestures, and even shied away from using the bus-drawing tool for sketching preliminary ideas. The resulting weakly shared mental image was evidenced in the drawing of the final bus route in phase 6. Although the group took turns, there were long hesitations before the next person took over in drawing. Often participants asked others for approval first ("You want it to go this way?").

Visual Representation

The map focused discussion by providing a shared artifact, highlighting salient features, drawing people out of their individual perspectives, and surfacing misunderstandings. Streets acceptable for bus driving had been highlighted, and the groups took only these routes into consideration. The white grid imposed onto the map on the PB_{EDC} (intended to show the underlying sensor grid) was difficult to differentiate from the roads, and a different color for the grid would have been more appropriate.

Size of Interface

The size of the SmartBoard made it difficult for one person to reach everywhere on the board, which meant that cooperation was needed to complete most tasks: Pens and tokens were often handed over to other participants who could easily reach that part of the board (see Figure 4). In the subsequent discussion, participants named size as an advantage for encouraging collaboration. The pattern of turn-taking during demonstration and implementation of design ideas is quite

Figure 4: Handing over pen

consistent; each participant seemed to be responsible for a region of the map. This did not appear to be a form of territoriality—when the discussion progressed to new issues, previous area responsibilities were abandoned and participants made full use of the board.

When analyzing the PB_{EDC} session, we noticed that the group sat down immediately, which could have contributed to their being less active. With the smaller working area of the PitA-Board, everything was within easy reach and could be seen easily without standing. In addition, the projection extended a bit over the edges of the PitA-Board onto the table, which seemed to create a sort of "barrier effect." In contrast, with the larger SB_{EDC} work space, people *needed* to stand to get a view from above and to reach farther. In addition, the SmartBoard was *inside* people's personal space throughout the session. The SmartBoard covered the whole table, whereas the Pita-Board had a large space around it where people laid down role sheets and unused pieces, and even put their hands. Touching the PitA-Board thus was a more explicit action and participants rarely touched its edges. The use of space is a topic for more thorough analysis of the videos as well as future studies, including the creation of a larger version of the PB_{EDC}.

Usefulness of the Simulation and Proposed New Features

Participants reacted very positively to one simulation feature: the visualization of walking distances. The colored walking-distance circles centered on houses and the highlighted overlays between these circles were used in phases 4 and 5 to support discussions of bus-route and bus-stop placement. The participants made excited comments during role play when circles appeared, and pointed this out in the subsequent discussion ("that was a nice little feature, you see the hot spots"). In contrast, the simulation facilities (e.g., animation of a bus following the route) did not offer much support for the discussion. Numerous questions that were raised could have benefited from support in either of the systems studied: How much time does the new bus route take? How much time does each bus stop add? How often would the bus go by? Which roads allow which driving speeds? How populated are different areas? How far is this path exactly? These, along with other suggestions and observations, provided us with ideas for future improvements.

The SB_{EDC} group generated so many issues that some risked being quickly forgotten. Collecting these into an *issue space* would have been useful. An idea inspired by Arias's "physical language of pieces" (descriptive, evaluative, prescriptive) [1] would allow participants to put "issue tokens" on locations where the problem was relevant, while a facilitator or an appointed group member took notes. The issue tokens would be kept as visible reminders of issues discussed, and participants could write on them.

Physical Language of Pieces

Analyses of the videos as well as participants' comments indicated that physical pieces used in the SB_{EDC} were superfluous and often produced breakdowns. Because the touch screen does not detect objects simply placed on it, the tokens representing participants' houses had to be consciously pressed onto the board. Due to an interaction between the simulation software and the SmartBoard, pressing on pieces could sometimes result in several objects being created. SB_{EDC} participants indicated that the physical objects were not necessary, required additional operations, and contributed to errors. Their use diminished as the session progressed.

When asked explicitly about their impressions concerning the physical pieces, SB_{EDC} participants described what they would prefer: "Instead of having to put it down and then press on it—that does not make sense—I put it there, that should be enough." Instead of a palette for object types, they suggested different physical objects, and instead of changing mode, they would prefer to just move or remove objects and have that detected by the system. The group suggested providing more physical pieces because "without differentiation, they don't matter." These observations support the decision to search for an alternative technology that can detect physical tokens.

Indeed, the PB_{EDC} video shows almost no technical problems for interaction with the PitA-Board. Filling out surveys by placing the individual house token first on a menu icon and then onto the preferred item (see Figure 2) was done quickly and fluently. One participant with no computer experience interacted with increasing confidence and valued interaction as "intuitive and easy." The only problems seemed to be related to limited sensor sensitivity at the edges of grid squares

Although the PB_{EDC} offered several physical tokens, interaction took place only in distinct, short phases and did not feel relevant to the users. In the follow-up discussion, participants evaluated interaction with tokens as intuitive but not important. We can trace the lack of relevance for physical tokens to the limited opportunity provided for their use. For instance, participants liked filling out the survey with their houses, but afterwards, the house tokens were used only for the short sequence of choosing walking distance in a similar pattern. Physical tokens came into play again only when participants decided to draw the bus route, first using the bus-route-drawing token and then switching to the bus-stop token. Thus, in addition to their limited number, tokens were designed to be used briefly in a certain activity rather than having a lasting, continuous significance.

Such problems with representational significance [17] were observed elsewhere in the PB_{EDC} session. The physical house tokens were nearly identical to the virtual house icons, even though they were used both to specify where the neighbor lived as well as to answer survey questions. As representations of houses, the real objects offered little additional value beyond leaving a "stamp," whereas their use for filling out survey, although intended to increase interaction, created confusion as its meaning changed from an artifact to a personalized tool or pointer. Given that the house token was effectively used for saying "me," having a human figurine for this representation might have been more significant; using it to stamp a house icon onto the map where "I" live, as well as to specify other information about "me."

Most other tokens were used for tool-like interaction rather than as graspable manifestations of physical/virtual artifacts. The bus-route token, a block with a bus route painted on it, was used for drawing, which is not an intuitive representation. Along similar lines, a single bus-stop token was used as a “stamp” to place all of the bus stops.

Sugimoto and colleagues [15] use a technological basis similar to the PitA-Board for interacting with an educational simulation game. They use multiple tokens of the same type and multiple types of objects, allowing exploratory positioning while providing feedback and easy changes. This suggests alternative designs for the PB_{EDC} to improve “graspability” and to give tokens greater representational significance. For the bus route, a real toy bus on wheels could be used to drive around the route, drawing as it goes. For the bus stops, multiple bus-stop tokens could be placed and moved, allowing easier and more natural relocation of bus stops than in stamp mode.

Mode Errors

In the SB_{EDC} session, subjects and facilitators alike repeatedly experienced small, visible disruptions due to mode errors. In the beginning, facilitators helped in selecting and changing modes when participants placed houses and filled out the survey (this alone involved two mode changes!). Over time, participants close to the panel took on this task and scaffolded mode changes by saying the necessary actions out loud, thereby heightening awareness and prompting each other. Although this became more fluent as the session progressed, mode errors continued to occur.

Parallel Interaction and Awareness

The lack of support for parallel interaction in the SB_{EDC} session presented itself at the start of phase 1 when four people reached onto the surface and began to draw, creating chaotic roads (see Figure 1). It took several minutes for the group to manage coordinated drawing; nevertheless, the rest of the session was interspersed with accidental parallel attempts.

Analysis of other situations (e.g., [11]) shows that groups can be highly aware of parallel interaction, which matches our observation in the SB_{EDC} session that the need to avoid parallel actions led to the establishment of shared responsibility for mode changes, high attentiveness to the interaction, and some division of labor. Although participants indicated that drawing in parallel would have been useful, they were ambivalent about whether having a single set of controls for changing modes and selecting object types was good or bad. System characteristics (e.g. size, shared artifacts, distribution of resources) that compel people to help each other or to coordinate actions may contribute to the evolution of group awareness and a common identity.

A seemingly paradoxical observation is that the PB_{EDC}’s parallelism (see Figure 2), although targeted at enhancing group interaction, seemed to make some activities more individual. This is especially visible during survey answering in phase 2. Because there was no need to pay attention to each other, people did not do so, thus requiring a separate discussion to introduce their personae. Rather than being contradictory, this paradox demonstrates one way in which the multiple levels of design interact, requiring carefully matching low-level features (such as parallel interaction) to the goals of higher-level activities (such as socialization).

Influence of Hardware on Interaction

The need to center pieces on grid squares of the PitA-Board was sometimes more problematic than anticipated. Participants often resorted to moving tokens in small circles. We will ameliorate this problem in future versions. The grid also can only recognize one token at a time on a given square, which restricts possible interaction at times. This was one reason why the house icons were designed to stay in place when the house token was removed: At times it was necessary to lift a house to put another token on that square, such as for the query tool or kiosk menus.

Designing Facilitation

The video analysis made us realize the influence of our facilitation on process. We interfered in discussion to transition from one phase to the next and introduced some new features during later phases in an attempt to avoid overwhelming participants with functionality in the beginning.

Some differences in group behavior can be traced to unintentional role models presented when demonstrating use and giving instructions. Most participants imitated the behavior of the SB_{EDC} facilitator, saying their responses aloud while filling out the survey. The facilitator for the PB_{EDC} talked less and explicitly encouraged working in parallel, and the participants immediately did so, acting concurrently and silently. We also realized that there were variations in implementing the phases. For example, the PB_{EDC} facilitator encouraged the participants only to try out placing and moving house tokens. In contrast, more actions, such as drawing a bus route, were delegated to participants in the SB_{EDC} session.

Our lesson from this is that facilitation needs to be designed and practiced. We need to think in greater detail about how to introduce tools and opportunities to involve people early in the process. We could use ourselves or members of our research group to simulate the session, then reflect on it, collecting ideas about alternative actions. This would simultaneously improve the facilitation process, train behavior, and improve consistency among facilitators.

LIMITATIONS AND GENERAL OBSERVATIONS

As we discuss in greater detail in [12,14] the use of role play has limits (it still does not represent real participants in real activities) and the quality of role playing varies (placing oneself in another’s position isn’t always easy). Nonetheless, role play can garner insights into design decisions in situations for which there is limited access to the target community.

Had we studied only single-user interaction with the systems, the issues of sharing space, the effects of cooperative drawing, the importance of sketching for building shared understanding would not have surfaced. In single-user situations, the size of the SmartBoard might have been perceived as a problem, rather than demonstrating the potential advantages. What simulation features might be useful became salient only after experiencing concrete group processes and their specific needs. Some aspects of the interaction could be tested in isolation with usual forms of usability testing, for example, individual interactions for changing and drawing bus routes. The insights gained by creating a context for interaction allow us to develop more appropriate interactions, which can then be tested and improved separately, and also allow us to focus on specific issues in future studies. Such issues include, for example, board size and its effects on collaboration, sketching functionality, physical design of tokens, interaction design for graspable tokens, and ideas for additional simulation features.

CONCLUSIONS

The study met its goal of helping to improve the design of the EDC by studying group interaction in semi-realistic settings. In a newer version of the SB_{EDC}, we have improved the use of physical pieces by adding personal figurines and improving bus-stop tokens, and we have added descriptive items with land use and road drawing to improve orientation of participants to the map. We are experimenting with ways to improve the route-drawing capabilities and are investigating ways to include sketching tools in the PB_{EDC}. We have created a larger version of the PitA-Board and will use it to investigate the effects of board size on interaction and cooperation. We hope that future iterations will allow us to improve both the method and systems to the point of being able to move into real situations and application.

ACKNOWLEDGMENTS

Members of L^3D have provided encouragement and feedback in the continued development of this work. A special thanks goes to Glenn Blauvelt for his patient assistance with digital video technology, the Hueftle-Shrewsburys as Eva’s host family, and Peter Bittner for his long-distance moral support. This research is supported by the Coleman Initiative and the NSF under Grant No. REC-0106976.

REFERENCES

1 Arias, E. G., Bottom-up Neighborhood Revitalization: Participatory Decision Support Approaches and Tools, In Urban Studies Journal—Special issue on Housing Markets, Neighborhood Dynamics and Societal Goals, 1996, 33, pp. 1831-1848.

2 Arias, E. G.; Eden, H.; Fischer, G., Enhancing Communication, Facilitating Shared Understanding, and Creating Better Artifacts by Integrating Physical and Computational Media for Design In Proceedings of Designing Interactive Systems (DIS '97) Amsterdam, The Netherlands, 1997; pp. 1-12.

3 Arias, E. G.; Eden, H.; Fischer, G.; Gorman, A.; Scharff, E., Transcending the Individual Human Mind—Creating Shared Understanding through Collaborative Design, In ACM Transactions on Computer-Human Interaction, 2000, 7, pp. 84-113.

4 Bruns, W., Grasping, Communicating, Understanding—Connecting Reality and Virtuality, In AI & Society, 1996, 10, pp. 6-14.

5 Dourish, P., Where the Action Is — The Foundations of Embodied Interaction; The MIT Press: Cambridge, MA, 2001.

6 Eden, H., Getting in on the (Inter)Action: Exploring Affordances for Collaborative Learning in a Context of Informed Participation In Proceedings of the Computer Supported Collaborative Learning (CSCL '2002) Conference; G. Stahl, Ed. Boulder, CO, 2002; pp. 399-407.

7 Engeström, Y.; Engeström, R.; Vähäaho, T., When the Center Doesn't Hold: The Importance of Knotworking. In Activity Theory and Social Practice: Cultural-Historical Approaches; S. Chaiklin, M. Hedegaard, and U. Jensen, Ed.; Aarhus University Press: Aarhus, Denmark, 1999.

8 Fischer, G., Beyond Human Computer Interaction: Designing Useful and Usable Computational Environments In People and Computers VIII: Proceedings of the HCI'93 Conference (Loughborough, England); Cambridge University Press: Cambridge, UK, 1993; pp. 17-31.

9 Fischer, G., Communities of Interest: Learning through the Interaction of Multiple Knowledge Systems In 24th Annual Information Systems Research Seminar in Scandinavia (IRIS'24), Ulvik, Norway; S. Bjornestad, R. Moe, A. Morch, and A. Opdahl, Ed.; Department of Information Science, Bergen, Norway, 2001; pp. 1-14.

10 Fitzmaurice, G. W.; Ishii, H.; Buxton, W., Bricks: Laying the Foundations for Graspable User Interfaces In Proceedings of ACM CHI'95 Conference on Human Factors in Computing Systems, 1995; pp. 442-449.

11 Hornecker, E., Graspable Interfaces as Tool for Cooperative Modelling In 24th Annual Information Systems Research Seminar in Scandinavia (IRIS'24), Ulvik, Norway; S. Bjornestad, R. Moe, A. Morch, and A. Opdahl, Ed.; Department of Information Science, Bergen, Norway, 2001; pp. 141-153.

12 Hornecker, E.; Eden, H.; Scharff, E., “In MY situation I would dislike THAAAT!”—Role Play as Assessment Method for Tools Supporting Participatory Planning. In PDC 2002; T. Binder, and P. Ehn, Ed. Malmö Sweden, 2002; pp. (submitted).

13 Jordan, B.; Henderson, A., Interaction Analysis: Foundations and Practice, In Journal of the Learning Sciences, 1995, 4, pp. 39-103.

14 Scharff, E.; Hornecker, E.; Eden, H., “Assessment of a graspable interface—Comparison of two versions of a system aimed at supporting participatory processes in urban planning: Assessment method and results. (working title),” research centre artec, will appear April 2002, Technical report # 92

15 Sugimoto, M.; Kusunoki, F.; Hashizume, H., A System for Supporting Group Activities with a Sensor-Embedded Board In E-CSCW Conference Supplement, 2001; pp. 25-28.

16 Tang, J. C., Findings from Observational Studies of Collaborative Work, In International Journal of Man-Machine-Studies, 1991, 34, pp. 143-160.

17 Ullmer, B.; Ishii, H., Emerging Frameworks for Tangible User Interfaces, In IBM Systems Journal, 2000, 39, pp. 915-931.

Author Information:

Hal Eden and Eric Scharff

Center for LifeLong Learning & Design

ECOT 717, 430 UCB
University of Colorado
Boulder, CO 80309
USA

{haleden, scharffe}@cs.colorado.edu

Eva Hornecker
research center artec
University of Bremen
Enrique-Schmidt-Str. 7 (SFG)
D-28359 Bremen
Germany

eva@artec.uni-bremen.de