Integrated Project on Interaction and Presence in Urban Environments

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Final prototype of Urban Renewal applications

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Abstract

This document describes the last cycle of evaluation-feedback-redesign undertaken in project phase IV. It presents the preparations of scenarios and contents, the development of the final prototype, the conduction of two participatory workshops as well as their detailed analysis.

The first workshop was carried out in Pontoise (France) in June 2009. It deals with the constitution of a greenway in the city of Pontoise and the future role of the public gardens of Lavandières in such a scheme. The second participatory workshop was conducted in November 2009 upon invitation of the Design Group, Department of Informatics, University of Oslo, which chose the redesign of the main metro station (Blindern), as well as connecting old and new campus as urban planning issues. In both workshops we invited as participants different types of stakeholders – urban planners and specialists, members of the municipality and representatives of the local community.

A detailed analysis of the fieldwork material around 8 different research questions is provided. We distinguish four sub-activities: plan intervention, perform intervention, understand MR scenes and evaluate result of intervention. Furthermore, we have identified four sets of activities (observational categories) that describe a) gestures, b) body posture and gaze, c) object manipulations, d) engaging with scene. Results of the analysis are provided as main findings as well as design guidelines.

In addition we provide an analysis of the four years work by describing the evolution of the technologies from a design perspective and from an urbanist perspective.

Intended Audience

This document is intended to all partners of the project, the EC, and to the reviewers for the fourth project's phase.

1 Workpackage Objectives

Objectives Phase IV	The objectives of phase IV were to: ▪ further improve the urban renewal prototypes with a main focus on the stability of the system and the usability of the different interactions. ▪ do further research on different forms of representation (visual and auditory) to be included in the next field trials. ▪ organize a final participatory workshop including several types of stakeholders and an elaborate scenario. ▪ participate in several small workshops and dissemination activities to assemble a high number of evaluations.
Results Phase IV	• The urban renewal prototypes were successfully further improved. The interactions were simplified by introducing the RFID board along with the info area and command cards. Further work was spend to stabilize the system and enable more fluent interactions. • An urban workshop prior to the participatory workshop was organized and provided significant information about suitable representations to be used as content. • A final participatory workshop was organized in Pontoise including two sessions with several types of stakeholders. The workshop scenario was created around a diverse set of urban issues. • In addition to the participatory workshop, the technologies were presented and evaluated in a Masterclass of ECSCW conference, the IPCity Summerschool and on a participatory workshop in Oslo.

2 Summary of Evaluation of MR-Tent

2.1 Workpackage objectives and research questions

The objectives of WP6 were detailed in the form of nine research questions leading the analysis of field material:

1. In which ways do participants' gestures contribute to achieving an understanding of the site, explain and plan transformations of the site?
2. Which role do gestures play in the mapping of events in the RE and the VE?
3. Which body configurations, boundary crossings and collaborative modes does the MR-Tent enable?
4. In how far does the design of interactions contribute to participants' ability to co-construct a scene?
5. What are the specific social qualities of haptic engagement?
6. How do different types of visual and sound content enable participants to express and experience their ideas?
7. How does switching between scales and different representations of the site contribute to participants' understanding?
8. How does sound contribute to participants' engaging with a scene?

2.2 Key findings and design guidelines

Mapping between events in the RE and events in the VE is done through relational gestures (connecting events on the CT, the screen, and also the physical site), talking, gaze, and bodily orientation within the MR-Tent (Figure 1).

Figure 1 : Understand MR scene: A participant tries to match places on the map with the MR scene: "This path here is this path over there" – points first on map (left) and then on screen (right)

Design guidelines:

Provide a sufficiently big map space 'within reach' for communicating urban issues with gestures that also supports the public visibility of action.

Consider screen size as an invitation to pointing and as an important aspect of immersion.

Participants collaboratively engage, enact and interact with small handles (content cards, command cards, barcode trays, and tokens) trough touching, holding, placing and moving these objects while discussing, reflecting or waiting. The objects stimulate different senses, creative use and support distributed attention (Figure 2).

Figure 2 : Participant moves the sound token with the different material slowly coordinated with the speed of tracking from above (left). While discussing the flows across the bridge, a participant grasps a flow token gently beating with it on the map (middle). A participant places a command card on the configuration area while holding a second one (right).

Design guidelines:

Provide same conditions for each participant (equal accessibility to content, interface and projection) as common basis for discussions and visions.

Provide multiple handles using several small objects varying in form and material to support collaborative interactions and stimulate different senses and creative use.

Through haptic engagement with physical objects (content cards, tokens) participants signal forthcoming action in a way visible to all. Haptic lends an expressive dimension to their interactions. The physicality of the map invites grown practices of touching, pointing, and annotating that support the focused attention of all on an area of intervention (Figure 3).

Figure 3 : Participants feel and touch the tokens while gently moving them (left). A participant's hand moving a content card in the middle of the table and withdrawing it immediately to grab a token, place it on the table and the content card on top of it. (middle and right)

Design guidelines:

Design possibilities to touch, feel and hold objects of various materials and forms.

Support multiple and creative ways for people to enact and interact with them.

Crossing MR boundaries forms an integral part of participants' understanding the urban site and their interventions. Being on site and sound play a large role in this process (Figure 4).

Figure 4 : Switching to a real time camera view – fixed as well as mobile – requires another reassessment of the scene. Reality elements come into play, which stimulate boundary crossings. Participants are delighted to have real people mix into the scene (left). Participants discuss and create boundaries. They place flows and 3D lines of objects, lines and textures (right).

Design guidelines:

Explore different ways of relating real and virtual in a complex interface, including visual openings to the real site and sound.

Dynamic content (e.g. flows), 3D lines textures, and expressive content (e.g. content representing activities), the size and colour of objects influence the impression of 'realness' of a scene and help participants create narrative structures, insert borders and manipulate the salience of a scene. (Figure 5 and Figure 6)

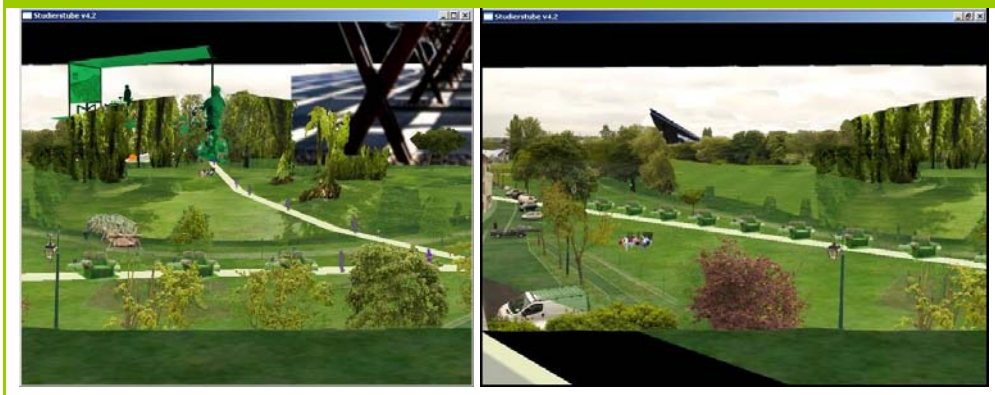


Figure 5 : The two objects (parking for cars and bikes) that had been placed in the aerial view introduce an element of 'surrealism' into the MR scene (left). The participants are surprised, but content with the impact of what they perceive as symbolic interventions. The narrative elements of different MR scenes are strengthened by objects that represent activities (right).

Figure 6 : Participants have just placed lines and textures that mark the parking zone they have planned (left). Coloured in blue the row of cabins pulls the blue building towards them, whilst the trees bind them even stronger together since they are encircling them and these geometrical forms step into the foreground; the green space with the cabins balances the CCI volume having an equal weight (right).

Design guidelines:

Provide dynamic and expressive content for participants to be able to create narrative structures and to compose a scene expressive to their ideas.

The availability of different forms of representations is a key feature of the MR-Tent; it offers participants different possibilities for constructing, understanding, and evaluating MR scenes (Figure 7 and Figure 8).

Figure 7 : The physical map lends itself to planning and performing intervention at different scales (left). One participant directs action. Her pointing gesture is coupled with object manipulations performed by two other participants (right).

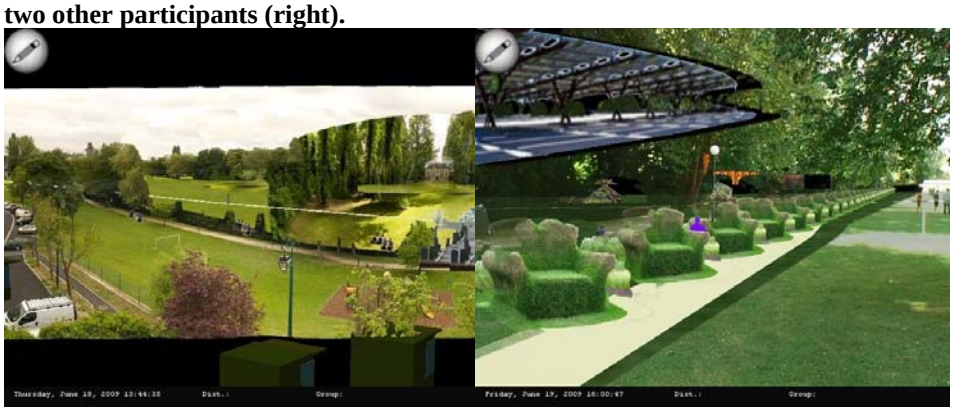


Figure 8 : The panoramas are strongly edited views of the site with the advantage of providing a 360° view and space for interventions. It is mostly used for constructing scenes (left). Both real time video streams, fixed camera and scout, have a special 'realness' quality, which however makes the virtual elements stand out as 'model' or 'surreal' (right).

Design guidelines:

Provide a sufficient number of representations and scales that together cover the whole site, thereby enriching the opportunities for participants to realize interventions.

Permit that the same area or spot can be seen in different representations and from different viewpoints.

Sound is a key element of the participant experience, pervading what they discuss, see and do. Sound contributes to the blurring of MR boundaries; it strengthens immersion into a MR scene; it contributes to the experience of spatial transformations; it evokes ambiences, thereby influencing action; particular interventions trigger engagement with sound.

There is the sound of birds. (11:56) Lots of laughter – all look outside
Ch: *But this not, this is not … magnifique, le chant du merle.* - E pointing outside: *So it is here* (as part of the panorama: in the bushes) *and Monsieur thinks it is there* (outside)! - B to G: *It is the sound of your small garden!* - B: *Where is the sound coming from? Is it here?* - 11:57:21 G: *This … du Hitchcock!* - G says this facing outside, the entire tent front is open, a sound of a motorbike starting up at the rue des Etannets driving past, softly breaking the silence.

In this scene we have three different sources of sound: the panorama sound (with a bird singing), real birds outside the tent, as well as a motorbike passing by. There is a blurring of MR boundaries – the bird sound could be part of the scene but also come from outside and it is associated with the imagined nearby garden of one of the participants.

Design guidelines:
Consider the importance of the real sound at different viewpoints (e.g. add panorama sound; transmit the sound of the AR view of the Scout) as increasing the sense of realness and immersion.
Create surround sound to strengthen immersion.

State of the Art

Since the invention of Durell Bishops, Marble Answering Machine (1992) (Smith G.C. 1995) , almost two decades ago, the interest in Tangible User Interfaces (TUIs) has grown constantly and with every year more tangible systems are showing up.

The MIT Tangible Media Group, headed by Hiroshi Ishii is continuously developing and experimenting with TUIs including many tabletop applications.

The Urp (Underkoffler et al. 1999) and the more advanced Augmented Urban Planning Workbench (Ishii et al. 2002) allow digital simulations of air flow, shadows, reflections, and other data based on the positions and orientations of physical models of buildings, on the table surface.

Newer developments go even one step further and incorporate the third dimension by allowing to form landscapes with clay (Illuminating Clay in Piper et al. 2002) or sand (Sand Scape in Ishii et al. 2008). Again different simulations allow the analysis of shadows, height maps, slopes and other characteristics of the interactively formable landmasses.

The Tangible Disaster (Kobayashi et al. 2007) allows to analyze disaster measures and simulate different kinds of disasters (fire, flood, tsunami,.) and evacuation scenarios during collaborative planning sessions. Physical objects ‚gpuckss' allow positioning disasters by placing them on the interactive map and additionally tuning parameters (i.e. scale) using dials attached to them.

Apparently, the commercial potential of TUIs has been identified recently. The repeatedly awarded reactable (Jordà et al. 2007) , an interactive tangible tabletop instrument, is now distributed commercially by Reactable Systems, a spinoff company of the Pompeu Fabra University, where it was developed. With the reactable, users can set up their own instrument interactively, by physically placing different objects (representing oscillators, filters, modulators...) and parameterizes them by rotating and using touch-input.

Microsoft is distributing its novel Windows-based platform Microsoft Surface (Wall 2009) since last year. Beside Multitouch tracking of fingers the platform supports the recognition of physical objects by their footprints. Several applications, mainly for the use in commercial space, have been presented. Examples reach from designing an own individual graphical layout for a snowboard or skateboard to studying the details of a wine in a restaurant by placing it on the table and navigating through menus via touch input. Also interactions like the collaborative browsing of photographs from a handycam or cell phone that connects seamlessly once placed on the table are supported.

Another notable interactive installation is instant city (Hauert et al. 2007) that combines gaming, music, architecture and collaborative aspects. It allows to build three dimensional structures and set up a city with rectangular building blocks, which simultaneously results in the interactive assembly of musical fragments of different composers.

The development of the reactable and the subsequent release of its tracking technology reactiVision (Kaltenbrunner et al. 2007) under the GNU/GPL as well as the open specifications of the TUIO protocol have triggered an enormous amount of developments based on this technology.

Besides academia and commerce, many amateur and semi-professional projects were developed in the last few years. Thanks to open source tracking technologies and the ever since improving computational power available to end-consumers, the required infrastructure is nowadays tangible to almost everyone. A standard PC, a web-cam, and some handicraft work allow to setup tangible systems with a minimal programming and material effort. This opens doors to novel ways of perception of human-computer interaction and gives room for new forms of creativity for the broad public, to experiment and play with.

It is difficult to keep track and overlook the rapidly growing amount of all these systems and tools, but while many of them seem only to utilize the available technologies and are limited to some initial experiments and tests with some basic ideas or just reproduce existing systems, a few of them open out into novel interfaces and interactions and are deployed in public space or embedded in art installations.

The Tangible Factory Planning (Guse 2007) is a tangible table based on reactiVision that allows to collaboratively plan and visualize production processes in combination with plans of new factory buildings and was developed within a diploma thesis.

Another of the many reactiVision-based tabletops is ImpulsBauhaus-Interactive Table (Weber and Wolter) and was on exhibition at the Bauhaus-University in Weimar marking the 90th anniversary of the establishment of Bauhaus. Visitors could browse and explore the biographs, complex relations and social networks between members of the movement.

3 Final MR-Tent Prototype: description of technologies

3.1 The MR-Tent

The MR Tent prototype was developed in a participatory design process undergoing several cycles of development-evaluation-redesign, each connected to a participatory workshop in the context of an urban planning project. It involves a multi-disciplinary team of technologists, artists, and social scientists working together with experienced urban planners. The urban specialists in the team suggested a set of ‘urban themes’ they considered as particularly relevant for urban projects and illustrated these by providing a number of visual examples: scale, temporality, borders and layers, fuzziness, ambience, and mobility. These themes guided technology development, as well as scenario and content creation for the workshops with users.

The technical infrastructure and the tent are set up outdoors on the site of the urban project. It is a combination of previously developed components (sketching tool, tangible tabletop, Hypermedia Database) that have been significantly extended and integrated to support the participant’s interventions in a seamlessly united workflow. Besides providing a mobile shelter for the MR-Technologies like ColorTable and Urban Sketcher, the tent provides the basis for connecting the inside with the outside of the surrounding as well as the insight and the outsight of the workshop participants (Figure 9).

Figure 9 : The MR-Tent standing on the planning-site in Pontoise.

3.2 The ColorTable

The ColorTable is the central technological component of the WP6 showcase. It supports a wide variety of features and different content-types and is capable of working and integrate with a variety of other systems. The ColorTable allows assigning content to colored tokens and positioning them on a map. The composed scene is visualized on the fly in 3D on a projection (Figure 10). Also the table surface itself, which holds exchangeable maps of the discussed site, is augmented with an additional projection. The round form of the table supports collaboration between actors in different scenarios, while the intuitive tangibility of the interface promotes a quick understanding and prompt usage of the technology, even for the inexperienced.

Figure 10 : The 3d visualization with panorama of a scene composed during the workshop in Pontoise.

3.2.1 Displays

The composed scene is rendered on a vertical projection that visualizes the different content types in a virtual or mixed-reality projection, while a projection from the top displays data on the table surface itself and acts as augmentation and overlay for the physical maps.

3.2.2 Objects

Tangible objects (tokens) in different shapes and colors provide physical handles to the digital content, and allow to position and manipulate it directly, by placing, moving and rotating them on the physical map. The tokens come in seven different colors and three shapes (triangle, rectangle, circle) (Figure 11). One additional color (purple) is used for special objects as eraser or moving the point of view, and is not available for arbitrary content assignments (that are described later)

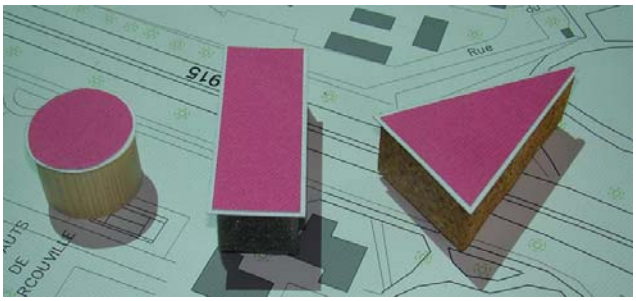


Figure 11 : The different shapes of tokens. Notice the different material features for eraser and point of view.

3.2.3 Configuration board

Most of the content needs to be assigned to a specific color before it can be used. Instead of the Tangible Selector and Barcode interface, we switched to RFID technology for content assignment. We created the configuration board, with fields of all available colors (Figure 12). The content is available as physical content cards, that the participants can browse through and finally, after making their decision, place on the field with the desired color. While the color can be chosen freely the type of content automatically bounds it to a determined shape. This shape is also printed on every content card as a helpful hint.

Figure 12 : The configuration area is used to assign content to the different colors, as well as manipulate attributes.

The configuration board reduced the number of Barcodes drastically (to a minimum for some other operations), and improved overall intuitivity and clarity of the system.

Connections (rectangular tokens)

Placing two rectangles of the same color results in a connection that can be also curved by rotating the rectangular tokens on the endpoints. The logic of the flows populating the streets and paths was heavily improved and now different content can be assigned here that varies the textures, traffic types and densities of different connections. The underlaying parametric curve is the cubic Bezier.

Ground Textures (circular tokens)

Areas that are enclosed by connections can be filled with ground textures (grass, stone, water,...) by simply placing a circular token in the area on the map. This approach replaced the former ground texture solution based on the voronoi-algorithms, which seemed too confusing and inflexible.

3d Objects and Billboards (triangular tokens)

While 3d geometries can be rotated arbitrarily along the vertical axis (by rotating the token) and can be used as houses and building blocks, the 2d billboards are rectangular images (with optional transparent regions) that always face the observer (trees, flowers,..). Similarly as in case of the streets placing to identical triangles, results in a line of objects of the associated type (alley with trees).

3.2.4 Content Attributes

While the broad majority of the content cards represents different content that can be assigned to the tangible objects, some of them can be used to manipulate content that has already been assigned. The following attributes can be changed by placing one of this cards on the color to be manipulated:

- Size
- Offset (distance from ground, for flying objects)
- Spacing (determines the distance between objects in case of making a line)
- Color overlay

The manipulations only apply to billboards and 3d objects (triangular tokens).

For size, offset and spacing there are increase and decrease cards. All the attributes-cards work incrementally. For instance, “Scale increase” increases the object by a couple of meters every second, until the card is removed from the area

3.2.5 Information Request

Instead of the Info screen we display information about the different colors and associations directly on the table now. The display switches automatically to the color changed at last, however information about a color and the assigned content (for all shapes: triangle, rectangle, circle) can be also requested manually by placing the dedicated: content request card on one of the color fields.

3.2.6 Maps and Viewpoints

Physical paper-maps of different scales and foci can be placed on the table surface and registered with a barcode (Figure 13). Additionally the available panorama positions are marked on each map and equipped with a barcode, so the participants can switch between them smoothly. All photo-realistic panoramic backgrounds also include depth information for handling occlusions properly. A rotatable wheel allows to rotate the field of view or alternatively to zoom in and out. Furthermore a video background with a fixed position and orientation can be displayed instead of the panorama or a special token (purple triangle) can be placed on the table to define a arbitrary point of view and orientation. In the latter case only a panorama with a generic horizon can be displayed.

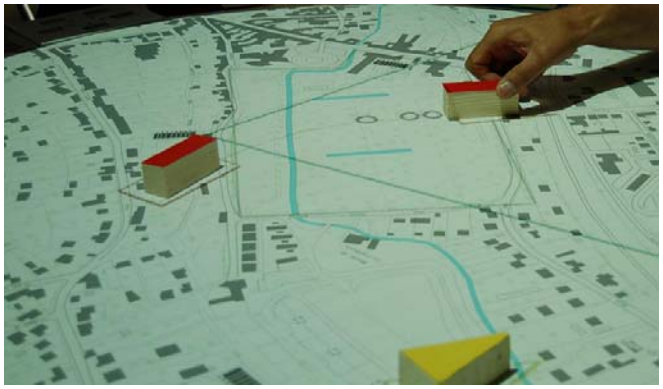


Figure 13: The table surface holds physical paper maps, and a projection from the top augments it with additional data.

3.2.7 Height Map

Since the virtual floor was always flat, it was difficult and in some cases impossible to align it with the panorama background, based on real photographs, in a satisfying way. A gray-scale topological height-map of the area solves this problem by assigning each coordinate also height information, that is taken into account for the rendering of the 3d view.

3.2.8 History Application

The history application is controlled by several barcodes and allows to freeze the composed arrangement at any time and later to freely browse through all saved states. The saving works incrementally, so users can save a scene, remove the tokens from the table and then assign and add new content to the existing frozen scene.

3.3 Compatibility with other Systems

The ColorTable provides (or provided once upon a time) functionality to integrate with the following systems:

Sound Application (Vienna)

A sound framework consisting of an application using max/msp (with ambisonics) and a sound library, as well as some well defined OSC messages is used to enrich the immersive experience, during composing an urban site, with spatial sound. Panorama sounds, different

object sounds and random sounds for the people and vehicles populating the streets and paths are used here.

Urban Sketcher (Graz)

The Mixed Reality application Urban Sketcher provides a direct input on the wall projection via an interface which is a layer over the mixed reality scene. The interaction with this 2D interface is performed with a Laser-Pointer close to the screen or from distance (Figure 14). The application is also accessible over an API which gives access to most available operations which are manifold. One of the key operations needed by the MR-Tent setup for a fluent workflow is the slow-fast rendering concept where all the different inputs are merged and then rendered to one central screen in the tent while keeping real-time requirements. The following inputs can be switched via the API of the application or the already mentioned user interface (for details see I5.7):

- Panorama View: static panorama with interactive rotation and zoom
- Aerial View: live video-stream of a webcam capturing a physical map of the site
- Scout View: live video-stream from a mobile scout
- Pan-Tilt-Unit View: live video-stream from outside the tent
- Token view: virtual view with interactive navigation through a color token

Figure 14 : Sketching in the mixed reality scene with the Laser-Pointer

A long term demand of the Urban Sketcher was to increase performance to allow fluent painting and sketching. This issue was finally met by the GPU painting implementation. The new concept for applying paint onto textures in the MR scene was integrated into the application and allows sketching at interactive frame rates now. Some of the key sketching features are:

- Sketching screen aligned or on specially inserted canvases in the mixed reality scene
- Placing and arranging additional content from the file system
- Building and texturing 2d and 3d geometries

To improve performance and maintain the high frame-rate required for sketching, the ColorTable renders its frames off-screen and transmits the resulting framebuffer (including depht information) over the network to the Urban Sketcher where it is merged and finally rendered to the central projection screen.

Paper Sketching (Vienna)

A camera grabs hand-drawn sketches and feeds them into our Media-Database. Content created in this way can be assigned to the tangible tokens in the same way as our prepared content and used in the scene.

CityWall (Helsinki) (unmaintained)

During the European City of Science 2008 in Grand Palais, screenshots of the scenes created with the ColorTable where displayed on the CityWall. The images were uploaded to our Flickr account automatically, that was on the other side accessed by the CityWall.

Augmented Map Table (Cambridge) (unmaintained)

The ColorTable can receive the position and orientation of the physical map from the map-tracker and use this matrices for the transformation pipelines to calculate table and world coordinates accordingly.

3.4 Dependency on other Systems

The following underlaying systems are crucial for the ColorTable stability and performance:

Color Tracking (Aalborg)

A camera above the table captures the picture of the surface with the tokens in different shapes and colors, and extracts their colors, shapes, positions and orientations.

HMDB (Helsinki)

Holds the majority of the used content data (panoramas, billboards, 3d objects, textures,..).

Studierstube (Graz)

This framework builds on top of the Coin3D scene-graph and is used for all of the rendering (top projection and 3d visualization)

Muddleware (Graz)

The Muddleware XML Server holds most of the configuration data and is used for internal communication between the different color table components.

OpenTracker (Graz)

Some of time-critical data that is subject to frequent changes (positions of objects, flows, paths) is transmitted via OpenTracker from the system logic to the rendering components.

4 Evaluation: the participatory workshops

The participatory workshop in Year Four, which took place in June 2009, was organised in cooperation with the City of Pontoise, the Agglomeration Community of Cergy-Pontoise and the University of Cergy-Pontoise. The urban project that has been chosen as the theme of this year's workshop has been defined as the future use of the Chamber of Commerce of Versailles (CCI) with the help of these institutions.

A second participatory workshop was conducted in November 2009 upon invitation of the Design Group, Department of Informatics, University of Oslo, which chose the redesign of the main metro station (Blindern), as well as connecting old and new campus as urban planning issues. Selection and preparation of participants for this workshop was done by the Design Group. We had developed a few additional ColorTable features and activated and further developed the Paper Sketcher, which had only been used once in 2008 at the City of Science event in Paris.

At the core of this evaluation is the workshop in Pontoise, with a special focus on the second workshop day. It will be complemented by some special observations and findings gained at the Oslo workshop.

4.1 Framework for analysis and method

Given the open evaluation format of participatory workshops, WP6 focuses on ethnographic fieldwork, which is mostly qualitative, with analysis of the ethnographic material being carried out collaboratively in the research team. While video documentation is the main documentation method, we also produce photographic images (taken by two members of the research team), screenshots (automatically generated every two minutes), and researcher notes. In addition, there is the possibility to upload scenes that have been saved by participants as relevant 'products' of their work so as to be able to analyze the visual and sound elements 'in action'.

The objectives of WP6 were detailed in the form of eight research questions leading the analysis of field material:

1. In which ways do participants' gestures contribute to achieving an understanding of the site, explain and plan transformations of the site?
2. Which role do gestures play in the mapping of events in the RE and the VE?
3. Which body configurations, boundary crossings and collaborative modes does the MR-Tent enable?
4. In how far does the design of interactions contribute to participants' ability to co-construct a scene?
5. What are the specific social qualities of haptic engagement?
6. How do different types of visual and sound content enable participants to express and experience their ideas?
7. How does switching between scales and different representations of the site contribute to participants' understanding?
8. How does sound contribute to participants' engaging with a scene?

In the MR-Tent participants co-construct, discuss and evaluate MR scenes representing their vision of the future of a site. We distinguish four sub-activities:

- Plan intervention – participants discuss the site, desirable interventions and prepare for these interventions;
- Perform intervention – participants construct elements of the scenes they have discussed before, modifying them until they 'feel right';

- Understand MR scenes – participants engage with the scene on the map as well as on the projection screen with the aim to identify and understand their interventions;
- Evaluate result of intervention – participants assess single elements or the whole of a scene, initiating eventual modifications and/or next steps.

Furthermore, we have identified four sets of activities (observational categories) that describe a) gestures, b) body posture and gaze, c) object manipulations, d) engaging with scene. The idea here is to understand at a high level of detail how the different features of the MR-Tent contribute to participants' co-constructing, discussing and evaluating MR scenes (Figure 15).

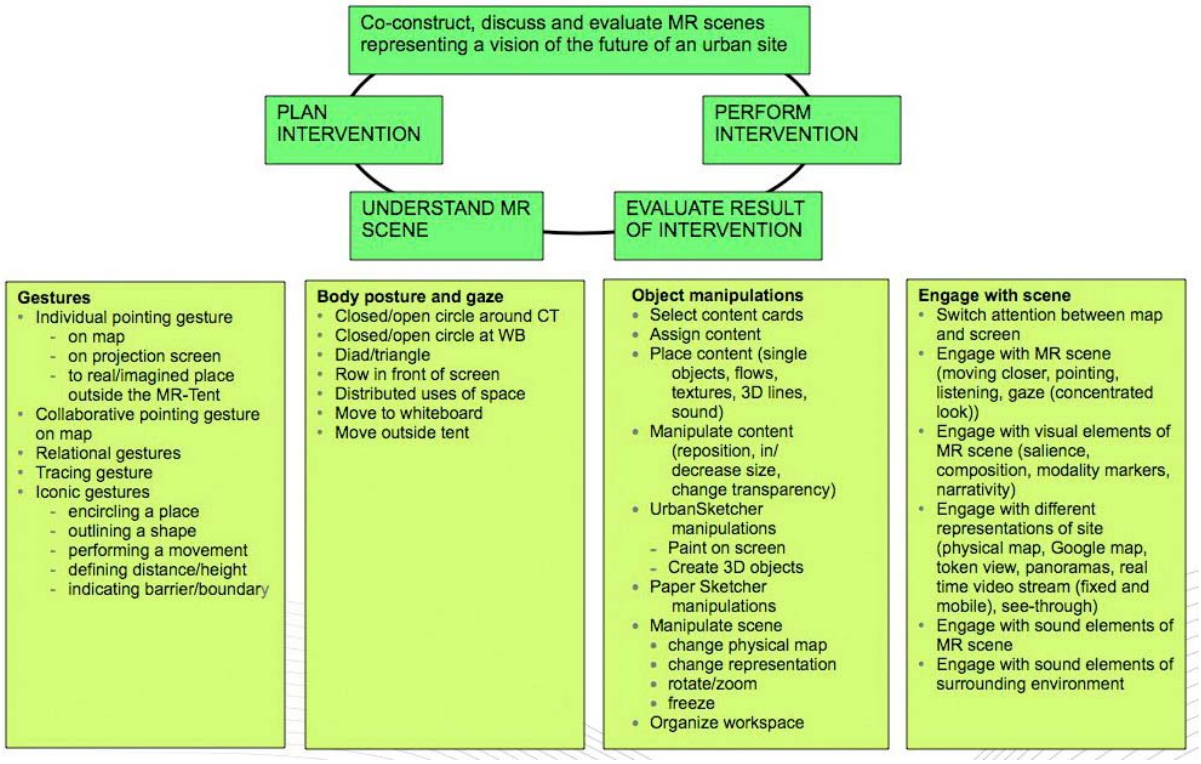


Figure 15: Activities (observational categories)

The research team typically watches the video material, which has been taken with two cameras - a fixed camera and the manually operated camera - several times, selecting significant scenes, and connecting them with the other material: pictures, log-in data (screenshots, saved scenes), interview data. The significance of scenes is judged on the basis of the research questions, which in turn are based on a set of concepts that reflect the theoretical approach developed within IPCity, as well as a detailed list of activities participants perform in the MR-Tent (Figure 15). These different elements – video material and photographs showing participants interactions, the composed MR scenes (also available as screenshots), and participants' multilevel talk – allow the team arrive, step-by-step, at consolidated interpretations of their observations within this conceptual framework. The ethnographic account, which is the result of such a time-consuming analysis, consists of a 'storyboard', in which descriptions of key observations in the form of selected images (video stills, photos, screenshots, descriptions of sound), context information, as well as pieces of verbatim transcripts are organized around key observational categories.

The enormous amount of video material also lends itself to a quantitative analysis, with a focus on particular aspects of participants' interactions and the objective to identify significant patterns.

	Workshop Pontoise June 2009	Workshop Oslo Nov 2009
Participants	8 (Day1) + 6 (Day2)	7 (Day 1) + 10 (Day 2)
Video (hours)	9 h 30 min	5h 30 min
Pictures	1500	1063
Saved screenshots	1588	477
Saved MR scenes	73	54
Free form interviews in preparation of WS	26	19
Free form interviews after WS	14	15

Table 1: Overview of empirical data collected in the two workshops

4.2 Participatory workshop in Pontoise: the site

Figure 16: The building of the CCI and its location

The CCI building is located near the city centre of Pontoise, a city founded in medieval times 40km to the west of Paris. It is a modern building and houses the direction of the Chamber of Commerce of Versailles. It is between one of its main axes of circulation of the city and the public garden of Lavandières and is surrounded by a garden and a parking area. (Figure 16) The CCI will soon be dislocated and its future use has been one of the questions that have been occupying the public authorities during the last few years. Which use for this site, which is centrally located? Which future for the existing building, preservation, transformation or demolition? Other questions would concern its relation with the garden of Lavandières and the city centre as well as the role it may play as an element of connection between the two.

*Urban elements that compose the immediate surroundings of the project site***:** The Marcouville Estate constitutes the western border of the garden of Lavandières and is made up of a big park with a chateau. The park is closed to public use for security reasons since the 2ndWW and local authorities are preparing a rehabilitation plan to make of it a city park. The chateau is used at the moment to organise training courses by the CCI: the future use of this building is another question that is being discussed by the CCI and the local government. The small creek that passes along the parking lot of the CCI divides the Marcouville Estate and the garden of Lavandières in two and constitutes another important element near the project site.

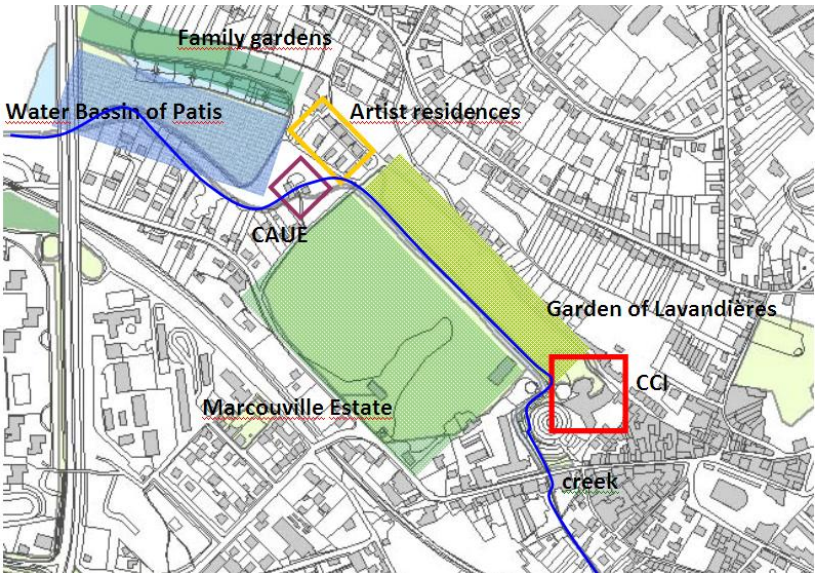


Figure 17: The immediate surroundings of the CCI

The creek reaches on the north west of the site the water mill of Couleuvre, which houses the Council of Architecture, Urban planning and environment of Val d'Oise (CAUE: Conseil d'Architecture, d'Urbanisme et de l'Environnement du Val d'Oise), an institution that works with the public authorities, as well as associations and inhabitants, to help them resolve issues related to their expertise. Meetings, workshops and seminars organised by the council makes of it an important urban player. Located in the Northern corner of the garden are the 'Cité Cézanne' - housing units and studios for artists in residence, where exhibitions as well as "open door days" are organized. The water basin of Patis that has been reserved to stop floods and that serves as a public garden the rest of the time as well as the family gardens that are placed nearby constitute other elements that are important within the immediate surroundings of the site. (Figure 17, Figure 18) These elements underpin the centrality of the project site and ask for a more global approach to its redefinition at an urban scale.

Figure 18: The basin of Patis and the family gardens, the creek and the garden of Lavandières & the water mill of Couleuvre

Centralities that compose the city of Pontoise: The project site is part of a system of elements at city scale that we call *centralities*. The old city is an important element of Pontoise with its train station and the cathedral and attracts many visitors from other cities. The river Oise constitutes an important recreational zone that defines the eastern border of the city and houses many interesting elements, such as the ramparts that descend towards its banks. The centre of the new town of Cergy-Pontoise includes several services, such as the commercial centre of Trois Fontaines and the RER station of Cergy-Prefecture that connects the city to Paris through a fast suburban train. The social housing neighbourhood of Marcouville, the military barracks of Caserne Bossut, as well as the St.Martin exhibition centre are the other centralities that compose the city. The question is how to valorise these different centralities and how to address issues of connectivity. Within this context, an

important question is to question the future of the project site as one of the elements of an urban pathway that would pass through the city and the different sites that compose it. (Figure 19)

Figure 19: The cathedral, the old city and the river Oise

4.3 Pontoise: workshop preparations

The preparation of a workshop on urban issues always implies understanding the local situation, including the political context, since any intervention on space has implications on several categories of stakeholders: land owners, city-users, inhabitants, service holders, etc. Local administrations and politicians are therefore very much involved in any project proposal concerning their jurisdiction. Depending on the relations among stakeholders and the characteristics of the site, the organisation of a workshop can be a real issue. The 2008 workshop concerning the Quartier Bossut (Pontoise) had addressed an urban scale project at the early stages of development. In the case of the 2009 workshop no particular project has been yet developed and participants were invited to express first ideas about a site. The choice of the site had been negotiated with the Municipality and Agglomeration Community representatives, who had participated in the previous workshop in Quartier Bossut (Pontoise).

4.3.1 Opportunities and 'political' context

The site chosen for the 2009 workshop consists of a sequence of spaces where no major transformations are foreseen but where the development of new uses and their eventual articulation poses interesting questions. The first reaction would be to preserve the site, which is mostly made up of open and green spaces and a workshop leading to intrusive or fancy propositions might provoke vivid reactions. On the other hand, a reflection at the early stages where nothing has yet been discussed allows for more freedom and all stakeholders concerned by the site can be invited to participate to the workshop without provoking any misunderstandings about the role the workshop plays within the real project process.

A number of stakeholders from the public and the private sector as well as neighbourhood associations and inhabitants are concerned by the future evolution of the site:

- The main question is the evolution of the CCI building, which will soon be abandoned by its owners, to be renovated or demolished. The parking lot next to it might give the possibility of creating a public space in a strategic spot of the town. For the moment the site is private and its opening to public uses depends on the negotiation with the public authorities.
- Marcouville Estate is owned by public authorities but managed by the chamber of commerce (CCI). The park is protected as a cultural and natural heritage site. It needs strong upkeeping and a project is in progress both to rehabilitate and to open it to public use. Municipality and Agglomeration Community are in charge of this process and the City of Pontoise green spaces service is responsible for its maintenance.

- Lavandières garden is a much-appreciated public space (a green area in a quite 'mineral' town development), where special public events take place (such as Fête de la Musique in June). Inhabitants are concerned by preserving its quiet character and are sometimes worried about possible troubles caused by youngsters or disrespectful people from other neighbourhoods. Some of these inhabitants are active in a local association.
- Moulin de la Couleuvre is an old building with a memorial status for the image of the city since it was depicted in an Impressionist painting. It was renovated and hosts the CAUE, a public office for advice on architectural, urban and environmental issues. Its staff and members welcome any activity, which might help think about the site.
- Cité Cézanne includes studios and flats for artists. It is managed by the social housing company of the City of Pontoise. The hosted artists wish to open their activities to public and citizens. Their attitude is generally less conservative than the inhabitants association but they are also confronted to the troubles due to disrespectful populations.
- Basin des Patis is interesting both from a technical point of view (it absorbs eventual floods and is therefore managed by the water specialists of the local authorities) and concerning urban issues (a green space with family gardens and a wilder area as the basin itself). The natural and biodiversity aspects are a potential for the inhabitants of Pontoise. Animations and pedagogical activities could be organised, to which CAUE could contribute. One of the main stakes is the balance between attracting visitors and preserving a quiet place.

4.3.2 Selecting participants

The workshop was organised in two sessions with two similar panels: in each group the main stakeholders of the site, as well as different competences - urban planners and designers, technical staff and elected counsellors from the city of Pontoise, as well as residents as experts of everyday life of the site – were represented. The composition of the groups depended also on the availability of stakeholders during one whole day for the workshop and their participation to the preparation workshop in May.

The two groups are heterogeneous and have progressed differently during the workshop. Several participants had already participated to previous IPCity workshops or demonstrations and it was interesting to include them in the group because they could facilitate the appropriation of the tools and observe the evolution since the last session.

The first group was made up of:

- A, an elected councillor of the City of Pontoise for education and former president of the local inhabitants association. She had assisted to a demonstration of IPCity tools in 2008. She knows the site and its stakes very well but is careful not to mix up her political functions with local implications.
- CL, architect, working at CAUE. She knows the site and is familiar with space representation media. She is concerned by participatory urban design.
- L, architect, consultant for CAUE, physically handicapped. He knows the site superficially since he mainly goes directly to CAUE, but his professional competences are increased by a sensibility to accessibility issues since he is on a wheelchair.
- J-C, gardener for the City of Pontoise: he knows the site both from a technical point of view due to maintenance and for the uses of the gardens.
- D, working in film sets and living in the Cité Cézanne (he is the president of the artists association). His everyday life experience of the site as inhabitant adds on to the look he has on space from his professional point of view.

- ME, artist living in the Cité Cézanne. Her everyday life experience of the site as inhabitant adds on to her artist sensitivity.
- P, student at the Cergy School of Art. He is not particularly familiar with the site but is sensible to the connection between art and public space. He has participated to urban workshops.

The second group was made up of:

- E, a young urban planner: he does not work in Cergy-Pontoise. He knows the context of the agglomeration area from other urban workshops: he has participated to the 2008 workshop. He is an urban expert and is open to other concerns.
- EV, working in CCI but not representing the deciders for the building. She is in charge of a team of city managers, making the link between the shopkeepers and the municipality. She knows the site, its commercial dynamics and the animation of public spaces. She had participated to the 2008 workshop.
- G, inhabitant of Pontoise, but not living near the site. He knows it because he is tenant of one of the Patis family gardens.
- C, head of the green spaces service of the City of Pontoise. He knows the stakes concerning garden maintenance and uses for the whole city of Pontoise
- S, artist living in the Cité Cézanne. His everyday life experience of the site as inhabitant adds on to his artist sensitivity.
- J, inhabitant and member of the local association.

4.3.3 Production of panoramas

Three panoramic images of the site from strategic viewpoints have been composed (Figure 20):

- From the street above the Lavandières garden: the nearest overview to the busiest open space in the site. It gave the opportunity to think about events in the gardens.
- From a flat in the higher floors in a building near the CCI. It gave the opportunity to discuss about the future of the building and the parking area next to it, as well as the articulation of the site to the rest of the city.
- From a path above the Patis area. It gave the opportunity to discuss about the whole sequence of green spaces from the point of view of the less known and busy of them.

Because of differences of heights (a small valley with quite steep sides) and of several visual obstacles it was difficult to have an immersive point of view giving the possibility to discuss about the whole sequence of spaces. The possibility to switch from one viewpoint to another was therefore particularly important.

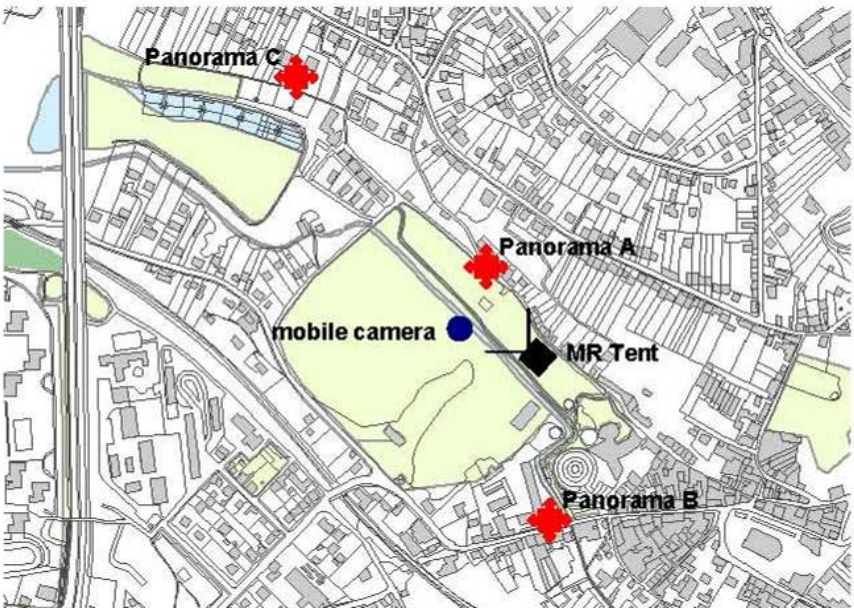


Figure 20: Viewpoints for creating panoramas

The production of panoramas was made difficult by the fact that trees populate large parts of the site. This required an intense editing and extending of the panoramas, based on decisions what to make visible and which spaces to open up for participants' interventions.

4.4 Pontoise: preparatory workshop

In preparation of the 2008 workshop the method of cultural probes had been used to help participants formulate their vision and researchers to refine the different scales of interrogation, the questions to be addressed and the content material to be prepared. In 2009 the researchers opted for the idea to organise a collective urban workshop using "traditional" (i.e. not technological) representational tools and techniques. The collective work of would allow participants to get to know each other and work on the workshop theme together: it would also serve as a comparative workshop environment which would enrich the analysis work to be done on the IPCity workshop in the MR environment.

In order to facilitate exchanges and collaborative work, the participants had at their disposal two maps at different scales printed in a format, which allowed them form a group and work together. Participants were offered a set of 300 A4 images depicting different scenes (parks, cityscapes, activities, people, nature, etc.), objects (banks, kiosks, small commercial activities, buildings, flowers, trees, waste disposals, parking areas, textures, symbols, etc.) and atmospheres (peaceful, crowded, chaotic, comfortable, etc.). These served as 'inspirational objects' permitting participants to express themselves on different issues and which would work as have been provided. In addition, the researchers had prepared a set of photos representing aspects of the project site.

White paper, tracing paper, colour felt pens and pencils, scissors, glue, tape were provided so as to enable participants to modify the content material, to make new compositions, to draw and to annotate. Digital cameras were available for taking additional pictures, and computers and printers to add to the set of images or to create new ones using software such as 3D-Max and Photoshop. The participants were left free to decide for themselves on the main technique of expression to be used, but this choice of material induced them to work with collages/patchwork. (Figure 21)

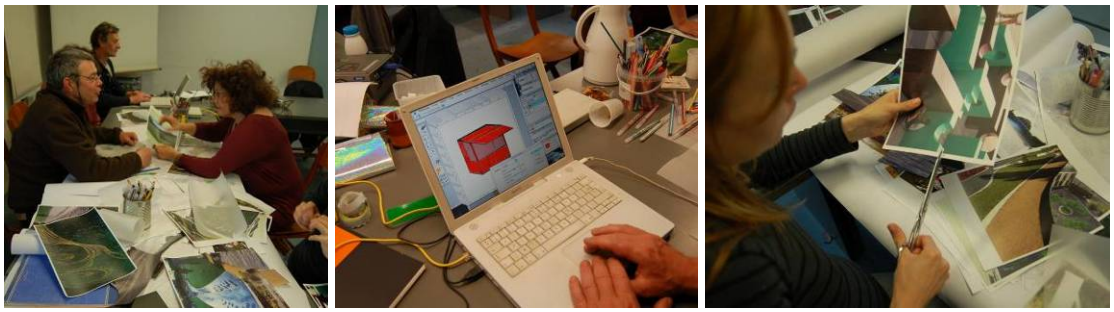


Figure 21: Participants working with different materials

Participants contributed their own experiences and thoughts concerning the project site, they collectively defined the problems that seemed relevant to them and also proposed solutions. They mainly used the maps and the pictures of the site for this part of the work. They either worked directly on the maps or used tracing paper creating different layers. They highlighted the maps by redrawing certain parts and annotating them. They used images – which they recomposed, modified and/or annotated – for making propositions concerning future uses and ambiences. Finally, they composed a spatially developed scenario.

The preparatory workshop took place May 4-5, 2009 in the CAUE building about a month before the MR-Tent workshop (June 18-19). It was organised in 2 sessions, with different participants and purposes. In both cases, the ideas and the production of the collective work become inspiration material for the production of content to enrich the sessions in the MR-Tent.

4.4.1 Day 1 - the urban workshop

The first day gathered potential participants for the June workshop with the IPCity technologies. The objective was to familiarize them with the site, the workshop themes and their fellow collaborators and to allow them develop those first ideas and strategies. Before the workshop participants received a folder with maps, a short history of the site and a description of the main issues to be addressed and were asked to prepare for this session by collecting ideas, memories and material about their experience of the site. They were first invited to share their ideas about the past and the present of the site during a discussion period and then worked in two groups to refine their ideas and to discuss the potential of the site. At the end of the day, the two groups presented their findings in a collective debriefing and have participated in an exercise with sound probes.

The workshop group was composed of technical staff from the city of Pontoise (the head of public space service and for green spaces (Ch), as well as one of the gardeners (J-Cl)), two elected councillors (including A), an urban planner (E), four architects working at CAUE (including CL) and two consultants (L and a landscape architect), the manager of the city of Pontoise (representing the CCI), a tenant of a family garden above the Patis basin (G), two residents (among them J), two artists from the Ateliers Cézanne (D and ME), and a student from Cergy School of Art (P). Not all of them could stay for the whole day and come back in June. Nevertheless, both the collective and the small group discussion brought many ideas to the fore, which constituted a starting point for the session in June, when the groups were mixed up in another configuration.

In the first part of the session, personal visions, perceptions, experiences and first ideas for the site were presented and discussed in a round table discussion. The main issues, stakes and controversies already emerged at this point: the importance of topography (steep slopes, especially on the north side of the small valley of the creek Viosne) and the relative isolation of the site; the use of the site at night by noisy young people who do not respect the rules of public places; connections to create (especially by refurbishing the “sentiers”, small existing pedestrian paths) and the dilemmas this could cause (opening the site brings animation, but also the risk of losing peace and quietness, looking for security through animation or by

closing with fences…); maintaining the trees and view issues for neighbours; water and biodiversity issues; quality of spaces. These became the basis for further exchange and negotiation in the further step, in smaller groups, when the participants were asked to discuss a common strategy and to present their findings at the end of the day.

Group A was composed by E, A, CL, J-J, Ch (green spaces), G, Gé, D and L. The group worked on four different layers over the site maps and produced also images and collages to illustrate specific ideas. The first layer was used to identify important elements of the site, especially those that were not very well known, such as an icehouse and mills (Moulin de la Couleuvre is only one out of 3 mills present in the area). It also showed the barriers to the site, including the steep slopes, which make the connexions between the “high” and “low” town difficult. On the second layer they represented their ideas about accessibility – existing and to be created. An idea was to introduce a path from the Patis basin to the river Oise for people that find climbing up the small road to the higher town difficult. Double arrows indicate connexions in two directions: towards outside the site, but leading into it. The latter correspond to the water paths, which participants put in evidence with other elements of the topography on the third layer. The last layer contains propositions such as bridges, monumental stairs from the “chateau” and a funicular to the higher town. Mental images and references to well known places appear in this case: Versailles for the stairs, Val Paraiso and Alpe d’Huez for elevator systems.

Figure 22: Participants using traditional representational techniques

Group B was composed by H, Ch (CAUE), SO, J, ME, S, PR (public spaces) and P (art student). The group started out by continuing the discussion of the morning session on the question of connections and uses with special emphasis on uses. The existence of a member of the neighbourhood association, J, and an artist from the Cité Cézanne, ME, who already had confronted their different opinions on the site assured that the discussion addressed controversial issues related to the upkeeping of the park, the future use of the water basin and the opening of the Marcouville estate to public use. Those who have wanted to profit from the occasion to imagine without constraints on the future of the site were slowed down by those who were very sensible to property issues and issues of financing. The discussion remained mainly focused on the scale of the gardens of Lavandières while other scales were only addressed to clarify certain issues concerning the future of the park. (Figure 22)

Participants mainly used the map to point out places or ideas; they were reluctant to use pens to draw and annotate and had to be incited to do so. In the end the urban planners and architects in the team were obliged to take this role, while the other group members participated in the sharing of ideas and also gave instructions what to draw and write. This group also found it difficult in the beginning to relate to the images. Only when they ran out of words and one of the architects in the group insisted, they started to look through them and immediately integrated them into their deliberations to show the others what they imagined the future site to be. Certain images served as a source of inspiration for new ideas on activities, materials to be used, textures and objects. Once they had decided on a scenario of future uses for the site they used these images to compose a collage. Participants have

actively participated to this phase where they have each cut and glued on images to augment the map on which they have worked.

4.4.2 Day 2 - the creative workshop

The second day had been planned as a creative workshop, involving eight artists living at Cité Cézanne and one working at CAUE. One of them, Denis, was able to make the link among the different sessions, since he participated in both, the sessions in May and in June.

The participants were invited to freely explore and express their perception of the site, assuming that they would be more comfortable with representational media. However, it took some time for them, too, to produce images and creative material since they were not using their usual tools. In terms of exchanges, some of them mainly worked individually and shared their ideas at specific moments, while others gathered for a group discussion and production.

The exchanges were mainly about activities and uses: leisure, art, socializing, etc. The group discussion started from connexions while a couple of individual works focused on single points. The highway bridge can become a piece of land art. Changes for the CCI were evoked: even if the building was not particularly appreciated, destruction was not an issue, but transformation, both aesthetically (painting the wall in “blue Klein”) and functionally. Ephemeral, light, mobile elements were proposed for outdoor spaces: shelters for leisure activities (picnics), temporary housing for homeless people, market, etc. All sort of paths and bridges animate the gardens and create connexions, playing with water and topography. One of the artists placed a lot of screens to insist on interactive multimedia connexions: she was “augmenting” the site, even if this is not the term she used (Figure 23).

Production of images and collages was more abundant than the previous day, when the scenario was more orientated towards strategies and focused more on plans. On the other hand, production of images was a rather individual activity, even if it occured after a collective discussion and sharing tasks.

Figure 23: Final work presented by groups at the end

4.5 Pontoise: urban issues

The participants of the IPCity workshop were invited to debate the future development of the site and co-construct their vision using the IPCity technologies. Core issues to be discussed were centrality and connectivity at city scale and use, ambiences, accessibility and flows at the scale of the immediate surroundings of the CCI. Participants were expected to define strategies of development that can eventually enrich the reflection of the city of Pontoise and the Agglomeration Community of Cergy-Pontoise. During the workshop, participants collectively discussed these questions in two steps.

During the first step, the participants were asked to lead a discussion at city scale, with a focus on centrality and connectivity. They should consider the different sites of interest in the city of Pontoise and the role that the CCI building may hold within this framework. The question of accessibility lead them to reflect on how to constitute *legible pathways* through connecting a sequence of centralities. This involved thinking about the quality of existing connections between different centres as well as those to be created (Figure 24).

During the second step, the participants were asked to discuss the CCI building in relation with its immediate surroundings, with a focus on issues related to ambience, use, their distribution in space and their co-existence. The task was to look at the water mill of Couleuvre, the Marcouville Estate, the garden of Lavandières and the creek as parts of a centrality to be created. The transformation of the CCI, its future use and its role as a connection between the garden and the city centre were other questions to be addressed.

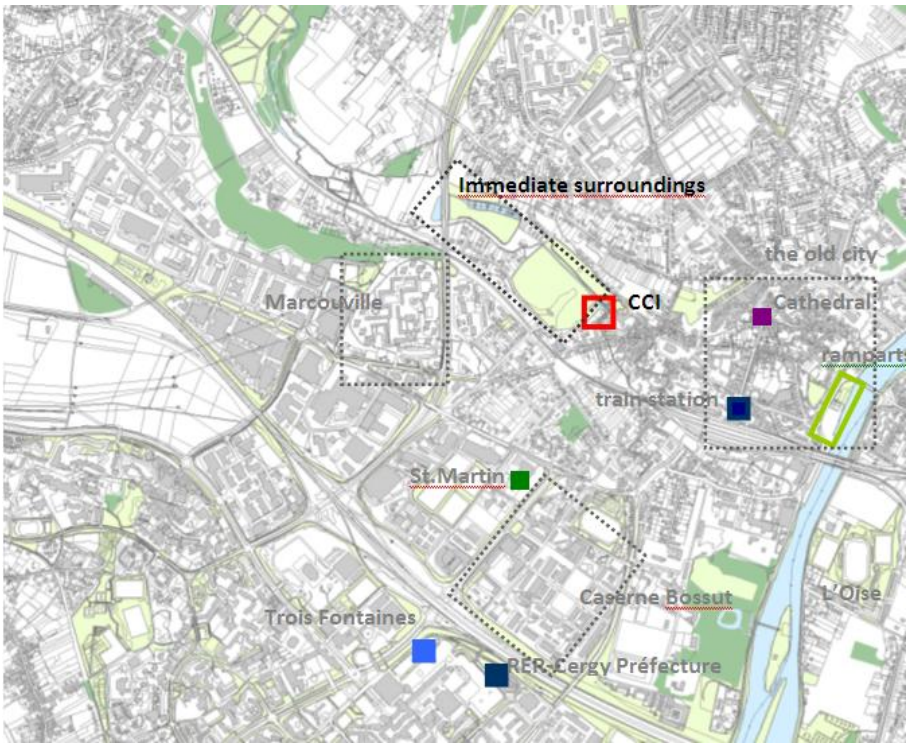


Figure 24: Different centralities of Pontoise

Scale of interrogation	Principal questions
City of Pontoise	**Centrality and connectivity** What are the different centralities of the city of Pontoise? Which ones are those of interest? How can they constitute an urban pathway within the city? Which role does the CCI play within this scenario? What are the different connections that connect these centralities? What are the new connections to be created? How?
Immediate surroundings	**Use, ambience, flows** What are the different elements that are in the immediate surroundings of the CCI? How can they evolve to create a centrality for the city of Pontoise? What are the different uses that may exist within this centrality? How does the chateau of Marcouville can be integrated within this scenario? Which role can the creek play as an element of continuity? What are the uses that can exist within the garden of Lavandières in this scenario?
The CCI building	Which role for the CCI building within this context? How can we use the building and its garden? Should we demolish the building, transform it or conserve it? Why? How can we better the passage between the city and the garden? What are the effects of this decision on the building?

4.6 Participatory workshop in Oslo

4.6.1 The metro station

The metro station is one of several public transport stations connected to the University and probably the most frequently used hub to the main campus of the university. The station was originally built in 1934 as an above ground metro station, crossing one of the main roads to

the university. In 1993, the station was rebuilt into an outdoor metro station with electric tracks and long platforms. This rebuild coincided with the decision in the city council to introduce a toll for entering the inner city. The border of the inner city was placed along the metro tracks, and the station design made it impossible for cars to cross the tracks. The station also got a bridge for non-motorized traffic (pedestrians and bicyclists) over the tracks (see Figure 25 : Overview of the station with its two platforms and the pedestrian bridge.Figure 25) constituting one of the main entrances to the university campus. This renovation was seen as temporary, awaiting the plans for the extension of the campus. Now, 15 years later, the plans have settled as the campus has been considerably extended, and the station has become an integrated part of the larger university environment. The upcoming anniversary for the University has become an occasion for renovating the station to a less temporary state.

Figure 25 : Overview of the station with its two platforms and the pedestrian bridge.

The station is located close to the main campus of the University and is connected to the Research & Development Park, which houses both commercial and university buildings. Alongside the station are the office and garage of the university's grounds maintenance. The station is also a part of a residential neighbourhood: adjacent to the station are some residential houses, two kindergartens, and a small convenience store. A small creek flows along the metro tracks, lead through pipes on the eastern side of the station. The current extension of the campus includes plans for bringing the creek out in the open again.

Approx. 10.000 travellers enter the station every day on their way to and from their destinations – their homes and/or the university. The 10.000 travellers give the possibility for 10.000 interactions each day. Currently the trains are running almost every five minutes during daytime. This means that the travellers do not spent much time at the station. Like any other university station, this station has huge seasonal variations as well as variations in the daily rhythms when it comes to the number of travellers on a particular day.

The station plays several roles with different and partly conflicting requirements. It is a traffic hub and therefore an information space, a public space, and a commercial space. The station is the gateway to the university and should guide newcomers and everyday travellers in coming and going to the university. Its third role is as a transfer place: it is a place one travels through and it therefore connects neighbourhoods, the University, the Research Park, and the two kindergartens as well connecting as the inner city with the walking trails and woods of the city periphery. Finally, the station is itself a local place, a part of a local community, which consists of the particular configurations of university and homes, kindergartens and work places.

4.6.2 Participants

Each day 6-8 participants were invited. All these representatives were real stakeholders with very different needs and ideas about the station.

The first group was made up of:

- I: university manager, representative for the university
- H: student
- C: student
- Ab: shop owner
- R: show employee
- Ag: CUNY environmental psychology

The second group was made up of:

- B: university architect
- A: space & sound researcher
- J: Bicyclist & universal design research
- K: universal design for blind
- D: traffic information
- S: daily user
- M: architect

Prior to the workshop, participants were interviewed about the station and helped us to find interesting photo and sound motives for the content cards. A sound and photo basis for the workshop was prepared including a number of images and sounds made for representation via the boxes.

As a preparation for the interview the participants got a package with a disposable camera, a note book, pencils and a map as tools for collecting their own data that we used as common ideas in the workshop. The information we got from the participants in the interviews gave ideas for what kind of images (and sounds) could be valuable elements of the workshop.

4.6.3 Setup technologies

As it was wintertime and also the transport of the whole MR-Tent to Oslo would have been too costly, it was decided to conduct the workshops in a fully equipped studio space in the basement of the university building. This gave us the opportunity to optimize the lighting on the one hand, to work with a rather large (2x3m) projection screen on the other hand.

The disadvantage of this location was the lack of a video connection outside and a situation of enclosure. Apart from the physical map (in three different scales) we had prepared four panoramas: P1 (a view from the bend in the current bridge at Blindern station, one with and one without a rather ugly building close to it); P4 (taken on the other bridge connecting the research park with the old campus); P5 (view from the kindergarden on the research park side of Blindern station); P6 (view from middle of present bridge across train tracks). As the topography of the site is quite hilly with the train running along a creek, a height map had been produced. The views restricted by trees and other objects made editing of the panoramas necessary. The narrowness of the site constrained the space for interventions.

4.7 Participants' visions and scenarios

4.7.1 Pontoise workshop in the MR-Tent

Given the enormous amount of material, we decided to perform a detailed multimodal analysis of the whole second workshop day while adding only selected and complimentary material from the first workshop day where this seemed relevant for completing our analysis. The reason for focusing on the second workshop day is that the group on this day was more stable, performing most of their interventions collaboratively throughout the day, whilst on the first day the composition of the group fluctuated.

The moderator of the second workshop day, Maria Basile, proposes that participants start by looking at previous work done in May, gathering them around a table outside the MR-Tent. Principal themes of discussion are: (1) creating connections versus creating centralities, (2) what to do with the CCI building, (3) the question of use. Participants discussed the consequences of having a well-connected centre - they do not want too many people to visit. Do we demolish the CCI building; do we keep it as it is? It would be interesting to modify it, to open it up. S addresses his idea of painting the CCI in 'bleu Klein' and turning it into a cultural centre. There is also a discussion about accessibility with contrary opinions coming to the fore. For example S likes the ideas of being in an encircled place. He talks about Siena and the surprise openings to a beautiful square. G mentions the many old people who live in the area including people with handicaps. There is also talking about preserving the smells of a place, the old walls, and all the memories. They decide to keep the rue des Etannets: it is part of the collective memory and should be preserved. EV refers to the idea of regrouping the artisans of the city in one space: why not here? They discuss the idea of installing multi-media interfaces in the park: this reintroduced the discussion on frequentation. We should not "denature the nature". People should be able to rest and breathe.

When participants gather around the ColorTable, they decide to work first on the intermediary scale map and the aerial view. S takes the pen and started to paint on the viaduct with the UrbanSketcher - he will use the lunch break to complete his 'mur végétal' with roses. The viaduct will become an artwork which will attract people and which will contribute to the centrality of the place. Next they create the connection between the château and the park - where should we put the pedestrian passage, how should we connect it to the park (with a staircase) and a bridge to pass over the creek. They change the map for the smaller scale one, placed a bridge across the Viosne, football players, and a series of grass fauteuils with a view from the central panorama. They also add a staircase symbolizing easy access for old and/or handicapped people from the higher part of town into the park. They start focussing on sound, associating sounds to the 2D images they had placed. One can hear the football players, children playing, people talking, and birds singing. There is the idea to associate sound with the bridge but it has already been frozen. Some explanation is needed about the pink token – you need to come nearer to be able to hear. For some seconds attention focuses on the approaching car.

Participants then start working on the detailed map: first on the connection between the park and the city centre. They recreate the CCI building in 'bleu Klein' with the Urban Sketcher. They define the limits of the parking area, attribute a texture and add flows. The parking will be used by those coming to the multi-functional centre that will be created within the CCI building. They change the scale of the map and come back to the question of connections. They want to connect the centre to the city centre creating commercial activities between the two. S talks about 'une gallerie ouverte' for people to stroll through. This idea evoked controversy and the panorama does not reach this far to further explore it.

EV (who is active all the time, pointing, making suggestions) proposes to look from the CCI to the town (Notre Dame): can't we open this? A lively discussion starts about the park. It should be opened and a connection to Marcouville should be made – this will bring people to the gardens. J gets very involved; he shows his local knowledge. The next discussion is on the entrance of the city that is the place before the CCI building. Should it be accessible to pedestrians or to cars? Where do we enter the park? Participants propose the chateau as the entrance of the park where there will be parking for the cars. J thinks that this is a terrible idea, building a parking space near the chateau. They decide to use the aerial view. Very visible on the aerial view are the paths, the blue building and the zoning. They place a high traffic route (in two parts), again with great precision. Then come parking in the upper left corner (represented by a 2D image) and parking for bicycles, which they colour (in green) because it is hard to see on the projected map.

G mentions that they don't have worked on a concept for the whole park. So they move to the central panorama again. There is a moment of surprise and laughter when they observe the giant parking buildings rise behind the trees. This seems alright on a symbolic level.

There is a little more work on the park, placing two ponds with water lilies on the location of the old ponds.

Next they activate the see-through – you can see the row of grass seats, the paths, and the football players. Can't we place the 'cabanes' now? Rather intrusive the noise of the car that returns regularly. They move the camera in direction of the CCI and decide to again work on this area. They activate the balcony panorama. Ch points to the parking on the map: this is a central point where several paths meet; we should make this parking smaller and place some green space. J thinks the parking a necessity for the people living here. The zoning is not easy to work out: where are the boundaries? Ch and E work on the new zoning and place a green texture. They also place the 'cabanes'. A row of big white cubes appears. We have to make them smaller, decrease the distance between them, and give them some colour. They settle on purple as a colour. Meantime there is some confusion about where the sound of football players comes from, since there are some boys playing outside the tent as well as a virtual team. EV moves outside to listen. Next they place a row of green arches.

They switch to the sound panorama. There is the sound of the park. They decide to use some of the sound cards and associate them with the not yet frozen content cards: people walking and talking quietly, a small shopping area. Birds are missing. So Maria suggests placing a new content card showing birds in the park. There is much noise outside. They switch to the video view: this is extraordinary! Ch takes the joystick to explore the view. Then the scout carrying the mobile video camera is ready. They turn their attention to the new CCI building, deciding to make an entrance for pedestrians to pass through using the UrbanSketcher. Markus gets instructions. The blue building becomes larger and somewhat repositioned. He cuts a hole into the semi-transparent blue building and places a greyish entrance on the façade. Twice an orange car appears, moving towards the building and vanishing in the entrance. Amusement. They close the session.

4.7.2 Oslo workshop in a studio space

In the first workshop seven people participated. Group work was made somewhat difficult by the presence of two Iranian participants (the shopkeeper at Blindern station and an architect friend of his), who not only did not speak English (and only of them Norwegian) but also found it difficult to participate in group work. They resorted to frequent side conversations. However, the group worked fast and engaged with much more content than participants on the second day, addressing almost the same issues as the latter.

We here give a summary account of the second workshop day, which was dominated by the presence of MK from the architectural firm that had won the bridge competition and also by a strong interest in discussing flows and issues of access, also for people in wheelchairs. Discussion starts with the current flows of people and bicycles and the new bridge comes soon into focus with MK explaining the project on the map with lots of gestures and the others joining in with questions. They agree on the need to think about the 'welcoming part' of the station. From there they briefly turn to 'the other bridge' further up the creek, discussing changes that the new informatics building will bring about. This bridge will be the most populates crossing, a park with a pond will make the new campus more attractive. Participants place a pond on the now construction site to then turn back to Blindern station.

They first work with P1 with the SevenUp building present, place a newsstand symbolizing information and discuss how to convert the area into a place. The moderator (I) suggests putting a sketch of the new bridge in the panorama and they add a stage with young people dancing, which MK connects with music from his mobile phone.

Next participants place flows and engage in a long discussion about access to the bridge, to the platforms, also in wheelchairs. They place flows (under the bridge, to the research park, between the platforms). They address conflicts between pedestrians and cyclists crossing at high speed. At some point MK places a sketch of a possible solution (separate lanes on the bridge) on transparent paper directly on the map. Solutions of slowing down bikers are discussed.

The bridge area now looks like a big traffic junction. Participants focus again on the welcoming idea. They start looking for content and while the rest of the group has a coffee break MK starts producing sketches of his ideas from the morning using the Paper Sketcher and places them in the panorama, creating a composition of different elements: a signpost, a (horizontal) map of the area (with people around), as well as a huge poster wall for students on one side of the platform, an information screen with people moving in front on the other side.

AL, a sound expert and artist, starts a discussion on sound, which focuses on how to augment the site itself with sound. They talk about unobtrusive forms of people passing by triggering sound by their movement only to be heard by them; about conveying information about places through sound; and discuss the rather intrusive panorama sound with trains arriving and leaving every few minutes. Finally, the briefly talk about access issues again and end with idea about turning the bridge into a place for displays as well as performances.

5 Multimodal analysis of aspects of collaboration and presence

The aim of our analysis is to understand how participants make use of the MR-Tent in co-constructing, discussing and evaluating MR scenes representing a vision of the future of the urban site. For this purpose we have subdivided participants' actions into four broad types of activities: plan intervention, perform intervention, understand MR scene, evaluate result of intervention. Our analysis proceeds in several steps:

- First, we will describe patterns of action we observed for each broad activity category, analyzing selected scenes, with a view onto the interplay between the different modes or semiotic resources (O'Halloran et al. 2009).
- Secondly, we will look at selected scenes demonstrating how participants engage with the visual and sound elements of the scene.
- In a third step, we will highlight the role of different types of gestures, of body posture and gaze, of the diversity of object manipulations, and of the intermingling of acting and talking in participants' co-constructing, developing a typology and providing small examples.

We will present observations and findings from both workshops, the one in Pontoise (focussing on the second workshop day) and the one in Oslo.

5.1.1 Plan interventions

Planning an intervention involves first of all discussion of what to do, reasoning about alternatives, and, secondly, selecting content – objects to place, types of flows, sound. These planning activities are characterized by particular uses of the MR-Tent.

Vignette 1 Orienting in panorama and looking for content representing activities[1]

12:46:03 Participants change to the smallest scale map (Figure 26/1)
12:46:21 Ch walks to the whiteboard (WB) looking for content (Figure 26/2).
The group discusses the choice of scale and view appropriate to their plan to place activities in the park:
12:46:34 EV*: … it is at this scale that we could do it, things for people … urban furniture for resting … this scale is good for doing this.*
12.46:59 M:*… would you like to zoom a bit and look at other viewpoints and then place the things? Or place immediately?*
12:47:10 EV: *Yes, we are still down there, we see from this viewpoint.* - Ch: *There we are fine.* – EV: *The view seems to be this one.* – M: *We are already there. But you may have to turn the zone of vision and zoom.* –
12:48:18 M: *Voilà, here you have your bridge. – Which is a bit too big I think. – It sits well there. – We still cannot see our stairs but this is not a problem.* – M: *Because it is outside the field of vision …* (Figure 26/*3)*
12:48:08 E zooms - participants have chosen the central panorama P1, where we see the two paths

[1] Abbreviations: Whiteboard (WB), ColorTable (CT), Configuration Area (CA); Body configuration (BC). All participants are referred to by their acrynom. Research team members: Maria (M), Burcu (B), Valerie (V), Michael (MI), Ina (I), Gammon (GA), Markus (MK), Jean-Jacques (JJ). Numbers in brackets refer to figures (starting with upper left).

The clocks of the two cameras had not been perfectly synchronized – the manually operated camera is 33 sec behind the fixed camera (FC), in Osloo it is 20 sec; also the year indicated in the Pontoise videos should be 2009 (and not 2008). Pontoise: P1 (central panorama with view onto château), P2 (panorama with view onto CCI and hill behind), P3 (panorama with view onto basin of Patis and viaduct). Oslo: P1 (panorama taken at bridge bend, a) with SevenUP building, b) with building deleted); P4 (view from 'other bridge' to research park); P5 (view from kindergarden); P6 view from centre of Blindern bridge).

they have placed: this is the area they have chosen for placing activities.
Next EV and G move to the WB conversing (Figure 26/4) and looking at content and soon after the others follow (Figure 26/5)
12:50:01 EV: *Activities like this one, this is good, the tai chi. We already have people doing tai chi. –* Ch: *Elements to train your muscles, for senior people … A sports parcours …*

Figure 26: Changing map and looking for content

Planning an intervention typically involves orienting oneself in the scene as well as on the map. In this Vignette some time is spent with finding the scale of the map suitable for placing activities in the park and with manipulating the scene – turning the cone of vision, zooming. They identify the two objects they have already placed – a bridge across the small river Viosne (la passerelle) and stairs facilitating access from the hillside across the rocks (falaises). Maria as the moderator leads these orienting activities. We can also see that activities and roles are distributed. Whilst the others are looking at the panorama, Ch already moves to the WB to look for content. As soon as the group has established the best map and view, first EV and G move to the WB, followed by M, before the others join.

Vignette 2 Orienting on map discussing connections and looking for content

14:4:24 View onto the building in 'bleu Klein' that was inserted in place of the old CCI with textures on the parking space having been changed to grey
14:41:44 Group looks for another map
14:41:57 They change back to medium scale map
14:42:01 Change back again to large scale map – their plan is to discuss the connection between the entrance into the park when arriving from the Notre Dame church

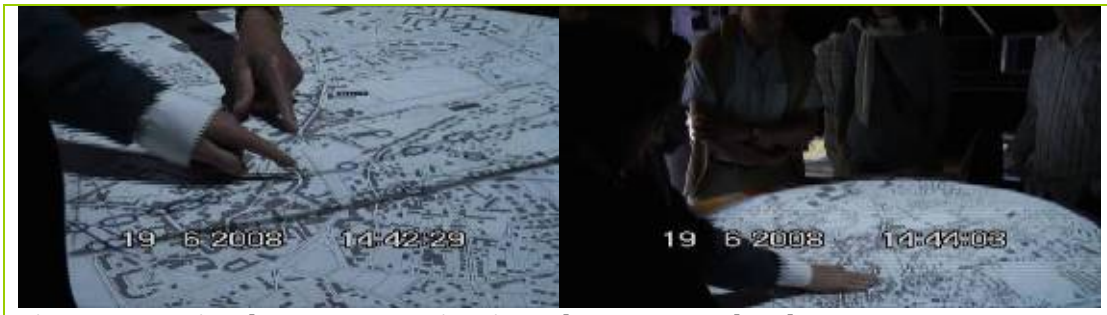


Figure 27: Tracing the street connecting site and Notre Dame church

14:42:08 S traces the street from CCI to Notre Dame with his finger (Figure 27/1)
14:42:24 He moves his finger back in the other direction (Figure 27/2)
EV+S: North is there, the church is over there … and there was the idea to move up … S: There is the cathedral, non?
14:42:29 J's hand comes in with his finger also moving on the street (Figure 27/3)
14:42:33 S's hand reappears – we can also see the barcode reader held by Eric
14:42:37 S' hand again moves back and forth tracing the road
14:42:51 S with his finger on the map
14:43:02 S rehearses the idea discussed in the morning about transforming the street into a shopping street for pedestrians covered by a transparent roof – at one point he places his hand on the map stressing his point (Figure 27/4)

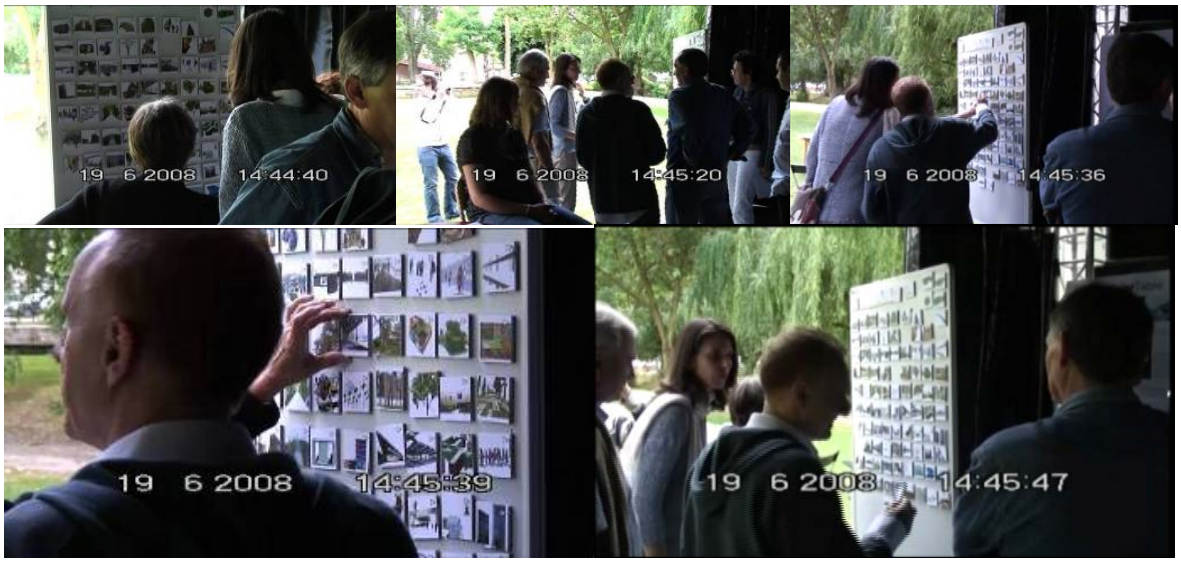


Figure 28: Selecting content while discussion is continuing

14:44:02 EV moves to WB and starts looking for content
14:44:40 EV and M are at the WB (Figure 28/1) – the others have stayed at the CT, G and S are discussing
14:44:50 EV takes a 2D image to have a close-up look - 14:44.53 She takes another image
14:45:20 All in open circle towards WB (Figure 28/2)
14:45:03 EV turns WB towards outside the tent
14:45:33 EV, S and M in front of WB looking at content, EV performs gesture
14:45:36 All three point to a content card (Figure 28/3)
14:45:39 EV takes content card (Figure 28/4) – she hands it over to S who takes it to the CT (5) – the whole group arranges itself around the CT

In the second vignette the map is in the centre of attention before content gets selected. The first move again is changing map, which is performed twice, so as to have the right scale for planning the intervention. In this scene S has taken the leading part, with EV collaborating and J bringing in his local knowledge. S with the help of EV starts orienting himself on the map – where is North, where is the church? He performs tracing gestures meant to achieve a

common understanding of which connection they are actually talking about and J joins with his finger verifying the facts. E is waiting with the barcode reader in his hand. When S explains the idea of this intervention, G brings forward his strong disagreement and the two get involved in a discussion. Meantime EV moves to the whiteboard looking for content – the group splits. M, EV and S are looking for content and in one moment all three point at the same card.

Vignette 3: Visualizing existing flows in an area

Discussion in Oslo on the first workshop day starts with the flows of people and cars around Blindern station and problems connected to that. Before actually setting new flows, participants decide to visualize the existing situation in a strongly collaborative way.

The sequence in Figure 29 starts with the first flow having been set. One participant moves half around the CT to give it a bend as she finds this 'more natural' (11:25:11). Next, a second participant sets flows by placing one blue token after the other and AG follows with the third one (11.28:0X). AG shortens one of the flows and sets the fourth one. A little later she is energetically reshuffling some of the flow ends without actually asking anybody. The final image gives an overview of the flow situation.

Participants then turn their attention to the screen evaluating what the have done. It is almost 'a network of highways' and they agree that the existing situation needs to be changed.

Figure 29: A network of flows around Blindern station

Planning an intervention these and many other scenes show involves different types of activities:

- Participants orient themselves on the map – this involves finding the map of the appropriate scale, pointing gestures on the map, either individually or collaboratively, and tracing gestures.

- They also orient themselves in the MR scene - this involves moving attention between map and screen, rotating and zooming, pointing to the scene identifying places and/or objects they already placed.
- Selection of content usually happens after a thorough discussion of the planned intervention. It is done either individually (someone looking for content that has been mentioned) or collaboratively.
- Shift of attention to content selection affects the group configuration, with one or several people moving to the WB and back to the CT, while others may continue discussion at or close to the CT. As the WB is located at the entrance to the MR-Tent this also occasions crossings of MR boundaries, looking or walking or pointing outside.

5.1.2 Perform intervention

There is a fluent transition between planning and performing an intervention. Performing involves different types of object manipulations, mainly placing objects, 3D lines, flows, textures or sound and manipulating the content – (re)positioning and (re)sizing it until it looks right. This may also require manipulating the scene, by changing map or background, rotating, zooming, and finally, when a decision has been reached, freezing the scene. Participants also have made use of the UrbanSketcher, painting on the screen and creating 3D objects.

Vignette 4: Setting flows

12:29:55 Group sets flow along rue des Etannets - Ch: … *rue de faible densité* (orange tokens)
12:30:17 M points to the flow of people in panorama explaining – from time to time an orange car passes – *this is a low traffic density road*
Group discusses where to position a path for bicycles and pedestrians
12:31:20 Ch and E set flow (yellow tokens) (Figure 30/1)
12:31:40 Three hands (Figure 30/2): Ch. touches yellow token, S points, E touches orange token – they try to achieve the tracking of two tokens close to each other - meantime EV and S talk about the situation
12:32:00 M: *Would you like to extend the connection to the square*? – EV: *Place Notre Dame?*

Figure 30: Setting flows

Setting flows usually involves two people that place the rectangular tokens at the intended endpoints, eventually adjusting the angles to produce a bend. When, as in this scene, two flows are placed close to each other, eventual tracking problems have to be taken care of. During this intervention attention is mostly focused on the map, with other group members commenting, directing, and pointing; as in (2) where two hands (Ch and E) take care of the endpoints of the two flows while S is commenting and pointing. Attention switches to the screen for crosschecking if a path has been placed well. Although also visible on the map as moving dots, the animation of a path seems more salient on the screen – see the orange car (and associated noise).

Vignette 5: Painting 'on' the viaduct

11:59:39 Participants have rotated P3 to match their real orientation within the site; therefore as S is

reaching out to the viaduct in P3 he is actually extending his arm towards the real highway. The visual panorama is pushed into a virtual distant background by the sketcher interface, reflecting the real spatial gap between the two sites. As S is painting he is also casting a shadow onto the projection, thereby placing an image of himself as observer onto the footpath looking onto the viaduct (Figure 31).

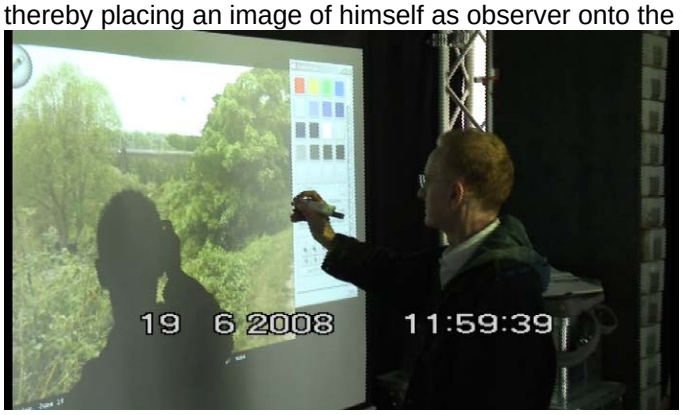


Figure 31: S painting on the viaduct

While S is carrying out his individual 'art project' transforming the viaduct, the other participants are arranged in a file in front of the screen – several are pointing, making comments, directing.

Painting on the screen is an individual and time consuming activity, requiring full attention to the tool, interface and taking place directly in front of the screen.

Vignette 6: Placing and manipulating a 3D line of chairs

The group has placed a series of chairs and they are looking for them in the panorama (P1) – G points with both hands
12.53:15 *We cannot see them since we have placed them closer to here and they are very small* (Figure 32/1) – V points them out on the screen – they start increasing the size
12:53:27 *Not too much, stop, we have to decrease again* – they look intently at the screen (Figure 32/2)
12:54:09 EV: *They are not really well positioned; we may have to push them to the other side?* - E and EV push the chairs to the other side of the path while the others look and direct (Figure 32/3), (Figure 32/4), Ch also helps
12:54:45 M: *They are between the Viosne and the … Well, are you satisfied?*

Figure 32: Increasing size of chairs – repositioning row of chairs

The group is placing a '3Dline' of green grassy chairs and they have trouble spotting them in the panorama. This involves engaging the MR scene, looking, pointing. Positioning the row

of chairs on the other side of the Viosne while happening on the map requires a lot of crosschecking on the screen.

Vignette 7: Defining a green space and placing row of cabanes

While still on the camera view, the group discusses the idea of cabanes (small stalls). Placing them along the wall using the camera view does not work well.
Long discussion about parking issue related to the fact that the cabanes have to be provided with goods on a daily basis – in Ch's view this highlights the need to preserve a green area along the Viosne – M suggests to return to the panorama (P2) – the new building in 'bleu Klein' reappears
Ch: *So here we have to reduce the parking … make a green space, which joins the other one on which we will place the cabanes, I think. We could redo a zone.*
15:32:24 M: *All this is free for the moment being* – points on map. - Ch: *This is free? – we can reduce the parking* - J explains the parking situation around the CCI – it is a necessity to provide enough parking space – the discussion takes place on the map
15:33:23 M: *Now, how do you want to cut your parking?*
15:33:40 While Ch rests his hand above the parking area on the map, E places two tokens on map within Ch's reach, which he takes up (Figure 33/1)
15:33:42 Ch creates line with orange tokens (Figure 33/2)
15:34:05 Ch and E exchange tokens over the CT (Figure 33/3)
15:34:15 Ch has placed second line with blue tokens
15:34:22 EV: *And can we with this placing be fairly accurate on the bandwidth?* – Ch is still adjusting tokens (Figure 33/4)
15:35:18 *Ch: Place a green coverage … a green texture – after this we place the cabanes.*

Figure 33: Ch and E collaborate in creating rows of objects

15:35:31 EV returns with a content card from the WB, which shows an object: *we could place this one if we are having fun, this is pretty* – M explains that you have to look for textures
15:35:40 Turn back to WB – Ch returns with a texture card
15:36:12 Ch suggests to place the cabanes
15:36:12 Ch places content card (3D cabanes) on red field
15:36:33 E asks – *we make a row*? – E and Ch collaborate (Figure 34/1)
15:36:53 Huge cabanes appear in the panorama (Figure 34/2)
15:36:59 *Hou … we have to reduce the size!*

Figure 34: Setting row of cabanes

In this vignette Ch takes a leading role. We can see how the planned intervention – rows of little stalls to be used for various purposes – triggers again a discussion on available parking space. Ch advocates the preservation of green and starts preparing the reduction of parking spaces the have already defined in a previous step arguing against J, the 'local expert'. M takes up a strong moderator role in this scene, pushing the group to act. EV is active commenting but also looking for content to place (and object instead of a texture). Ch and E collaborate in getting the lines precisely defined before Ch. places the green texture and he goes on adjusting for a while. As a next step both of them place a row of stalls on the map, with the immediate effect drawing attention to the panorama.

Vignette 8: Modifying a 3D object

Seen from the perspective of the mobile scout the blue CCI building that has been constructed with the UrbanSketcher looks out of scale. Participants ask MK him to enlarge and reposition the CCI: *OK, this is the maximum – and we would like to make a hole. – OK. – So that the (blue) person can enter. – And the idea is that the path leads into the building.*

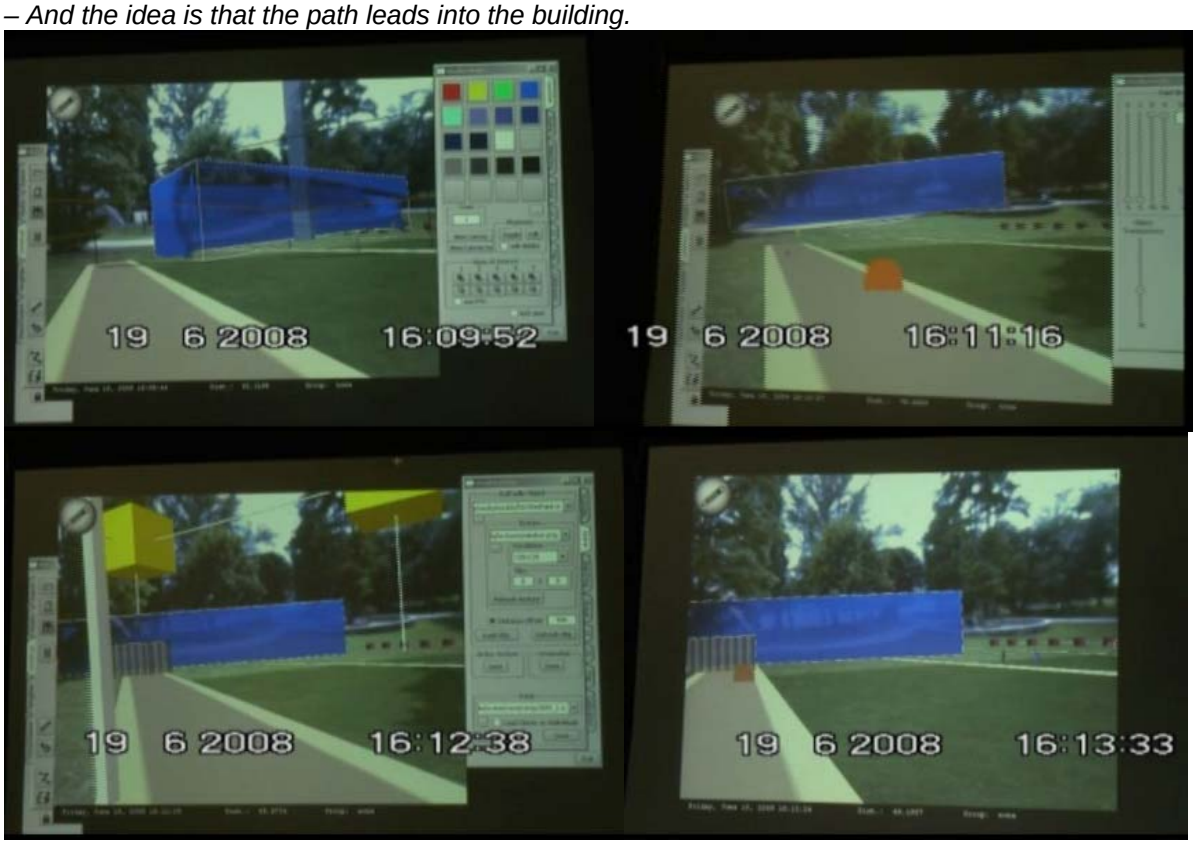


Figure 35: Moving the building – a car approaches – adding an entrance

16:08:54 MK starts to construct the entrance – and then to reposition the blue building towards the street. *Very good. Now we need a hole that corresponds to the road. – MK: This is difficult. I cannot because I would have to arrive from the other side.* - MK decides to rotate the building. – *Paint it in white, just the hole! – There is even a car that enters, a car, look!* - MK first tries to cut a hole into the

façade, nearly wiping it out. He then constructs an additional sketch object, onto which he places a fence texture, from this distance appearing like made from tin, which he repositions and rescales to become the entrance into the CCI: - *This is not bad. – A door like an Egyptian temple.* (Figure 35)

In this scene MK performs an intervention that needs some practice, hence appears too time consuming to participants. They direct his actions, which is to realize an idea they had from the beginning of the blue building being transparent and open to people to pass (and continue towards Notre Dame through a shopping mall.

Vignette 9: Perform intervention with paper sketcher

During the Oslo workshop MK decided to visualize his ideas from the morning and as he did not find suitable content he used the paper sketcher. We see MK with one of his sketches underneath the webcam, next with the command cards in his hands and finally placing one of the sketches (Figure 36).

Figure 36: Sketching object and placing it in the scene

The sequence of images in Figure 37 illustrates MK's evolving composition. He took great care in placing, sizing and colouring the objects. Colour affects the salience of objects. We can see that the forgotten red post box that JH has positioned asserts its place in the composition, so does the yellow colour lend weight to the overview map and size to the signpost. The flow of people and cyclists brings a narrative elements in the scene; so do the people who are clustered around the map and the people jumping in front of the information board on the other platform.

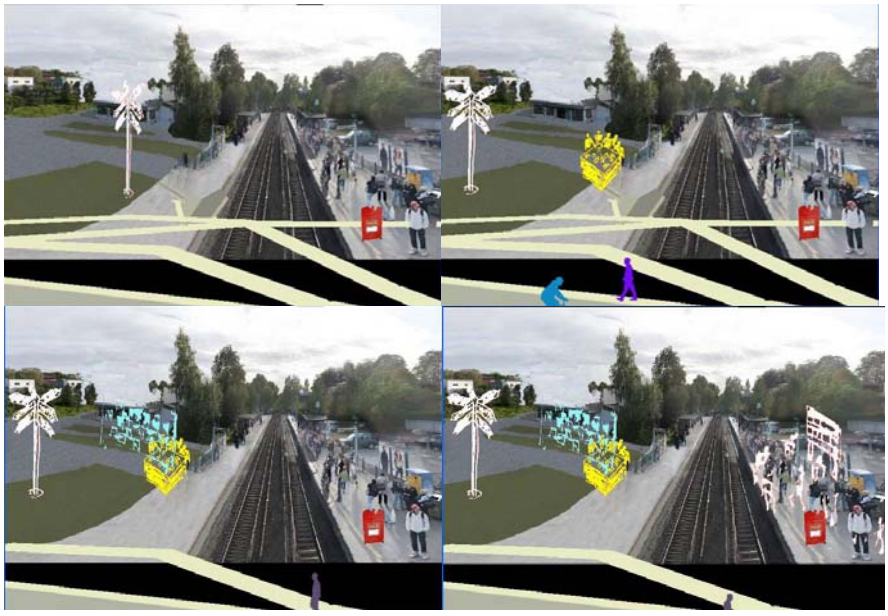


Figure 37: Scene composition

The six vignettes illustrate some activities that are typical when it comes to performing an intervention:

- Participants make much more use of the screen when performing an intervention then when discussing and planning; they are in fact building a scene and need to know how their interventions translate into a MR scene and different backgrounds.
- Engaging with the scene implies opening up spatially in a half circle with a view onto the screen. Those who actually perform the intervention switch attention between CT and screen, also bodily (re)orienting rather frequently between table and projection.
- For activities, such as setting flows or a 3D line, usually two people are required. In this group one person – E – has taken the role of 'technology support' – already preparing the tools for the next intervention while the others are still discussing. Hence, typically, two of the participants perform whilst the others are commenting, pointing on the map or on the screen, directing, watching the scene change or continuing their discussion, attentive to the next move.
- The UrbanSketcher offers attractive possibilities of building a MR scene, with the constraint that it's operation requires some practice and it is not a collaborative tool. In the last scene participants direct 3D construction and repositioning, bringing up new challenges.
- The paper sketcher is easy to handle and offers a possibility to produce visual content 'on the fly'.
- Performing an intervention often implies evaluating a previous step – e.g. what about the parking zones we have defined – and/or modifying a previous intervention.

5.1.3 Understand MR scene

Understanding an MR scene happens from the very first interventions on and it is often intermingled with planning and performing activities. When the scenes get richer and participants explore different backgrounds and viewpoints the 'understanding' activities become more and more prominent, as the following vignettes show.

Vignette 10: Searching for objects in scene

Ch and EV have left for a short period of time and M, J and E continue. M explains CT and previous actions to J, who has just arrived – E takes the role of technology support – they look at the screen trying to identify objects that have already been placed.
15:17:35 J: *Where on this map (screen) are the ponds (douve), we can't see the ponds?*
15:17:45 E pushes the yellow token a bit
15:17:53 J: *This we can put here – traces a line along the Viosne with his finger – et là – tracing again*
15:18:33 J: *This is a path* – M: *No, this is the cone of vision* – points out on map
15:18:08 J: *This path here is this path over there* – points first on map (Figure 38/1) and then on screen (Figure 38/2)
15:19:40 I turns wheels – rotates
15:19:59 E shifts blue token
15:20:06 The other pond appears – all are staring on the screen
15:20:35 E deactivates the zooming function and starts rotating
FC15:21:55 M and MI touch blue token looking at the screen (Figure 38/3)
FC15:22:10 *And where is the other pond? – It is behind the trees. – It was not behind the trees in the beginning – Has it disappeared? – We have lost a pond.* – FC15:22:20 V moves yellow token - FC15:22:29 *Ah, here it is!* (Figure 38/4)

Figure 38: Searching for objects in MR scene

Participants in this scene engage with the scene trying to explain the scene that has already been constructed to J, identifying objects that have been placed. This searching for objects in the panorama involves rotating, zooming as well as slightly repositioning the objects to make them 'appear'. J performs a dual pointing gesture that is meant to connect a path on the map with the corresponding path in the projection. While attention is concentrated on the screen, some action is performed on the map – tracing, pointing out (the cone of vision with both arms), and adjusting the position of tokens.

Vignette 11: Understanding scene seen through see-through

15:24:05 M: *We have to explain Monsieur Bernard* (J) … - E starts explaining
15:24:03 His arm appears on the screen – he points along the passerelle with a tracing gesture
15:24:03 E makes a turn back to the CT/map
15:24:20 E points with his finger on rue des Etannets on the map – from the other side of the table J also points with his arm stretched out (Figure 39/1), (Figure 39/2)
15:24:26 E has turned back to the screen
15:24:45 J identifies the footballers they have placed before
15:24:50 J points at place on the map while E points at same place on screen (Figure 39/3)
15:25:30 J: Ah, at the foot of the wall … E makes the corresponding movement with his hand on the map and starts explaining the idea of artists using the cabanes (Figure 39/4)
15:26:00 V suggests to use the camera view for placing the cabanes

Figure 39: E explains scene as seen through see-through interacting with J

As the see-through offers a completely different perspective, positioning in the uneven terrain is not so exact and the 2D objects don't change angle automatically, understanding the scene requires some effort. This time E activates his role of urban expert explaining the scene to the others. He physically switches between screen and map, pointing out objects. Mapping places and interventions on the map and on the screen is achieved through gestures - tracing and pointing gestures on the screen and on the map some of them collaborative.

Vignette 12: Crossing MR boundaries

16:00:40 Switch to camera view
16:00:46 This is extraordinary!
16:01:32 M asks Ch to try out the joystick
16:02:03 M starts describing what can be seen: *the parking, the two ponds, the viaduct, the Basins de Patis, the wooden passerelle* … (Figure 40)

Figure 40: M identifying objects

16:02:22 Ch: *The stairs we will put them back where they were before*.
16:02:27 Ch: *Voilà , there are people playing!* – A young woman can be seen playing in front of the window (Figure 41)

Figure 41: A 'real' person' appears in the see-through view

FC16:03:08 – Ch starts zooming – *I don't know how* – he shifts view as far to the right as possible where you see the building in 'bleu Klein' emerge, pretty flat from this perspective

FC16:04:42 – Scout can be seen walking outside in direction of CCI
FC16:04:46 Ch takes a picture – some have turned their backs to the CT looking outside where scout is walking
16:03:10 *We are still on the side of the ducks – no, they have flown away – but we have birds, they are very present*
Switch to scout with mobile camera
16:04:23 One can see the cabanes – there is also the triangular building from the morning
16:04:35 Maybe we can erase it – J gives it a try – the building does not disappear from the map
16:06:07 Ch points to the triangular building (Figure 42)

Figure 42: Ch identifies triangular building in scene and J performs iconic gesture

16:06:15 J: *This one with the point* – he performs an iconic gesture
Looking at the screen they discuss that the cabanes are so small – they also identify the huge car parking they have placed
At some point the erasing has worked.

Switching to a real time camera view – fixed as well as mobile – requires another reassessment of the scene. Reality elements come into play, which stimulate boundary crossings. Participants are delighted to have real people mix into the scene. The fact that there is a scout with a mobile camera to direct makes them turn their attention to the area around the tent – from which perspective do they want to view the scene. Finally, the stubborn appearance and reappearance of an object that one of them had placed in the morning makes them want to erase it. Some time is needed to identify it in the projected scene – J performs an iconic gesture describing the triangular building – and even more (for technical reasons) to erase it. Also the sound brings virtual (the birds) and real (the noise of people outside) elements to participants' attention.

Understanding a scene, although mixed with other activities, has its own dynamics:

- Participants deeply engage with a scene on the screen, identifying and describing but also mapping. This mapping involves tracing and pointing gestures, often dual in nature – pointing to something on the map and on the screen.
- Switching background always requires reassessing a scene and eventually modifying it, as can be seen in the case of the triangular building.
- Manipulating the scene may be necessary, either a slight repositioning of an object so as to make it visible and 'in place' from a particular perspective, or rotating, zooming.
- Crossing mixed reality boundaries is an integral part of understanding. Some things just happen – like the noise of something that could be either virtual or real, the

appearance of a real person or event in the scene. The cameras, both fixed and mobile, bring the site outside to the immediate attention of participants and make them engage more explicitly with this outside.

- Participants are more often in an open formation in front of the screen and occasionally move again closer to the CT to point out something on the map.

5.1.4 Evaluate result of intervention

Evaluating is an activity that is not easy to separate from others, as participants frequently assess what they have done without necessarily entering a long conversation. While some of the previous vignettes have elements of participants evaluating, we also identified more explicit evaluation activities.

Vignette 13: Questioning an intervention

14:34:56 Using a frozen zone created by paths they place a ground texture with orange token – it looks like water – they take a second texture token to cover the whole place
14:35:26 S pointing on map (Figure 43/1): *A whole part has been demolished … you have obliterated all?* - V: *But these two are good, don't you think so?* – M: *Not so much because they pass through the parking space.* – V: *Then you have to redo them, erase those that are not places well, you have to redo them.*
Two parallel discussions: S talks with B gesticulating, both standing closer to the screen; the rest of the group continues in a half circle in front of the CT
M: *Are you satisfied with this definition of the parking zone or do you want to …*
14:35:46 EV: *Let's say that this changes the whole configuration of the quartier since this building has been shifted; it is no longer on the same place* (Figure 43/2). – M: *You can move it*. – EV: *The building is where we are right now.* – M: *Look, it moves*. – S: *Oh yes, voilà, and the texture stays underneath, this does not matter.*

Figure 43: Questioning position of new building (above)

In this scene the group has just placed textures that mark the parking zone they have planned. This leads them to discuss the new building in 'bleu Klein' that replaces the old CCI building, as well as the zoning they just completed. While V suggests to redo the lines so that they better fit their idea, the discussion of the new building continues, with the attention of all mainly focussing on the screen, with M, V, EV, and S emphasizing their arguments by pointing on map and screen.

Vignette 14: Revoking the issue of parking

15:26:23: Ch returns – J starts explaining to him – the discussion takes mainly place on the map with lots of pointing (Figure 44/1).
J: *The car parking we have placed it there, we cannot put it close to the château*.
EV: *There we have worked on the entrance to the town*. … EV: *What could be interesting is to redo the parking in a more aesthetic way. It is not nice.*
15:26:45 E comes back to the CT from the WB and presents a content card (Figure 44/2): *We try to reposition the cabanes*. - EV: *The small houses? Did we see one along the wall?* – E: *One along the wall and one …*
15:26:56 E, EV, J, Ch around the table arguing
Ch: *This is also something we have placed this morning? – No, these are the ponds.* – E: *Ah, these are ponds … then we are in Marcouville, agree?* – J: *The players are on the other side, there and there*.
15:27:26: Ch: *Well, can I start reflecting? Since there we have the parking and you enter through thus small gate there? …. J: Yes but it's just awful. – Thus we have placed parking for bicycles.*

Figure 44: Ch and J discussing previous interventions; E presenting content card with cabanes

In this vignette participants first go back to a previous intervention reassuming the arguments – EV would like to find an aesthetically more pleasing solution for the car parking. E evokes the agenda of the cabanes who has already fetched the content card. Ch, who has been absent for a little while scans the screen, reassesses the scene, identifying the ponds they have already placed and orienting himself in the panorama. Then he goes back to the question of the parking proposing to engage in a moment of reflection.

Vignette 15: Discussing the cabanes

The cabanes have been placed:
15:36:59 *Hou… we have to make them smaller. – Very big cabane!- 2,5 or 3m.*(Figure 45)

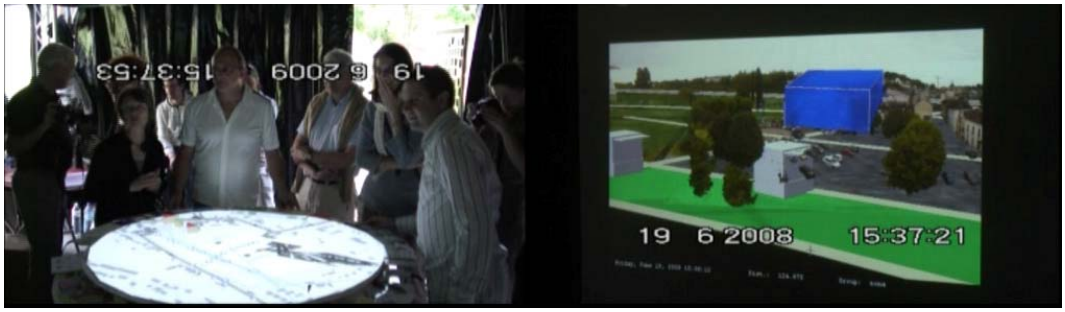


Figure 45: Evaluating size of cabanes

15:37:22 Ch: *Not bad – we can maybe reduce the distance between them. – We are at how much now? – Don't know … 5.*
Ch: *This looks good.* – EV: *This looks strange*.
15:37:53 Ch: *The axis is a bit …*(Figure 46)

Figure 46: Evaluating spacing of cabanes

Here evaluation is an integral part of participants placing and manipulating a row of cabanes. They are looking at the scene, engaging with it, arguing about the right size, right distance between the objects, as well as the exact positioning.

Vignette 16: Shifting attention

Participants have placed a flow under Blindern bridge, then one between the station and the research park, which MK is slightly bending, and one from the Blindern side to the other side of the platform. BA: *All these flows are crossing each other in a way.* MK starts explaining the logistics of approaching from the research park. The topic of bikes crossing at high speed comes up and MK produces a sketch on transparent paper visualizing the proposed separation of flows across the bridge (13:28:34). BA makes an argument about that you have to accept conflicts (in this case between bikes and pedestrians) but K insists on thinking about people in wheelchairs. We can see the maze of flows created at the station. At some point in this discussion I points out that Blindern station has now become a major traffic junction. We see in the next image that somebody has turned the wheel to switch attention away from the flows to the 'welcoming' part of the station they had been discussing in the morning. There is a lot of noise: the panorama noise with incoming and departing trains, the (flow) car, as well as the noise of bicycles. Traffic is very present in this scene. (Figure 47)

Figure 47: Becoming aware and switch of focus

Evaluation in all four vignettes involves participants standing back, engaging with a scene, and reflecting together. These reflections are occasioned by different types of events:

- It may be a controversial issue, such as car parking, that continues to raise concerns and triggers new ideas;
- A switch of perspectives that requires participants orient themselves in the scene, looking for objects they had placed;
- Or a becoming aware of a neglected issue and, as a consequence, switching focus.

- Placing and manipulating content – resizing, defining distances, etc. – is often accompanied by moments of critical assessment.
- Evaluation draws participants' attention to the screen; engagement with the CT happens mainly for the purpose of mapping – what we see in the projection is connected to an intervention in this particular place on the map – or when new ideas come up that have to be communicated on the map.

5.1.5 Engage with scene – the role of visual elements and sound

Visual representations are at the core of mixed reality technologies - in physical form (e.g. content cards, maps), as well as on screens of different types. Participants in field trials attend to multiple visual fields. Our analysis seeks to understand how different representations (of an urban project or a part of the city) and different types of visual content enable participants to express and experience their ideas and/or to accomplish certain tasks. In the MR-Tent we also work with sound, looking at how sound contributes to participants engaging with an MR scene and/or a task.

As already mentioned, researchers (Kress and van Leeuwen 1996, O'Toole 1994, to whom also Stenglin 2009 refers in her analysis of space), distinguish between the representational, the modal and the compositional aspect of visual material. Key concepts in the analysis of visual material are: salience, composition, modality markers, and narrative structures. As the following analysis will show these aspects cannot be really separated and if only for analytical reasons.

'Realness': The concept of *salience* addresses the fact that elements of an image attract the viewer's attention to different degrees, depending on their placement, their size, their colour, their sharpness, etc. *Modality markers* have a guiding function for the viewer's attribution of realistic value to a representation: "Modality both realizes and produces social affine", by aligning the viewer, reader, listener with certain representations and not with others, it produces what we call true/untrue, real/not real, thereby having the potential to produce new values and modes of thinking (Kress and van Leeuwen 1996).

The first example is taken from participants having worked with the aerial view as a background for discussing connections and parking lots. They then switch to P1 - the bicycle and car park now seem gigantic because they were scaled as icons relative to the aerial view, and there is no translation of object scale between these representations. In P1 (Figure 48) the symbolic turns into the concrete on the physical map. The projection of the car park on the map covers half the length of the site, whilst all the other objects in the scene are scaled relative to each other: the two objects (parking for cars and bikes) introduce an element of 'surrealism' into the MR scene. The participants are surprised, but content with the impact of what they perceive as symbolic interventions.

Figure 48: A 'symbolic intervention'

In the second example we can see how an ‘oversized’ objects changes the meaning of the whole MR scene. E suggests placing a cultural centre behind the château (12:26:33); it is approximately four times as large as the château. Hidden behind the old big trees it makes the site appear small; the path now leads directly to the château and the site becomes a transitory space, extending and forming the entrance into the centre (Figure 49).

Figure 49: An object changing the meaning of a scene

Real size does not necessarily make a scene more real. Let us go back to participants placing stairs, which are supposed to provide access from the hillside above rue des Etannets. This takes some time. In Figure 50 the stairs appear as leading from the building of the P1 viewing point and being turned towards the basin of Patis. Participants then move the stairs closer to the intersecting pedestrian flows; they now seem to make a connection towards Marcouville. The blue flow people are passing underneath it (12:41:33). In a next step they decrease the size of the stairs to 5 m; this makes them ‘fall out of the scene’ even more: they have been reduced to a small footbridge crossing the river but leading nowhere, just towards a barrier of trees; they are positioned close to but failing to connect to the flows (12:41:43).

Figure 50: An intervention ‘falling out of the scene’

Colour makes strong effect (Figure 51). Painted in grey the 3D line of cabanes participants have created close to the building in ‘bleu Klein’ become part of the green area almost disappearing into the ground, pushing the blue CCI behind the panorama trees into the background, increasing the optical distance between them, and making the trees lifted from the ground. Coloured in blue they pull the CCI towards them, whilst the trees bind them even stronger together since they are encircling them and these geometrical forms step into the foreground; the green space with the cabanes balances the CCI volume having an equal weight.

The purple cabanes are a mixture between these two previous spatial configurations: they are resting on the green space but are no longer part of it; instead they integrate with the

panorama background; the blue CCI is pulled forward as they sink into the background, and thereby also the ring of trees is pulled forward becoming slightly narrower and even more dynamic; the parked cars (panorama) rest between the trees but are also pulled forward in-between the cabanes. The blue cabanes have the strongest counter weight to the city, thereby becoming part of it more than the purple cabanes, because they are so naturally part of the city that the CCI becomes isolated and the strength of the whole is diminished.

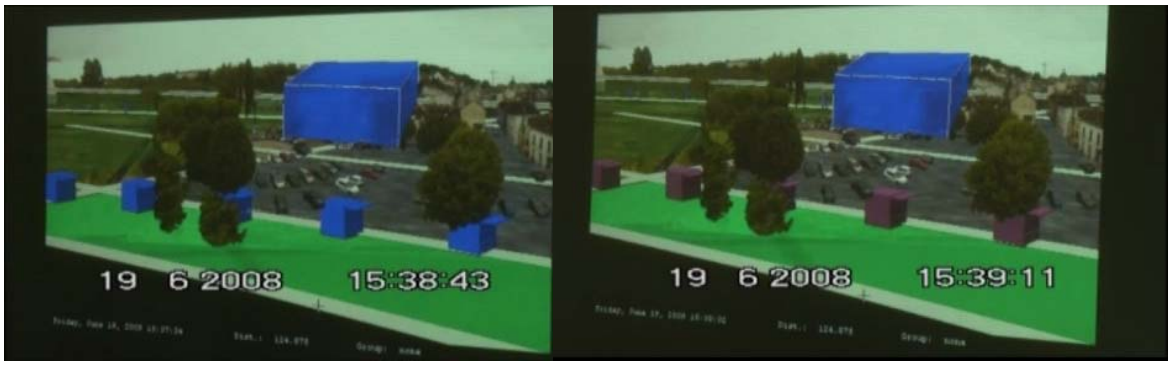


Figure 51: The effect of colour

Dynamic representations are special modality markers. Like in real life different temporal orders co-exist in the MR scene. Going back to Figure 54 we can one the one hand see that flows bring a dynamic dimension into the MR scene. The blue people are very visible (as is the car that appears from time to time) - they enliven the space, visually and audibly. Also apparent is the co-existence of two different temporalities: one is created by the dynamics of the flows on the quiet site; the other one by the soccer players that occupy the space for a longer duration of time.

A similar observation holds for the MR Scene depicted in Figure 52 (see also Vignette 8). Participants have placed a bridge (passerelle) across the Viosne leading into the Château Park and they are repositioning it (12:37:33) bringing it closer to the central axis. Later they discuss attaching a sound to it and decide on birds. The placement of the bridge seems strange because it is untouched by the pedestrian flows; it offers a separate access into the garden. We could imagine a 'flâneur' slowly crossing the bridge. This creates another time alongside the flows. There are three different visual time lines created by the rhythm of the site (outside the tent), the flows and the bridge signalling slow movement.

Figure 52: Different visual time lines

Sketching also brings a dynamic element in to the scene (Figure 53). Whilst participants are discussing how to segment the space around the CCI (which has been removed from P2), M is sketching a model to represent the idea of the new or transformed one; S steps forward indicating the CCI's relative proportions (14:30:44). Due to the blue pedestrian flows that animate P2, there is a moment in which it seems to be live sketching as in the case of a live stream that some one is sending from a mobile device (14:31:33).

Figure 53: Live sketching

Narrative structures: *Narrative image structures* are based on the connection of visual elements through vectors. Narrative patterns serve to present unfolding actions and events, processes of change, as well as transitory spatial arrangements.

The scene depicted in Figure 49 has a strong narrative element, in which sound takes its part. The triangular cultural centre transforms the space; it also changes the meaning of the flows. The blue people on the old (already existing) paths now seem to be walking away from the main path. The constant grumbling of cars creates a distance to the site, like a foggy wall, whilst the P1 viewpoint draws the participants inside, like into some 'secret garden' untouched by what is happening around. This is not just a park with some paths and a dominant building – participants' interventions have transformed it into a scene. L takes a photo of the scene, thereby becoming part of it, like a tourist standing on a hill making photos of a scenic attraction.

Figure 54: Activities bring a narrative dimension into a scene

The narrative elements of different MR scenes are strengthened by objects that represent activities. In this MR scene (Figure 54) E and EV have repositioned the 3D line of green grassy chairs, moving it behind the river (see also Vignette 8). There is a constant sound of flows, like wind brushing into a microphone; otherwise the scene seems tranquil. The green chairs now appear as a boundary to the Château Park, making it not completely translucent.

M suggests connecting an ambient sound (12:55:28). While Ch wants something 'calme', EV suggests the sound of children at play. - Ch places a group of people practicing tai-chi (12:56:43). They can be seen practicing in the Lavandières gardens, whilst blue people walk by on the path in front of the green chairs that seem to invite them to sit down and rest. – Participants also place a group of soccer players discussing where exactly to position them. - The sound of real soccer players outside, breaking awkwardly into the scene (12:57:42). – The soccer players have been diminished to real scale - they are playing in the middle of the street between the parking cars (12:57:42).

Compositional aspects: *Composition* is to do with the internal values and relations of the content and the interaction space it creates with the viewer. Framing is an aspect to do with

composition produced through format, background surface, physical frames or overlays of surfaces and substances. Framing allows setting a focus, creating relationships and boundaries, thereby also redefining the action space.

We can see that changing the viewing angle may bring other aspects of the composition to the fore. Zooming out from P1 and rotating makes visible that P1 has been taken from the window of residential building in the rue des Etannets (12:58:30). The stairs EV has placed (Figure 55; they are hidden behind the time mark) now seem to be emerging out of the building, leading the inhabitants directly down into the park. The central pedestrian path passes directly through the closed row of housing, towards the cemetery behind the hill. The site seems pretty empty, apart from the paths and the green chairs. - E moves the soccer players (green token) into the Lavandières gardens.

The car (flow) on the rue des Etannets seems to move forward again gaining speed; the soccer players are partially hidden behind the trees, forming a group cornered by the dominant pedestrian flows along the main axis. From this angle the strong division of the space by the flows becomes apparent creating boundaries. Also the parking cars (part of the panorama) create a border between the housing and the (virtual) flow of cars driving along the rue des Etannets, creating a closed area.

Figure 55: Making boundaries visible

Participants discuss and create boundaries. They place flows and 3D lines of objects (Figure 55), and as we will see later, lines and textures (Figure 51).

Planning one of the earlier interventions participants for the first time examined P2 with the CCI building removed (Figure 56). They are evaluating the flows they have placed. On the low-density pedestrian street along the rue des Etannets there is hardly a person walking by, and it takes a while until the first car appears; it clearly separates the living area from the site (we have to account for the fact that there is no height map of the ground and the wall has been removed). By placing the flow participants have reconstructed existing boundaries that have gone lost in this representation, in order to manifest and discuss the problems of connectivity.

Figure 56: Reconstructing existing boundaries

Among the many aspects of the constructed MR scenes that are to do with composition, one is to do with defining the 'right' size of objects. We have already seen that this is not necessarily oriented towards 'realness'. Participants have placed a 3D line of cabanes (Figure 57). The grey cabins appear completely over scaled; the abstract blue CCI lifts off the ground appearing to turn into a bridge between them; the trees become part of their façades; also the parking cars are sucked up into these gigantic blocks. Participants immediately agree to diminish the size of the cabins (see also Vignettes 6 and 13). This example shows how compositional aspects are manipulated all the time by repositioning or resizing an object, working with colour, etc.

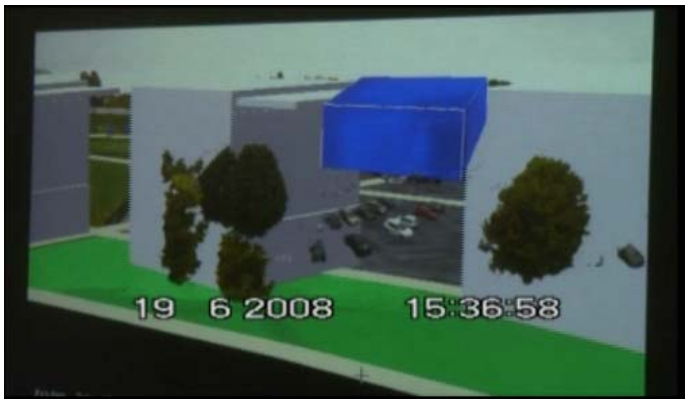


Figure 57: The effect of size

In the next MR scene (Figure 58) we see ponds (covered by water lilies) which participants have placed to emphasize and embellish the existing ones that are muddy and hardly visible. They have been positioned approximately on their actual location in the Château Park. Several scales coincide in this scene: the scale of the physical map on the CT, the scale of the over dimensioned car parking; the scale of the blue people. The scale of the ponds adds to the viewer's sense of dimension; it maps to the actual space outside. It also increases the realness of participants' interventions, because it is an additional reconstruction of the real place.

Figure 58: Co-existence of several scales

Different representations of the site

In Pontoise we for the first time worked with all representations of the site we had planned for:

- Three panoramas taken from different viewpoints and edited so as to make space for interventions;
- An aerial view for working on larger scale issues for which no panorama could be provided;
- A see-through installation that allows viewing interventions as projected through a window directly 'onto' the site;
- A real time video stream produces a) by a fixed and b) a mobile camera (scout);
- A 'token view' constructed for focused explorations of the soundscape.

Panoramas: The central panorama P1 is used most often by participants, as it offers a view onto the core area of intervention and, as parts of the trees have been removed to allow for a view onto the château, there is much space for interventions. In general we have observed that participants need to orient themselves in different spaces- the panorama, the physical map and workspace, and the tent position on site – simultaneously and that they have to align these perspectives. P2 represents the most complex situation in this respect. In Figure 59 participants' position in the tent is oriented towards the basin of Patis, whilst at the same time being on a footpath looking down onto it and working with an overview map of the whole area. It is as if the two spaces had been cut and fused, the entire space in-between being removed. This immersive element is strengthened by the P3 bird sounds that could easily be just outside the tent.

Figure 59: P2 - complex spatial situation

Let's consider the moment when they switch their attention to the CCI. There is an interesting intermediary stage, when participants are still oriented towards the basin of Patis, with the P3 space projected on the screen, and are standing with their backs turned to the CCI; they are discussing on the largest scale map (with the entire site covering the table). They have connected the tent with the parking lot by the CCI outside moving themselves into that spot pulling away from P3 reconstructing the real distance between the CCI and the basin. (The viaduct is a misfit, shrill and heavy, imposing and unconnected to the landscape and places surrounding). This 'mismatch' between the orientations of the MR-Tent and the workspace on the one hand, the place on which they are working on the other hand, is a constraint that results from the fact that the tent itself is not mobile (Figure 60).

Figure 60: Need for aligning perspectives

Participants perform a lot of 'mapping' activities to deal with this need to align different perspectives, as in Figure 61, where we see EV reaching out to the Place de la Lavandière on the map. Her body and stretched our arm are oriented parallel to the actual place, thereby taking in the real position of the CCI and connecting it. P2 offers a different viewpoint on the Place de la Lavandière. Looking at the screen participants connect the spot on the map in the counter direction from above, except that from this viewpoint they see the entire parking lot covering the place directed towards the hills behind and only just hitting the edge of the virtual CCI building.

Figure 61: Mapping

Real time video stream: The real time video stream provided by the fixed pan-tilt camera outside the tent provides a limited view of the site and a strange perspective on objects that have been placed using the panorama views and some of the objects are hidden behind the trees. Still, there is liveliness and a sense of presence participants appreciate (see Vignette 10). Reality elements come into play, such as people passing in front of the tent. At the same time the virtual scene as seen against the real scene captured by a camera assumes 'surreal' touch (Figure 62).

Figure 62: Real time video screen from fixed camera

The mobile camera operated by a scout has the obvious advantage of allowing views from different points onto the scene. The views in Figure 63 show the blue CCI building and the small cabanes like models placed in the park. Participants decide to adapt the shape and size of the building to the scout view, to align it with the path they had set and let the traffic pass through (Figure 63). We can say that the real time video stream offers additional possibilities of understanding, evaluating and modifying interventions. It would be important to also transmit the sound from the position of the AR view or the Scout. We observed that in the video views there is a lack of ambience and sense of space.

Figure 63: Scout view

See-through: It offers the most effective intermingling of real and virtual (reality elements), as it is the nearly unmediated confrontation with the place as 'it is' (seen through a window). As with the real time video stream, the virtual overlay diminishes the 'realness' of the place (see Vignette 9).

Aerial view: The projected aerial view is more or less a replication of the physical map on the CT map with its icons. It has more volume being in relief and is a better representation of the density and topology of the housing and green areas. It produces a sense of 'wholeness' because the participants are disconnected, thrown out of the site they have been working on and in. Their work turns into more of a map-based abstract planning (Figure 64).

Figure 64: Aerial view

Token view: Two of the scenes we have analyzed are to do with focusing on sound, exploring the soundscape with the sound token (only possible when activating the token view) and eventually adding sound to the MR scene. In the 'token view' (Figure 65) objects are projected against a 'neutral' background (green floor, black sky). This representation was chosen because the panoramas are already filled with ambient sound. This together with the fact that most 2D objects are already associated with a sound file does not encourage participants to actively work with sound. The pink sound token, with which they can explore the soundscape, is mobile with the result that there is no consistent relationship to the position of the tent and the surrounding site. Hence participants are no longer able to match the perspectives of the mobile pink token with their physical orientation within physical space.

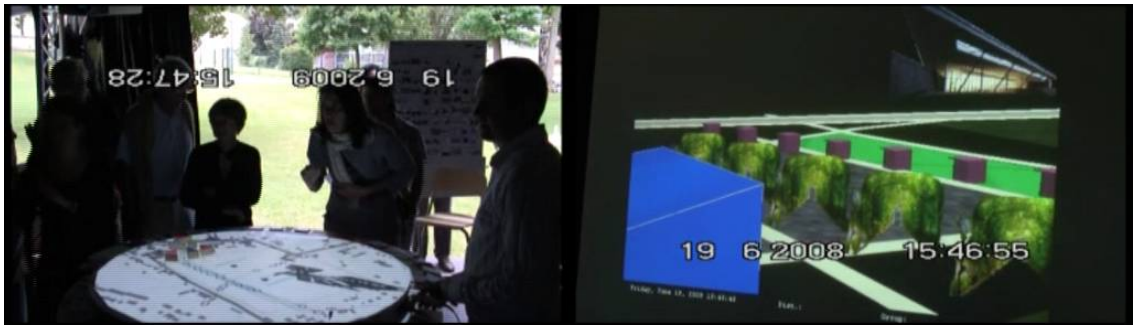


Figure 65: Token view

The influence of screen size

The fact that in Oslo we were able to project on a large screen (3x2m), gave rise to some interesting observations concerning screen size. The screen is used a lot for pointing out places in the environment, as can be seen in Figure 66 where AG and H are both running to the screen pointing towards a place 'behind' (first workshop day).

Figure 66: Pointing out a place 'behind'

Discussion on the second workshop day switches to 'the other bridge' connecting the old campus with the research park (Figure 67). BA starts explaining why the decision was made not to place a metro station exactly at this spot. They then turn back to Blindern station continuing discussion of the area, which they cannot see in P4 and they keep moving the tokens although they are in another panorama. After 2 min BA pulls them back to P4 saying that actually the other bridge will be the most populated crossing between the two campuses once the large new buildings have been completed. He switches between map and screen. JH comes in too, pointing out things on the screen (11:30:04). BA is saying that the little creek will be used to create a pond in front of the new Informatics building.

Figure 67: Discussion on the large screen

BA: *There is a pond, maybe you put the pond in*. – JH fetches the content card (11.30:46)Now JH starts positioning the token representing a pond looking all the time at the screen. (Figure 68)

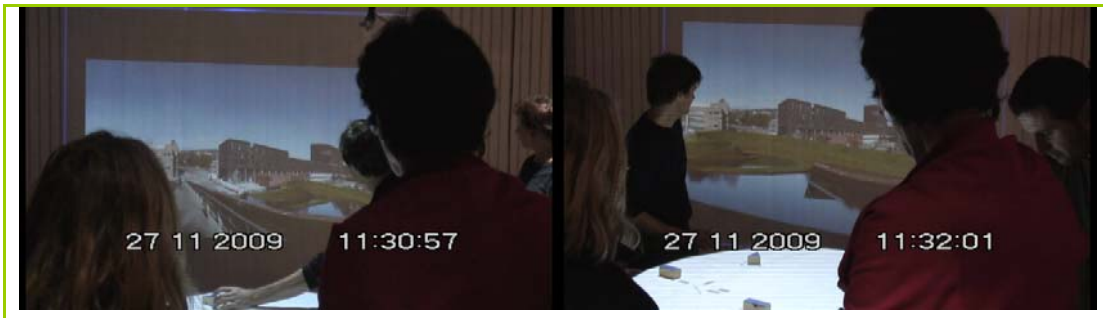


Figure 68: Placing the pond with gaze directed at screen

In the next scene we see K in front of the screen – she is pointing at the ticket machines on the platform, talking about how people arrive, maybe in the wheelchair: … *and then actually just around the corner behind you* (she performs a relational gesture pointing at an imagined real place at the station (12:58:20)). She continues describing how people get to the other side, physically moving to the platform on the other side and pointing along the platform. (Figure 69)

Figure 69: Explaining and relating places

Remember that in Oslo the workshop took place in a windowless studio. The large screen is the only representation of the site and its size invites bodily engaging with it. Hence, some of the pointing that takes place on the map is shifted to the screen. We also observed that the screen was more directly involved in object manipulations, such as positioning an object.

Switch representation, scale, rotate viewpoint and zoom: Participants switch representation for different purposes. They usually discuss which representation and scale of physical map fits their purpose best. It is mostly a switch of focus and theme that motivates these switches.

As we have seen in the situations and MR scenes so far, participants rotate the viewing angle, mostly to a) bring the place of intervention into their field of vision; b) identify objects they have placed before; and c) to test the visual effect of their interventions and make modification (see e.g. the example of placing the stairs). Rotating also brings a dynamic component into a scene.

Zooming is done to improve the perspective onto a scene, it means standing back to have a view from a distance or moving closer. We observed situations where zooming strengthens sense of place.

Sound as an integral part of MR scenes

Sound is much less studied than visual material. In IPCity we do not focus on sound as such but on sound as an element of mixed reality. We are interested in

- How sound in connection with images influences participants' relationships to a scene;
- Sound as contributing to 'immersion' by introducing a dynamic element into an otherwise static scene;
- Sound elements as representing aspects/ideas that otherwise would be invisible, difficult to express.

We start this part of the analysis with the role of sound, since it is a key element of participants' experience in the MR-Tent, pervading what they discuss, see and do. The soundscape in the MR-Tent is composed of different elements:

- The sound associated with a panorama as recorded at the viewpoint at which the panorama has been taken;
- The sound of flows – people talking, bicycles and cars passing by – which depends on the density of the flow;
- The sound associated with objects participants place, either connected by default with the object or introduced and associated intentionally;
- The sound of the real site, on which the tent has been placed.

These sounds and combinations of them assume different roles. First of all, while in some scenes particular sounds dominate, in others they mix and assume a certain density, as in the following example:

There is the sound of birds.
11:56 …. Lots of laughter – all look outside
Ch: *But this not, this is not … magnifique, le chant du merle.*
E pointing outside: *So it is here* (as part of the panorama: in the bushes) *and Monsieur thinks it is there* (outside)!
B to G: *It is the sound of your small garden!*
B: *Where is the sound coming from? Is it here?* - 11:57:21 G: *This … du Hitchcock!*
G says this facing outside, the entire tent front is open, a sound of a motorbike starting up at the rue des Etannets driving past, softly breaking the silence.

In this scene we have three different sources of sound: the panorama sound (with a bird singing), real birds outside the tent, as well as a motorbike passing by. There is a blurring of MR boundaries – the bird sound could be part of the scene but also come from outside and it is associated with the imagined nearby garden of one of the participants.

A similar effect can be observed in another scene (12:53:29), where front of the tent is completely open and the weather has become part of the inside. The real cars outside and the flows sound scratchy, as if dried out and cranky in the moisture, whilst the panorama birds seem to sing cheerfully outside the tent in the sun. Bicycles (flow sound) rattle past (12:54:24), mixing with the sound of a car (flow sound), as if heard by the blue people (flow animation) walking. Here the sound does not only blur MR boundaries; it pulls participants into the scene, having them experience the sound from the point of hearing of the blue people.

Sound in the MR-Tent does not only produce immersive effects, it also contributes to the experience of spatial transformations; like in the following scene (Figure 70):

Figure 70: Sound as transforming space

Here we can see that E (with his back turned to the camera) is the only one who has positioned himself towards the real site of the new building in 'bleu Klein' they are constructing with the urban sketcher. Acting from this position seems allow him match the real with the virtual rumbling of traffic (P2 panorama sound) from the rue de Rouen and the water of the Viosne below, interrupted by the occasional voice of a bird, which sounds as if filling a silence. Possibly this spreading silence is produced by the spilling of the tent site into the P2 space. These two spaces combine and recombine into a different kind of space.

The following scene from the Oslo workshop illustrates the interplay of visual and sound elements.

Participants have placed a newspaper stand and now start adding a drawing of the new bridge. They first place it then turn it and back again and increase its size. MI suggests taking the other drawing with the more frontal view. This seems to work better. Next they add a small stage with musicians as standing for entertainment and MK starts looking for a sound not finding sound content that satisfies him. We see him next searching for sound on his mobile phone, which he then places on the table associating it with the scene (12:00:0X). A little later (12:00:59) we see a blue (flow) person walk towards the stage while the music continues in the background. (Figure 71)

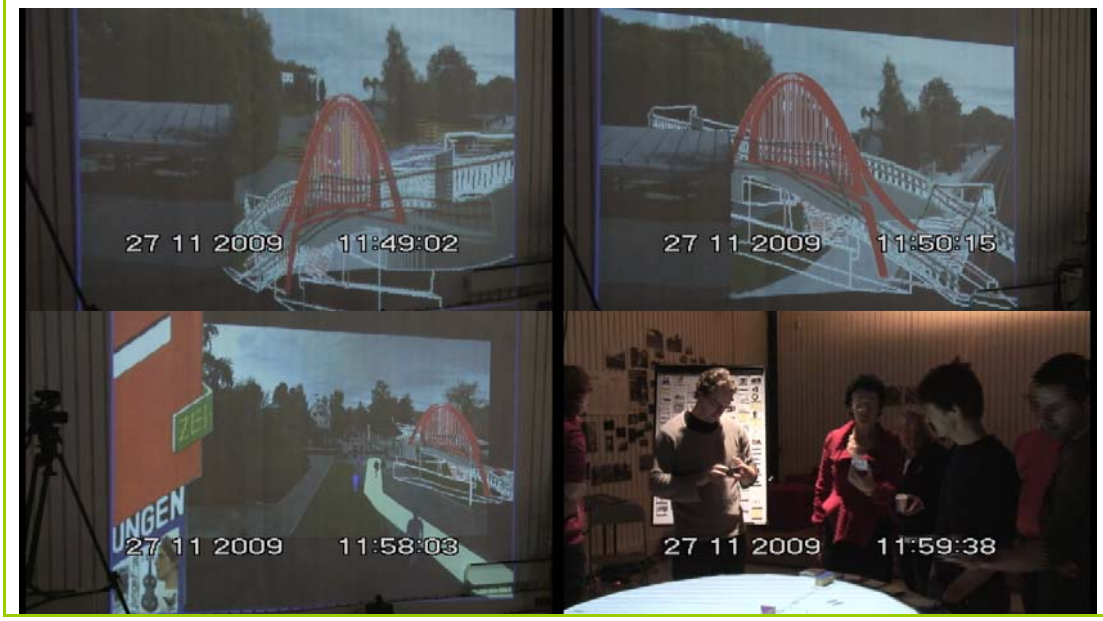


Figure 71: Scene composition with visual and sound elements

The first part of this scene is focused on placing a huge object – the bridge – in the scene. This also involves finding the right viewpoint in terms of angle of vision and distance. The resulting view is one of a pedestrian (blue person) approaching the long ramp of the bridge the visual impact of which is reduced by the oversized newspaper stand in the left corner. The bridge gradually becomes part of a narrative when participants place a stage with dancing young people in the foreground and MK turns on the music on his mobile phone. We can also see from this scene that some interventions suggest to think about sound - having placed a stage with dancing young people in the area leading from the old campus to the bridge, MK starts searching for music on his mobile phone and places it on the table. This scene is filled with sounds: trains coming and departing, birds singing, the sound of walking on asphalt, and the music MK has placed.

This more active engagement with sound is often triggered by some action For example, during the last part of the Oslo workshop participants engage in a discussion about sound with AL, a sound expert and artist. They are focusing on possibilities of augmenting a place with sound in unobtrusive ways: it could be triggered by actions such as people passing only to be heard by them. They also talk about sound providing directions (sound of bubbles leading to the chemistry building and so on) and have a discussion on sound guiding blind people on the street. MK looks for a sound on his mobile and performs a swishing and then a clicking sound with it moving it up and down (Figure 72).

Figure 72: Associating sound with an idea and performing it

Sound may trigger participants' thinking, as we can see in the scene from the Oslo workshop, when participants are placing a pond on the present construction site (in P4). Birds can be heard – the sound is rather strong. It gets covered whenever the train passes by (panorama sound). JH takes up this ambience as '*cheerful*' and immediately suggests to go back to Blindern and work on 'the welcoming part'. JH starts changing the map and they decide to continue work with the bridge panorama P6. The sound of birds has obviously acted as a reminder of a pleasurable ambience, hence a topic participants had decided to work on (see also the scene depicted in Figure 68).

The sound of traffic plays a particular role. It is part of the panorama sound and particularly strong in connection with P3, which has been taken close to the highway; it is part of some of the low and high density paths participants have constructed, with the single car passing rue

des Etannets from time to time seemingly particularly noisy; and finally, there is real traffic outside the tent. For example, there is a moment (12:41:33) when the birds sound again as if they were coming from outside the tent, whilst within the traffic gains weight and persists, with the P1 space being drawn into the tent, both immersed in traffic. The sound of traffic, although often annoying, seems inevitable, as can be seen in the following scene:

15 :44 :48 Ch: *There we need the sound of people passing by – calm pedestrians*.
Did we put a bit of bird sound in the gardens? – Not yet.
JJ: *You don' want to remove the road that makes so much noise? – It has taken us three quarters of an hour to place this road. – We have to live with the noise.*

When we look at what types of sound participants refer to as 'missing', most of them are to do with the atmosphere of a quiet green space with some 'implants' that are to do with the activities they envision: children at play, people talking (softly), youngsters quarrelling (not so softly), Chinese music (to go with a tai-chi group), and some nicely animated sound of market place (to be associated with the cabanes) and the lively sound of a 'place italienne'. Interestingly, they insist on birds (they place a group of ducks). There is discussion about how many different sounds to introduce: *Here we are close to the children. – Here we are with the playing. – We are about to superimpose many sounds here.* (15:55:54)

Our main findings from this analysis of the visual and sound elements of MR scenes and how participants understand and work with them can be summed up as follows:

- Salience of elements: What to participants appears as the 'right' size of an object is not necessarily determined by realness but by the effect they produce, as is the case when an object has a strong symbolic meaning or transforms the scene into something else.
- Narrative image structures are present in many MR scenes and mainly created by dynamic elements (flows), objects representing activities, and in general the expressiveness of objects.
- Compositional aspects of MR scenes are mostly to do with framings that are created by flows, 3D lines, textures, as well as large objects. These interventions allow participants structure the site, create boundaries or mark areas for specific purposes. Changing the viewing angle allows participants explore compositional aspects.
- Modality markers are to do with how real a scene is perceived. Dynamic representations and sound add to this realism, as do colour, the size of objects and their positioning in relation to each other.
- The availability of different representations is a crucial feature of the MR-Tent, as different representations offer participants different possibilities for constructing, understanding, and evaluating MR scenes. The physical map and the aerial view lend themselves to planning; the panorama views are mostly used for constructing scenes; see-through and (fixed as well as mobile) real time video stream have a special 'realness' quality which however makes the virtual elements stand out as 'models' or as 'surreal'.
- Sound is a key element of the participant experience, pervading what they discuss, see and do. Several aspects of sound as an element of MR scenes stand out: it contributes to a blurring of MR boundaries; it strengthens immersion into a scene, pulling participants into it; it contributes to the experience of spatial transformations; it evokes ambiences, thereby influencing action; particular interventions trigger engagement with sound.

5.1.6 Types and roles of gestures

Gestures are seen as an important part of referential practice and researchers analyze how bodily gestures and actions are used in relation to talk in order to direct and encourage one

another to look at a particular object. Gestures help to render a feature of the world visible and gaze (as well as the whole body) follows the gesture that displays an object. Goodwin (1998) sees pointing as part of entities and events provided by other meaning making resources - talk, properties of space, body posture, as well as the larger activity (collaborative action) of which it is part. Pointing takes place within a participatory framework, which is defined by participants' postural orientation and addressee orientation – people orient toward other participants, maybe also to specific phenomena located beyond them in the surround. The human body serves as a special visual field – a complex entity that can construct multiple displays, which mutually frame each other (Goodwin 1998).

In his study of architects at work Murphy (2003) analyzes gestures as establishing visual attention through making information - on a map, on the screen – relevant for he interactive purpose. He pays special attention to *tracing gestures*, which are simultaneously deictic and iconic, when, for example, conveying the length of a street or ramp. He also identifies *relational gestures* as an important part of architectural practice, which seem to be a specialized version of what Goodwin (1998) terms dual pointing: in the case Murray analyzes a relational gesture consists of an architect tracing something in the air and connecting it to a particular spot on the plan of a building.

Haviland (1996) in his analysis of narrative gestural spaces of aboriginal people makes an interesting distinction between: the immediate local space; the narrated gesture space – people use gestures to insert things far away in this immediate local space; and the interactional space, defined by the configuration and orientation of the bodies of the interactants: "This space has a privileged interactional character, being conjointly available to interlocutors for gesticulation. Interlocutors in a sense create this space by virtue of their interaction; they do not find it in the local surround but carry it with them" (p. 23). He also talks about "creative pointing gestures" that "move from immediate local space to a narrated hypothetical space, laminated over the former and deriving its structure therefrom, and then swiftly back again. A seemingly simple gesture points at once to a local building and to a narrated roadside bar long disappeared" (p. 35). Many gestures in the MR-Tent have such a narrated element, pointing to something that is imagined, not yet present, and may become part of an intervention.

In our analysis we distinguish different types of gestures:

- Deictic pointing gestures – pointing something out on the map or on the screen:
- Pointing gestures with iconic display - e.g. pointing at a place on the map and forming a circle to indicate the shape of a playground;
- Iconic gestures – gestures that describe the shape of an object or indicate height or distance;
- Relational gestures;
- Tracing gestures;
- Collaborative pointing – two or more people pointing simultaneously.

We are not interested in gestures as such but in how far they contribute to participants' co-constructing, discussing and evaluating MR scenes in the MR-Tent.

The different types of gestures are shown in Figure 73, Figure 74, Figure 75, Figure 76 and Figure 77.

Pointing gestures

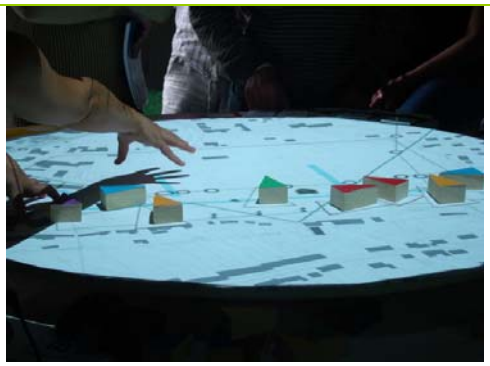
	(1) Plan intervention: The group is planning to replace the viaduct across the Patis and gather at the WB looking for a bridge. Ch proposes action turning his body and arm in direction of the intended intervention. Ch: “We cannot simply redesign …” – he turns back to the CT pointing with his arm in direction of the viaduct on the map.
	(2) Plan intervention Ch communicates plan to reduce the parking and place a green texture with his fingers suspended above the area of intervention, scrutinizing it. M intervenes: “ All this is free for the moment being” – she makes a circular gesture on the area with her arm stretched out (see Vignette 6).
	(3) Perform intervention EV directs action: “To be able to walk towards ‘Le Moulin de la Coulèvre’, I would … in direction of the mill, voilà, like this maybe … “. Her pointing gesture is coupled with object manipulations performed by Ch and E.
	(4) Plan intervention Ch points at screen while explaining his plan: “There we have to reduce the parking … make a green space, which joins the other one on which we will place the cabanes, I think. We could redo a zone”.
 Finger indicating exact spot	 Hand indicating area

Figure 73: Pointing gestures

Iconic gestures

	(7) Plan intervention E asks if it is possible to place a pedestrian path in an position elevated above the ground – he performs the gesture indicating the height level twice.
	(8) Perform intervention The group decides to erase a building that had been placed in the morning and no longer fits – they are looking for it. J: “Ceci en pointe” – performs iconic triangle gesture.
	(9) Plan intervention Participants discuss the absence of connections between the different ‘quartiers’ of Cergy-Pontoise, which do not communicate well, in this case the barrier between the hillside and the Lavandière gardens.

Figure 74: Iconic gestures

Tracing gestures

(10) Plan intervention

The group has changed map/scale to discuss connection between the CCI and Notre Dame. S and EV are discussing. S traces the road from CCI to Notre Dame with his finger: “North is there, the church is here … “. – “And then there was this idea of going up again … “. S moves his finger in direction of the church where it rests for a moment: “This is the cathedral, non?” (14:42:24). He moves al the way back and J’s hand comes in.

Figure 75: Tracing gestures

Relational gestures

(11) Understand MR scene:

J tries to match places on the map with the MR scene: “This path here is this path over there” – points first on map (left) and then on screen (right)

(12) K pointing with one hand to a place on the sceen (ticket machines) and with the other on what can be seen ‘round the corner’ in the RE

Figure 76: Relational gestures

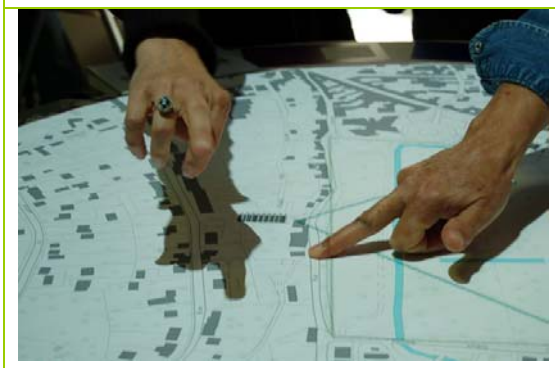
Collaborative gestures

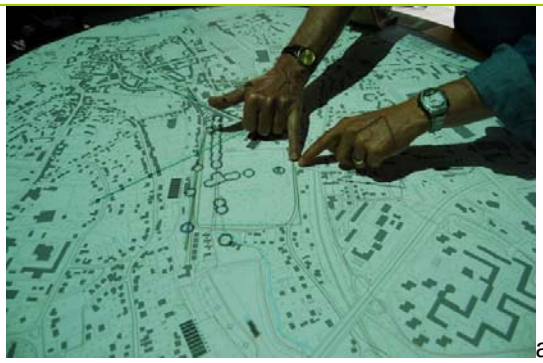
(13) Plan intervention

14:50:59 G puts his finger on a roundabout on the map
14:51:10 J’s finger joins
14:51:12 They both make a confirming gesture with their fingers on the map
14:51:22 G moves further up the road with his finger on the map

(14) Understand MR scene

All in front of see-through:
15:24:20 E points with his finger on rue des Etannets: “There is a passerelle (bridge) here”. From the other side of the table J also points with his arm stretched out: “Which comes from rue des Etannets“.





a) a) One hand pointing at exact spot, the other searching; b) two hands pointing simultaneously at exact spot; c) one hand points while other places token.

Figure 77: Collaborative gestures

In the MR-Tent gestures are influenced by the spatial layout, as well as the tools at hand. We can summarize our observations as follows:

Most pointing gestures take place on the physical map and as part of planning an intervention. We can distinguish:

- Pointing at exact spot on map;
- Pointing with arm stretched out in direction of an intervention;
- Designating an area on the map by e.g. an encircling movement, the hand indicating the area above or on the map;
- Directing action, such as object manipulation, by pointing;
- Tracing gestures, which are mostly deictic, e.g. delineating a path on the map.

Often pointing implies collaborative action – two participants simultaneously pointing; or one pointing to direct action of another participant; or delineating different places in an area of intervention.

Understanding an MR scene involves a lot of pointing at the screen. This is done to explain a planned intervention; to identify objects in the MR scene; and also when finally a ‘lost object’ appears on the scene as result of manipulating the scene.

Participants also perform iconic gestures of different kinds. These are tightly related to their planned or performed interventions, describing an object (e.g. the triangular shape of a building). Many of these gestures are what Murray (2003) terms metaphorical: “Metaphoric gestures, on the other hand, are representational gestures that depict abstract concepts that have no real world form. The *gesture's form* is indeed exactly the same as an iconic gesture except that it has no counterpart referent in the speech-text”.

We are particular interested in relational gestures, as they most obviously perform a kind of ‘mapping’ between events in the RE and those in the VE. Much of this mapping is done through talk and gaze. Participants also engage bodily in mapping, through e.g. pointing first at a place or object on the map and then it’s corresponding on the screen. Participants also turn their bodies to the real space outside, pointing towards a particular place or in a particular direction.

5.1.7 Use of space – body configurations

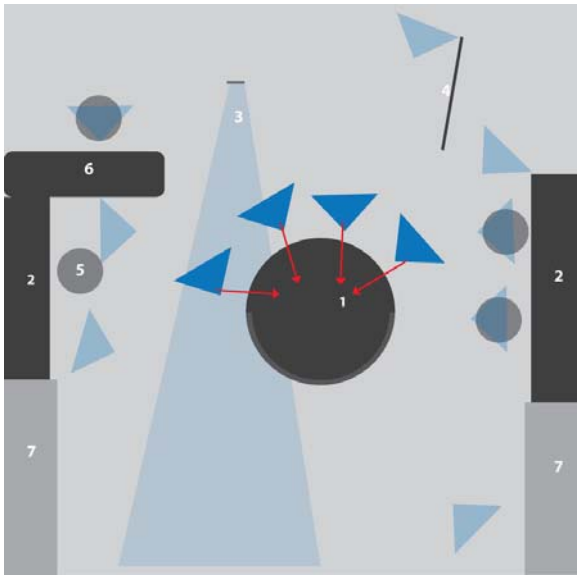
This section provides a more systematic analysis of how participants make use of the MR-Tent space. Such a spatial analysis is important for a better understanding of modes of cooperation that unfold in such a tightly structured space. As Hindmarsh and Pilnick (2007) argue, the body has central and critical role “as a resource for real-time coordination”. From previous research we also know that an ubiquitous organizational feature of face-to-face conversations is the use of space to frame interactions. Much of this research goes back to Kendon (1996) who has described how people actively use the position and orientation of their bodies to collaborate in the management of their conversational interactions. He has coined the term F-formation for these spatial configurations, arguing that changes in interaction often correlate with changes of the F-formation. Common formations are e.g. the O-formation typical of people who enter a conversation and create a shared interaction space or a circular arrangement, which is used for co-operative, symmetrical interactions (Healey et al.). Other studies investigate how the framing of the space (walls, objects), its accessibility and connectedness, as well as the cultural meanings shape social interaction (e.g. Stenglin 2009).

Kirsh’s research on the use of space focuses on the body posture and position itself, on the spatial location as an integral part of the way we think, plan, behave and shape (Kirsh 1995). His goal is to provide principal classifications of some ways space is used and create a framework. The data is drawn from videos of cooking, assembly and packing, observations at supermarkets and so forth. His classifications are among others spatial arrangements that simplify choice and perception. In his later research with colleagues he tries to understand the organization of cognitive systems and workspace by using the theory of distributed cognition. They observed peoples behaviour with Pad++ and found difference between how they manipulate icons, objects or emergent structure and their cognition. They argue that we constantly organize and reorganize our workplace to enhance performance and state that space is a resource that must be managed (Hollan, Hutchins and Kirsh 2000).

According to Tang and Minneman users can enact body and gestures in space, or even bring physical objects to an interface. The use of an interface is influenced by the spatial arrangement of the interface and the collaborators (Tang and Minneman 1991). New media, such as collaborative environments and novel interfaces, force researchers to analyse what is fundamental about communication (Gerhard, Moore and Hobbs 2004) besides language including non-verbal communication and the bodily engagement in the provided surrounding.

Research on ambient displays essentially deals with the meaning of ambient spaces, making use of the entire physical environment and awareness as a state of knowing about the environment in which you exist (Wismeski et al 1998). Both arguments are fundamental for understanding the use of a complex MR tabletop interface like the ColorTable. Wismeksi et al further argue that the length of time a person spends in the provided environment will likely influence the person’s facility for using it – our observations in the MR tent concur.

An approach to understanding the use of space was important in the design of the MR tent and the ColorTable to provide accessibility for the use of the distributed interactions and actions. The MR-Tent is a constrained space, with the CT in the center, together with a projection screen and space for supporting technologies. At the same time it is installed in an open space with a window on one side and one the other side it can be opened completely. Figure 78 shows the spatial layout of the MR-Tent with all its equipment.



Objects in the MR-Tent:

1 ColorTable - fixed
2 2 sidebars - fixed
3 Projection - fixed (ceiling)
4 Whiteboard - mobile
5 Chairs - mobile
6 1 Table - mobile
7 Storage space

Body postures are visualized by blue triangles – the cone end indicates the direction the person is facing. Red arrows indicate the gaze.

People:
Research person
Participant

Figure 78: MR-Tent ground plan

In the following we examine several typical configurations of participants within this space.

Forming a close circle around the CT

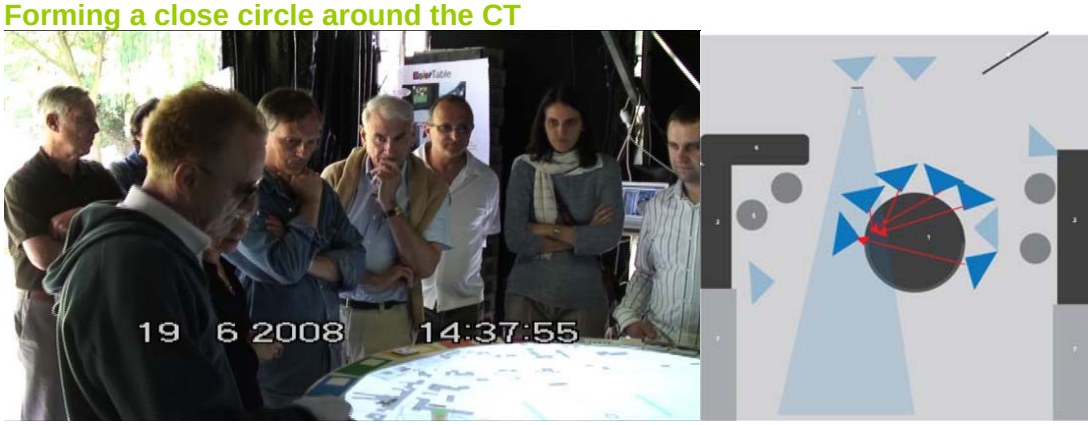


Figure 79: Closed circle around table

Participants are checking the map trying to identify specific locations. They gather around the CT, forming a close circle (Figure 79)

Working with the scout

Figure 80: Scout scene

As described also in Figure 63 the mobile scout enables participants to explore a MR scene from different points of views on-site. (Figure 80)

Forming an open circle around CT

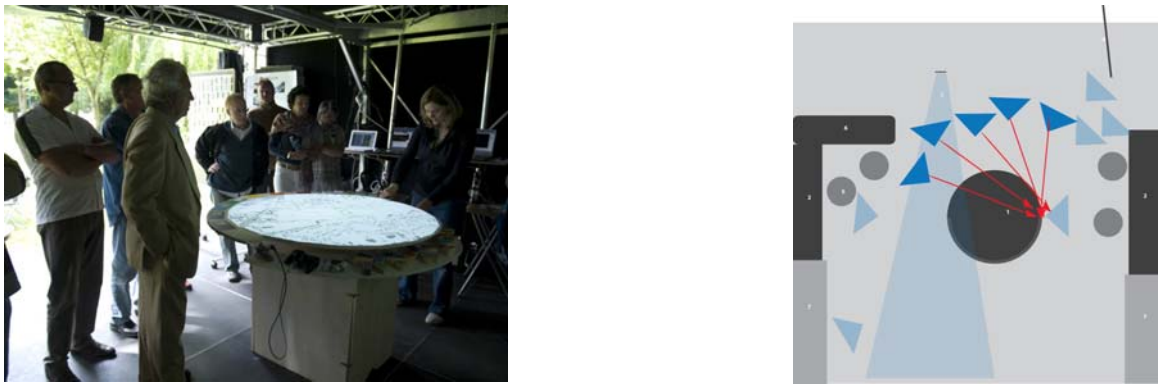


Figure 81 : Open circle around CT

Participants keep distance in position and posture to the CT while watching the presented interactions (they are listening to an explanation). (Figure 81)

Forming a close circle around CT

Figure 82 : Close circle around CT

Participants gaze at the map to find a specific point. Their posture is facing CT, their head directed to the point on the map. Checking the map and trying to find locations (Figure 82).

Forming an open circle around WB

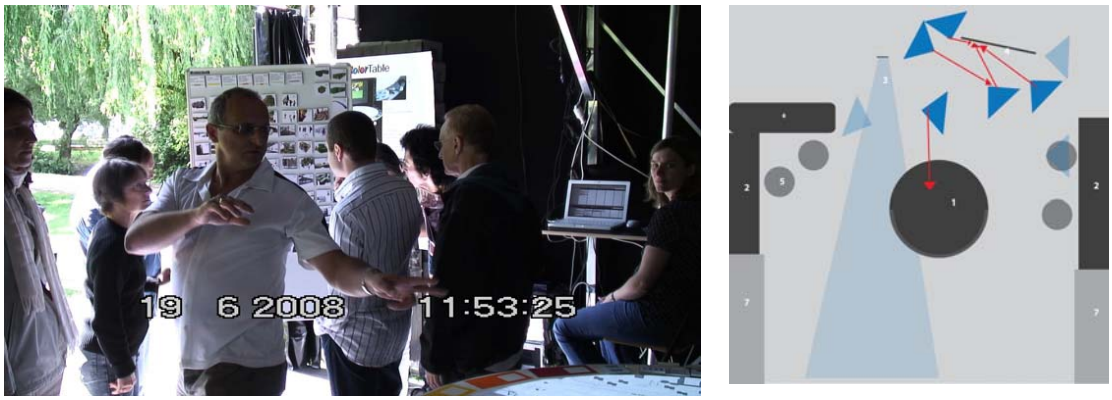


Figure 83: At WB – distributed attention

Participants face content at WB in some distance, while one participant connects to CT with his posture and hands/arms movement and directed gaze. Most participants are discussing content in front of the WB. This spatial configuration is open and changing; also participants' gaze travels between WB, CT and P (see also pointing gestures) (Figure 83).

Forming a close circle around WB

Figure 84: All at WB

Participants discuss and select content. They are gathering around WB (content board) and form a group with their bodies oriented towards the WB in an upright posture, their heads moving between content and person talking (Figure 84).

Distributed collaboration

Figure 85: Distributed collaboration

The group of participants forms a slightly distanced curve at the front side of CT – arms folded. The person at WB is acts with arms, hands and changing gaze. Participants are working on a scene collaboratively at the CT while one of them has moved to the WB to look at the content cards (Figure 85).

Forming a row

Figure 86: Row in front of screen

Some participants are watching one of them use the sketcher while discussion at the CT continues. They forming a row – a frontal arrangement with bodies and gazes directed at the screen (Figure 86).

Forming a triangle

Figure 87: Three discussing at CT

Participants discuss a detail on the map. Three of them form a triangle with their bodies and their gaze directed in an o-shape. The basis line of the triangle is the CT (Figure 87).

Using the whole circle

Figure 88: EV using the whole circle of the CT

One participant searches for and puts away tokens, using all supporting surfaces. She moves around the whole circle to grab with one hand and her gaze fixed to her target (Figure 88).

Use of CA (configuration area)

Figure 89 : Using the CA

Participants form a curve and engage with the CT by leaning against it and acting on the CA with arms, hands, and fingers. Their gazes follow these movements. G and S arrange content cards at CA and assign content, stacking content cards on CA and holding some in one hand (Figure 89).

Organizing workspace

Figure 90: Tidying up

Two participants are arranging their own workspace on the CT, tidying up after freeze. They have positioned themselves at a small distance from the CT to be able to place tokens and cards on the lower level bar with both hands and direct gaze directed at the bar (Figure 90).

The use of space in and around the MR tent can be described by different forms of body postures and spatial configurations. We three basic formations, all three varying with respect to the distance and accuracy (close or open configurations):

- Row/line formation e.g. lining up to watch somebody draw with the Urban Sketcher;
- Circle formation e.g. to collaborate at the CT and manipulate tokens – the full circle is rarely used, as this means turning one's back to the projection screen;
- Triangle formation e.g. to discuss a specific issue in detail in a close group.

Assisted by graphical snapshots (we selected essential situations, took freeze frames and made ground plans of the whole MR tent) we can summarize the use of space in the MR tent as following:

- Most frequent used space: The technologies and physical objects are distributed in the MR tent. People mostly used the free space in between CT and WB in various configurations according to their needs.
- Most frequently used way: The CT is placed fix in the middle of the tent, the WB mobile at the entrance front. Participants mostly walked between these two parts of the interface (selecting content, bringing it to CT) turning the WB only on the spot.
- Most frequently used configuration: The CT provide the main interactions. Therefore working at the CT was time consuming and people commonly formed a curve around the CA (front side of CT) with three or more people in different positions and postures.

Space in the MR tent was limited because of the distributed parts of the interface (CT, WB, projection, urban sketcher) and the huge amount of technical equipment. The free space was needed for the workshop participants to move between these parts and for the research group to assist, guide and document. The maximum for a comfortable use is ten people at a time.

In the MR tent participants kept distance when listening and observing and moved closer when interacting. The body positions were aligned with the current communication partner during talking and discussing. Interacting with tokens and the map at the CT (height of bar table) constrained people to outreach the arm and bend the upper body. The round table specified the curve and circle formation when used by three people or more. Participants divided their roles for space according to their main interaction e.g. assigning content by standing in front of CA, grabbing and passing tokens by standing next CA on both sides to reach the lower side bars and working with the wheel and barcode reader by standing on the left side of CA.

When engaged in complex interactions (simultaneous to communicating), attention gets distributed, with the position of the body and the senses or arm/hand movement also being distributed, mainly in two ways:

- Body position, arm movement and gaze all are aligned in the same direction;
- The body position is angled in one direction, sometimes performing or manipulating with one or both arms/hands – the head with gaze is directed to something else (e.g. talking to other participants).

The openness of the tent provides a strong connection to the outside space. People look and point outside, they walk outside for a short break. Also the fact that the WB is positioned at the entrance to the tent, strengthens the inside-outside connection.

5.1.8 Object manipulations

Object manipulations are an essential element of tangible interaction as they influence what participants do with the user interface and how they are doing it. An in depth analysis of different aspects of manipulations helps designing interfaces for a specific context and specific users. Benford et al. (2003) classify movements of an interface into sensible, sensable and derirables ones. Sensible movements are naturally performed, sensable ones can be measured by the system and desirable ones are required by the application. They propose a method based on this classification to discover potential problems of an interface and inspire new features.

An approach for developing a higher diversity of object manipulations deals with a higher focus on user actions. Buur et al. (2004) and Jensen et al. (2005) propose design methods to encourage skilled actions in TUI design, such as the Hands-Only Scenario or the Video Action Wall. Larssen et al. (2007) introduce four themes around how our bodies establish

relationships with things and discuss which role these themes can play in TUI exploration and design.

We first describe selected interactions to discuss special characteristics of participant's haptic engagement in the next section.

Assign content

There are different ways, in which participants assign content: a) The participant selects a tracking colour in CA (the configuration area) and places a content card on the selected colour free rectangle at the CA with one hand; b) the P grasps a token from the side bar of the CT with one or both hands or gets it passed from the other Ps and puts his selected content card on the adequate colour zone at the CA with the other hand (Figure 91).

	G is standing in front of CA and places a content card with the thumb and forefinger of his left hand in the blue zone to assign a 2D object, while holding the dedicated blue triangle token in his right hand.

Figure 91: Placing content card on CA

Scale increase/decrease

Having placed an object, participants frequently change its size. We observed two ways of doing this: a) a participant searches for right command card, places the card on the adequate colour zone on the CA with one hand (between thumb and fingers) and takes it off at the right moment while observing the projection closely; b) two or more participants search for the right command card, one participant places the card on the appropriate colour zone on the CA with one hand. They watch the projection together while communicating about the right size. One participant takes of the card at the right moment (Figure 92).

	E places the command card "Scale decrease" on the adequate red colour zone of the single object he wants to manipulate. He uses his left hand and holds the card in a gentle grasp. The second hand still holds the "scale increase" card used before.

Figure 92: Placing command card on CA

Rotate & zoom

Participants rotate the panorama for various reasons: to see the section of the panorama where they want to place an object; to find an object that has been placed already; to have a better view onto an element to be painted (e.g. viaduct); to see "more" at the same time. The common way of rotating is that a participant looks for right barcode command card and reads barcode. For this both hands are needed: one for holding the card, one for the reader (or when the card has been placed at CA, only one hand for reader). The participant then turns the wooden wheel by grasp hand and movement of arm, while checking the projection (Figure 93).

	E is slowly turning the wooden wheel while checking with gaze at projection. He uses the right hand and holds the previously needed barcode reader in his left hand.

Figure 93: E rotating

Change view (background)

Participants change view to a) have a view onto a place where they want to place objects; to navigate with the sound token (virtual view); to explore what they have created in the camera (mobile/fix) view; when no panorama shows the place where they work on (aerial view). Either a participant grabs barcode reader and moves the arm towards the panorama barcode on the map; or s/he looks for right barcode command card and reads barcode. This interaction requires both hands: one for the card, one for the reader (Figure 94).

	J. grabs barcode reader and command card - reads barcode using both hands (left); Ps switch to aerial view to work on a street not visible in any panorama (right)

Figure 94: J with barcode command card

Place connections & flows

This is done to a) mark how to traverse an area / the site; b) mark a specific connection between two places; c) add flows to an existing road; use connection as a border of a zone. Again, we observed different workflows:

- Participant places two rectangles simultaneously;
- Participant places rectangles sequentially, placing first one token while holding the second token in the other hand;
- Two participants place the rectangles together – one each.

These interactions are performed with arm stretched out and the hand grasping rom above or from the side between thumb and fingers. The body is close to CT or leaning against it, the gaze is fixed on the hand and token (Figure 95).

E places the orange rectangle on a specific point on the map with his left outstretched arm bending over the table with his upper body, holding the token with a grasp from above. The second orange rectangle is enclosed in his right hand. His gaze is fixed on the left hand.

E places the second rectangle on the map – supported by a third hand. He bends and stretches to reach the accurate point, his gaze fixed on the hand and token.

Figure 95: Placing flows

Reposition 3D lines & connections

Repositioning is done e.g. in order to align the perspective of the image with the perspective of the panorama (e.g. chairs looking in one direction) or to have the objects on a specific side of the street. Either one participant touches one or both triangles from the side with one or more fingertips and pushes – simultaneously or sequentially; or two participants move the triangles on the map with the grasp hand from the side – again simultaneously or sequentially (Figure 96).

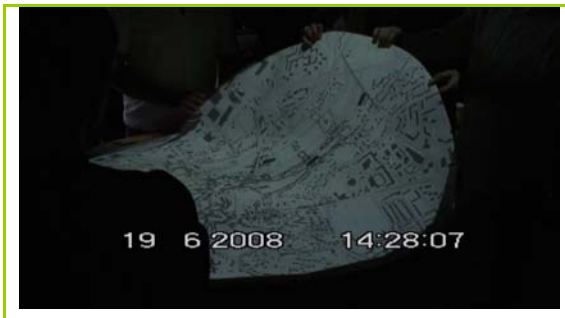
EV starts to reposition a connection (blue rectangle) by grabbing the token with the thumb and forefinger of the right hand and pushing it forward directly on the map.

EV uses both hands (thumb and forefinger each) changing the position of the blue rectangles simultaneous. G helps with his left hand indicating the right distance.

Figure 96: Repositioning

Change physical map & scale

This is done to place objects that have a similar scale as the map or to place objects on a place only visible on a bigger map. This is usually done by two to four participants together: they grab the map on top, lift it, pull out of the maps below and place it on top, working with both hands. Then a participant grabs barcode reader, twists the arm to reach the barcode on the map and presses the button on the barcode reader handle (Figure 97).



Participants together grab the map on top, lift it; they pull one out of the below and place it on top; E grabs barcode reader, twists the arm to reach the barcode on the map and presses the button on the barcode reader handle.

Figure 97: Changing physical map

Produce and place content with Paper Sketcher

In case no suitable content is found, participants use the paper sketcher (Figure 98).

Figure 98 : M sketches his idea on a A4 sheet with a black pen (left). He places the A4 sheet on the adequate area underneath the camera (middle). He chooses the size of the painted picture on the card in their hand for taking it to the ColorTable and reading the Barcode (right).

Based on our observations we can summarize some main issues showing how participants are using the MR Tent technologies. The diverse manipulations in the MR Tent can be performed with a different numbers of hands collaborating. We distinguish:

- One-hand manipulations: e.g. placing an object or painting onto the screen;
- Two-hands manipulations: e.g. reposition 3D line or freezing;
- More hands manipulations: e.g. changing map.

While performing object manipulations, participants check the result with their gaze onto the top view, onto the screen or onto hands action. While zooming, for instance, participants' hands actions are at the wheel, while their gaze is at the screen. In contrast, rotating has hands action at the wheel and gaze directed onto the map. Both actions are superimposed when organizing workspace or select content cards when hands action and gaze have the same direction.

In most cases, object manipulations are planned and participants do them for the same reason for which they have been developed. We however also extracted ad-hoc manipulations (done for another reason) or unsupported ones (planned, but not implemented). Examples are:

- Planned manipulation: increase size, add sound;

- Ad hoc manipulation: entice tracking by softly repositioning tokens on the map; reposition object to “find” it in the perspective view;
- Unsupported manipulation: change transparency, change offset of pedestrian path.

The MR Tent technologies support objects manipulations with different degrees of complexity. Some simple manipulations can be performed in one step, others require a whole sequence of steps to be done before participants reach their goal:

- Complex manipulations: placing content, zooming or create 3D object
- Simple manipulations: change size, change panorama.

5.1.9 Haptic engagement

Verbeek and Kockelkoren (1998) introduce the notion of ‘engaging objects’. Referring to the writings by the American philosopher Albert Borgmann, they define as engaging the capacity of objects to absorb people’s attention, thereby increasing their engagement with each other and the world. This engaging capacity reaches beyond an object providing a specific functionality. The physical qualities of an object have an important part in this engaging capacity and engagement is supported by haptic directness. When handling a physical object, we are in direct haptic contact with it, receiving haptic feedback. Directness means that there is no ‘interface’ other than the shape, texture, temperature, and moisture of the object itself. Hull’s ‘art of gazing with my hand’ is a telling example. Hornecker and Buur (2006) argue that haptic directness provides an isomorphy between manipulation and result – we can watch the effects of our activities while performing them - and that it enables simultaneous interaction.

The ColorTable and the Whiteboard with the content cards provide a diversity of designed physical object. They vary in form, size, material and colour. The tokens and cards (content cards, command cards, and barcode cards), which have undergone several cycles of re-design, are central to participants’ interactions. They invite haptic engagement in several ways and support haptic orientation:

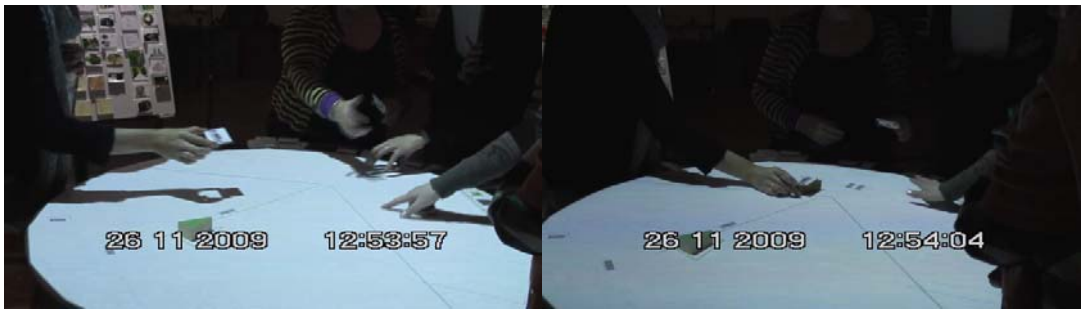
- The basic geometric forms and materials are familiar to participants. The topside is always covered with a colour or a print out. People know how to hold and use them.
- We made use of different materials (wood, Plexiglas, cork) to distinguish the different types of tokens (in addition to colour and shape) and cards - people can feel and see the difference.
- The sizes invite to grab and hold in one hand. People are discussing or interacting and simultaneous holding tokens and cards to play or to have them when needed (Figure 99).
- The different objects are combined as needed: people work with several objects of different materials and surfaces simultaneously.

Figure 99: Holding more tokens in one or both hands for later use, to play with, to provide and pass them to others or organize them (left and center). One participant holds “his” cards in a pile in one hand (right).

Participants liked working with the small content cards representing content (Figure 100). At the beginning they sometimes positioned them directly on the table. People brought together

the same material - thin and thick paper/cardboard. After having understood the need to link them with a token, the cards they had selected remained on the edge of the table, signalling 'this is a pile of our images'.

Participants are placing a lot of content in the MR scene (Oslo, first workshop day). They start with a bridge. We then see AG's hand moving a content card in the middle of the table and withdrawing it immediately to grab a token, place it on the table and the content card on top of it.



They then put a café near the SevenUp building and next the sketch of a 'hopscotch', which they colour and resize. At the end of the scene we see several object tokens on the table as well as five content cards representing also other content they have talked about.

Figure 100 : Engaging with content cards

Participants produce paper sketches (they sketch with a pen while holding the sheet) and place them directly on top of the map (bringing together the same materials) for additional map information. They touch the paper by showing details and areas with finger and hand (Figure 101).

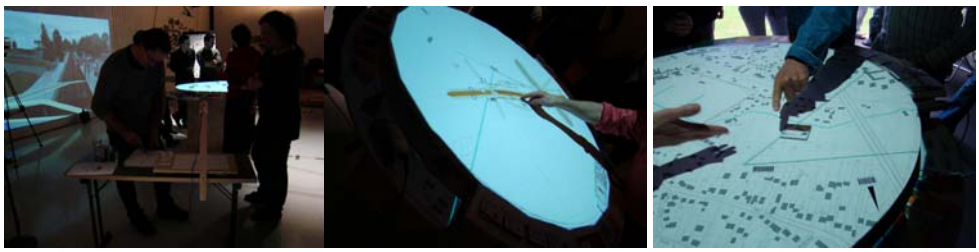


Figure 101: Sketching on paper (left). Touching with finger to point on a specific spot (middle). Content card placed on the map to show idea immediately (right).

This is a scene from the Oslo workshop, taken from a long discussion of flows across the bridge focussing some time on the fact that lots of bicycles will be crossing, some of them a high speed. The idea is to provide two separate lanes for pedestrians and cyclists. MK moves to the sketcher and returns with a sketch on transparent paper, which he places on the flow crossing the bridge, thereby annotating the map in a way very common with architects and planners. It is the proposed solution of two separate lanes. We can also see the stairs coming up from both platforms. MK is explaining with the pen in his hand. We also see JH's hand coming in.

Figure 102: Map annotated with paper sketch

What is remarkable in this scene is that participants stay on the CT for the whole discussion without looking at the projection. The annotation on the physical map represents 'solution' and as it would be difficult to visualize this solution in the MR scene, participants stay within the physical world of map and sketch (Figure 102).

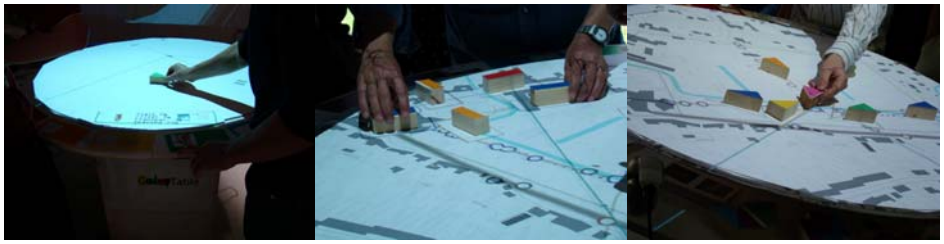


Figure 103: Participants feel and touch the tokens while moving them. The form, size and material supports to understand the appropriate use.

Typical patterns of working with the coloured tokens emerged during the different discussion and interaction steps Figure 103). When searching for the right tokens to perform the next interaction step, participants took care not to obstruct the tracking and placed the inactive tokens into the 'shadow' area of the table (Figure 104).

Figure 104: Engaging with two materials at the same time. Right picture: P feels and touches token and content card. Left picture: P holds barcode reader and two cards to have them ready for use.

Tokens are also used expressively, for example to make a point. Here we see JH who while discussing the flows across the bridge (second workshop day) grasping a flow token gently beating with it on the map.

Figure 105: Beating with token on map

The barcode reader as a technical equipment of the ColorTable can only be used in one way: its form and industrialized surface does not provide any other. A quite common observation was that some participants work collaboratively with the tokens on the tabletop, while others wait for their turn with a token and content card in the hand.

Further engagement of the haptic sense with objects and their materials takes place when changing map (people are familiar to touch and handle printed paper maps from their own experiences.) and turn the wheel for zooming and rotating (Figure 106).

Figure 106: The wooden wheel entices participants to move it – participant grabs the edge and turns it (right). Participants change map by engaging with the big sheet of paper map (left).

Haptic engagement has a pronounced social quality:

- Piles of cards, content cards held in one hand or placed on the map signal forthcoming action in a way visible to all;
- Interaction with tokens may assume a strong expressive dimension visible in the quality of participants' gestures, e.g. beating, feeling, and touching;
- The physicality of the map invites grown practices of touching, pointing (individually or collaboratively), and annotating that support the focused attention of all on an area of intervention.

5.1.10 The intermingling of acting and talking

In this subsection we have a closer look at how talking and doing are interrelated. The aim here is not to perform a thorough discourse analysis but rather to understand the particular relation between what participants say with their 'project' and the tools provided in the MR-Tent. For this purpose a number of smaller scenes have been selected from the vignettes. In their analysis we use the broad activity category: understand MR scene, plan intervention, and perform intervention.

Perform intervention

We start with two simple sequences of directing action. The first image (see Vignette 3) shows an act of collaborative gesturing. While C and E are adjusting the yellow and orange tokens representing a path so that they get tracked, EV with her hand stretched out over the CT proposes to have the yellow token pointing towards "Le Moulin de Coulèvre". The next image shows Ch following the suggestion of EV (Figure 107).

A more complex action is depicted in the following sequence (see Vignette 5). Participants here change the size of an object they have placed. It starts with Ch holding the attribute card on the RFID to withdraw it in the right moment. All are watching and M exclaims: "Ah, voilà, voilà!" pointing at the screen, when the chairs appear in the panorama. In the next image it is EV who holds the attribute card and all are gazing at the screen, while M shouts "stop" (Figure 108).

The 'doing' of performing an intervention is coupled with talk in different ways:

- EV performs a verbal-gestural directing on the map with Ch's hand following the direction with the token;

- An object manipulation (change size of object) is performed, which requires engaging with the MR scene, and stopped by verbal action.

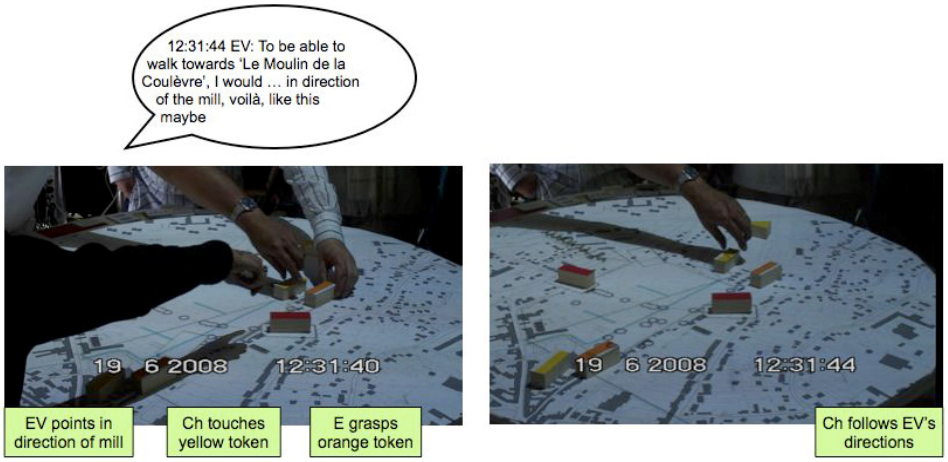


Figure 107: Directing placement of flow

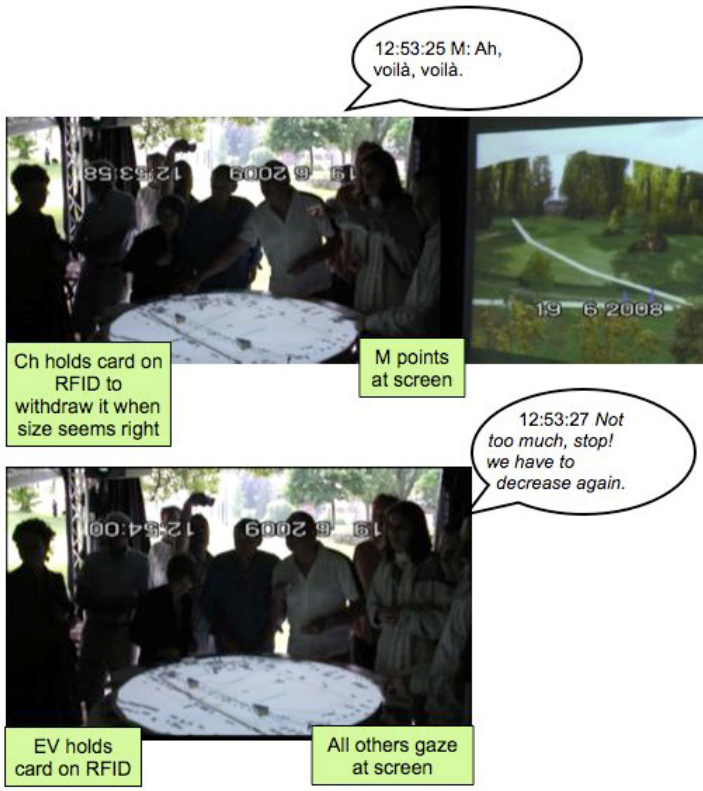


Figure 108: Directing manipulation of object size

Understand MR scene

In the next sequence (see Vignette 8) the group tries to make a previous intervention visible on the screen. They are looking for the other 'pond' they have placed before, making guesses where it could be: "It is behind the trees" – "It was not behind the trees in the beginning". V intervenes, pushing the yellow token and proposing action – "you need to turn a bit". The pond appears at the upper left side of the panorama, M and V both point at the screen: "Ah, here it is!" (Figure 109).

Figure 109: Identifying object in MR scene

Figure 110: Identifying an object in the scene and preparing the next step

Understanding often requires acting and is intricately connected with planning a next step, as can be seen in the following sequence (see Vignette 4). It starts with S performing an iconic gesture emphasizing his point about the placing of the green chairs ("en quinconce"), with his arms pointing in direction of the screen. The chairs are not visible – M assumes they may be too small. EV confirms – "we have placed them closer to here and they are very small", pointing towards the closer to here on the screen. In the last image we see V who has moved to the screen, pointing out the chairs. At the same time, Ch and E are already preparing for the next step (Figure 110).

Understanding the MR scene in both sequences involves identifying an object that has been placed. We can see the following patterns:

- Verbal assessment of the scene – what cannot be seen and why – followed by action (object manipulation), directing of action (manipulate scene: rotate) or pointing (onto screen);

- Scene manipulation followed by verbal action accompanied by pointing onto screen;
- Engagement with the scene while a plan is formulated verbally and through gestures;
- Parallel action (object manipulation) as part of established understanding.

Plan intervention

The sequence (see Vignette 1 and Figure 111) starts with EV formulating a plan while assessing the appropriateness of the scale of the map for this purpose. She whilst talking points out the area of intervention with her hand turned flat. In the next image we see M gaze at the screen, first asking if participants would like to change viewpoint, then asserting the viewpoint to be seen in the projection is the correct one. G and Ch are looking on the map; EV and Ch confirm M's statement. The sequence closes with M confirming again, pointing at the screen – "we are already there" – but at the same time suggesting action – "you may have to turn the zone of vision and zoom" to make the area of intervention visible. Ch follows M's gesture and E has his hand at the wheel ready to perform the action.

EV has formulated a rather general plan – "things for people … urban furniture for resting" and there is the need to assess if scale and viewpoint are appropriate. This involves engaging with map and projection, pointing, and suggesting action.

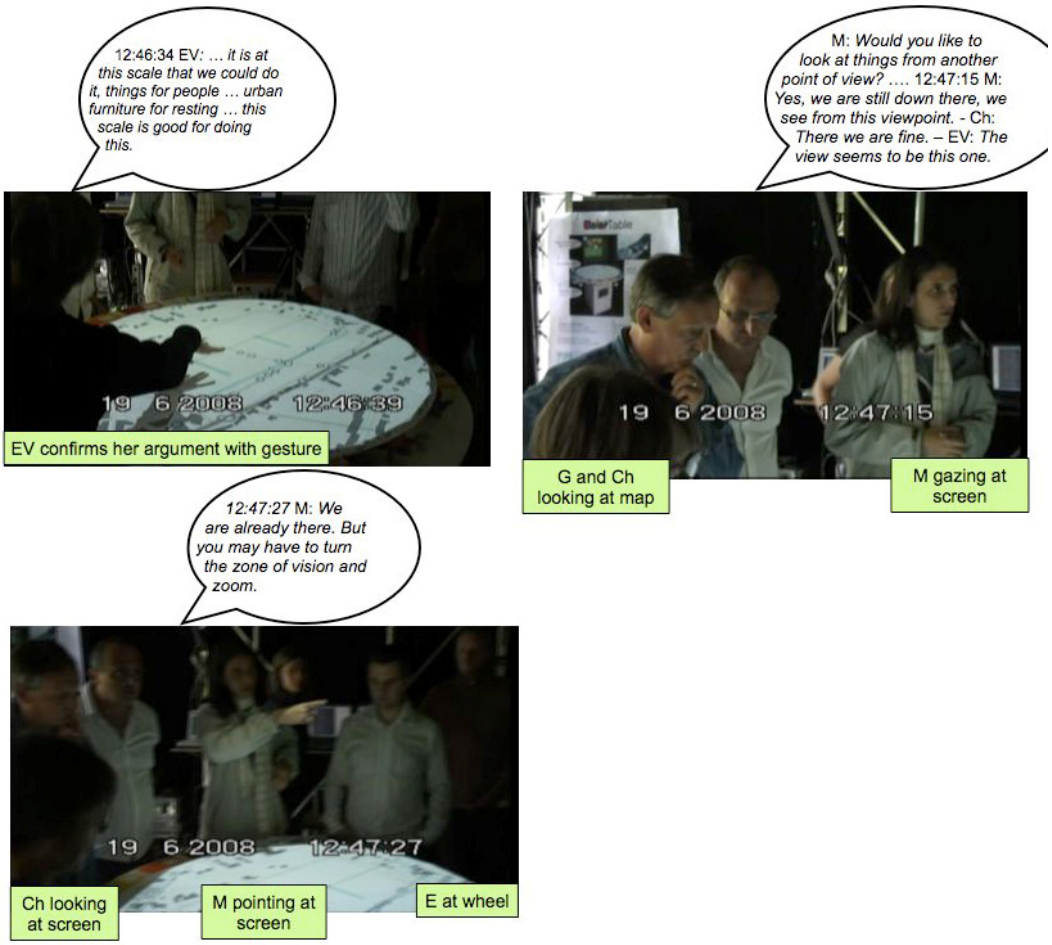


Figure 111: Finding the appropriate scale and viewpoint for intervention

The next two sequences (see Vignette 6) provide examples of planning action. We first see Ch pointing to the screen while formulating a plan, with all listening and following his gesture. M supports him making all aware that "all this is free for the moment being" while Ch looks on the map with his fingers suspended over the area of intervention, taking up M's remark and

asking: “All this is free”?, and he continues with his plan: “We can reduce the parking” (Figure 112).

The next sequence (Figure 113), a few minutes later, shows three parallel actions. In the first image Ch says: Now we have to place a green coverage” while turning to an RFID field. Following a suggestion M made to him, E in his role as ‘technology support’ freezes the scene. While this is happening EV has an idea of what to place and, as we can see in the next image, she has already turned to the WB while Ch continues talking about the “green coverage” with his hand on the map while already formulating the next step: “ … after this we place the cabanes”. The panorama shows the area of the intervention.

Figure 112: Formulating a plan

Figure 113: Continuing with the plan while setting first action

This sequence (which has not been included in one of the vignettes) shows EV and Ch planning action together, with EV taking the lead and Ch providing support (Figure 114). It stars with EV, holding a content card in her right hand asking (herself) where to place the cabanes, while Ch is looking onto the screen. In the next image EV places the blue token (representing the cabanes) on the map while looking at the screen; Ch looks onto the map listening. EV then lifts the token again, looking at the screen, ensuring herself: “And this is the pedestrian path?” Ch lifts his right hand to intervene. Pointing with his whole hand on the map he proposes to first freeze the previous interventions so as to make space for this new one. EV still holds the content card in her hand. The last image shows Ch pointing out the path with a tracing gesture on the map while EV is formulating the next plan.

Figure 114: Looking for the right place for the ‘green arches''

In this scene EV does most of the talking, which is focused on orienting herself in the MR scene and deliberating where to place the cabanes. She talks with a content card in her hand, places the cabanes tentatively, lifting the token again. Ch comes in with a practical suggestion – to freeze the scene – to then start a tracing gesture on the map.

Planning and intervention is foremost done verbally, with action being intertwined in different ways:

- A verbal formulation of a plan is followed by a verbal assessment (of scale and viewpoint), which involves pointing on map, engaging with scene, pointing on screen, and verbal direction of action;
- A verbal formulation of a plan is tightly coupled with engaging with scene (gazing, pointing), followed by a verbal assessment and a verbal-gestural confirmation of plan on map;
- A verbal formulation of a plan is tightly coupled with an object manipulation (RFID field) and continued verbally and with gestures on map while other (verbal and physical) actions start;

- Participants engage with scene while planning an intervention: a) switching attention between map and screen, b) talking while manipulating objects (holding content card, placing then lifting token), c) tracing gestures on map.

Typically, a lot of talking in the MR-Tent has the character of *articulation work,* which is an integral part of collaborative work and, at the same time, a sort of 'meta' activity: "Articulation work is work to make work work"; it comprises all the "activities undertaken to ensure the articulation of activities within the cooperative arrangement" (Schmidt 2002: 462). It is also important to note that participants cooperatively create representations of what they talk about, making use of additional semiotic resources for expressing their ideas.

5.1.11 Collaboration modes in the MR-Tent

We have seen already many instances of collaboration in the MR-Tent. Here we will summarize these observations, looking at four situations through the lens of collaboration issues.

Distributed collaboration (Vignette 5 revisited)

MK starts explaining the bridge project developed in his studio. He uses a lot of pointing as well as iconic gestures. *It is slightly curved* – he makes gesture in the air back and forth (11:14:21); the steel structure is very thin. It is almost seven meters wide (11:14:2). There is a continuous stream of bicycles … there are some crossings here. MK performs gestures explaining the main flow of people around the junction. – S: *And what about the stairs*? - MK and BA both point at the same spot on the map (11:15:29). FH wants to know about the main entrance from the new bridge and he and MK are simultaneously moving their fingers on the area they are talking about (11:15: 36). – K: *So it is like it is now?* – MK (moving his two fingers): *Yes, you just have to stretch and turn a bit* …. JH: *How do we make it into a welcoming area?* …. – K: *There is an information area here and* (searching) *there*. – Both she and JH point to the same spot on the map.

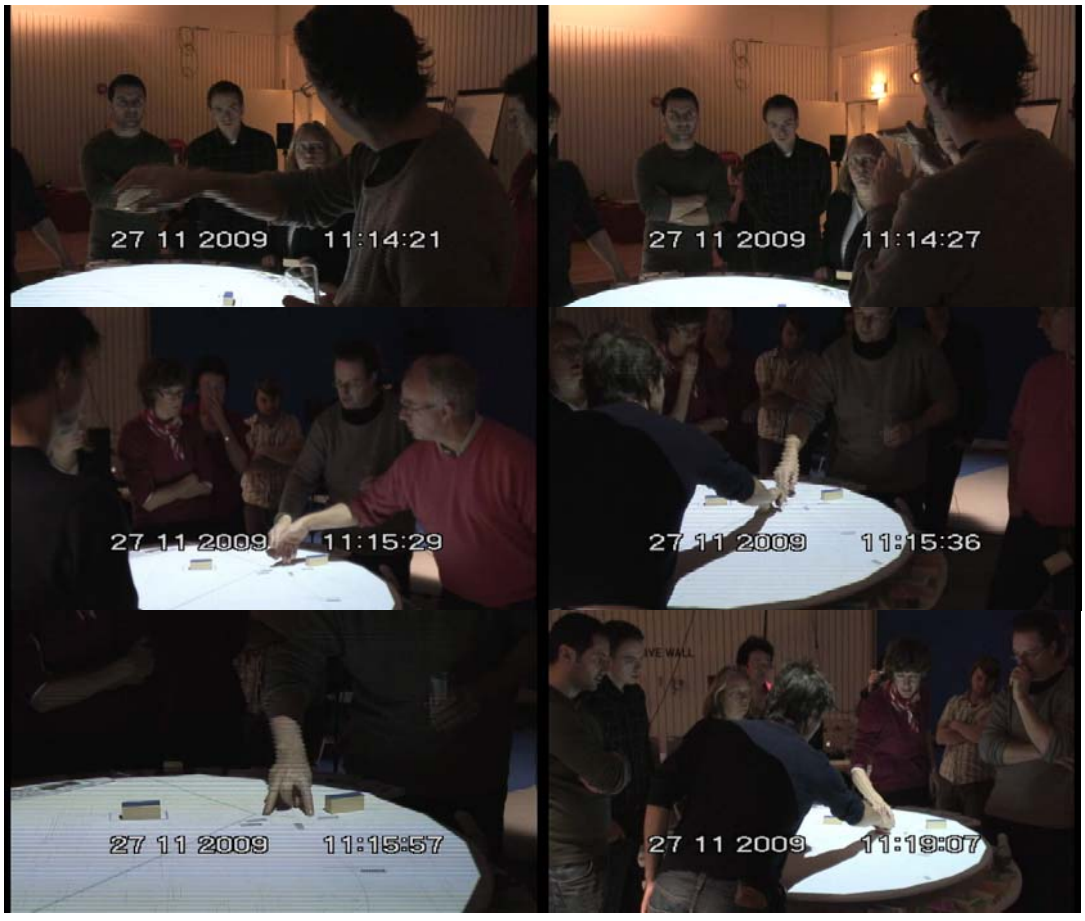


Figure 115: Explaining a flow situation on the map

This is a typical scene, in which several participants are deeply involved in discussing a flow situation on the map (Figure 115). It involves continuous pointing, tracing and iconic gestures. Often their hands come together on the map.

The group has placed a line of green chairs and they are looking for them in the panorama - they are very small – V points them out on the screen – Ch places attribute card on RFID – EV watching: *Stop, stop, stop …* 12:53:27 M: *Not too much, stop, we have to decrease again!*
12:54:09 EV: *They are not really well positioned; we may have to push them to the other side?* - E and EV push the chairs to the other side of the path checking all the time their position on the screen while the others look and direct
12:54:38 G turns briefly to WB - 12:54:45 M: *They are between the Viosne and the … Well, are you satisfied?* - G he returns asking a question an M, Ch, and E follow him to the WB, while EV continues gazing at screen
12:55:09 Ch is the first to return from the WB – he adjusts the position of the blue tokens, representing the line of chairs, for a short moment using both hands
M suggests to associate an 'ambience' with the scene – EV proposes 'children playing' – E moves to WB and EV follows him
12:55:43 G and Ch are at CT – Ch lifts up a content card from the edge of the table while G is talking and pointing at a spot on the map – Ch puts a content card directly on the table – laughter

We can identify the following pattern:

- All participants engage with MR scene, trying to identify the 3D line placed before;
- Ch starts object manipulation (increase/decrease size) with EV directing and commenting;
- EV and E collaborate in object manipulation, repositioning 3D line;
- G initiates brief formation of group away from CT to discuss and issue, while EV continues engagement with MR scene;
- Ch returns to CT continuing object manipulation;
- M (as moderator) initiates new action – EV makes proposition, turns to WB, with E following her;
- G and Ch form dyad at CT with verbal-gestural argument and object manipulation.

This dynamical pattern is typical of what we term distributed collaboration. It starts with all participants around the CT in common action. Different types of object manipulation 'invite' different patterns of collaboration: increase/decrease size of object usually involves one or more participants direct/comment this action; setting or manipulating a 3D line or flow is mostly done by two people, each of which takes care of one of the tokens; placing new content may involve one participant pointing and the other one placing. Proposing new action is often accompanied by a shift in collaboration, such as in this case where two participants. move to the WB while two others are already starting a new action.

Triadic collaboration (collaborative gestures revisited)

Figure 116: Collaborative gestures as part of planning activities

Planning an intervention, G points to the road between the CCI building and the château – EV gets involved, pointing out on map – E prepares connection tokens
14:48:46 EV points to parking on the map – J, EV and G form triangle - we see panorama with new building in 'bleu Klein' and parking
14:50:45 EV performs encircling gesture moving round several times: *I think we should also improve the visual appearance where you enter the town since this an entrance into town?*
14:50:59 G puts his finger on roundabout: *We can make an entrance here*.
14:51:10 J's finger joins: *The new roundabout is there; the little one is there*. – J and G both make a confirming gesture with their fingers on the map
14:51:24 G moves further up the road with his finger on the map: *And there we could think of an entrance with parking, this would clear this part here and this would bring another type of people.*

In this scene EV, G and J form a triad in discussing possible interventions close to the château, whilst E and M are listening (S has left and Ch is absent for a short while) (Figure 116). Both J and G act in their role as local experts. EV puts forward a proposition, encircling a small area with her finger, with the others following up talking and gesturing. Action here takes place on the map only. Collaboration proceeds in steps of identifying places and suggesting action with lots of pointing and tracing.

Dyadic collaboration

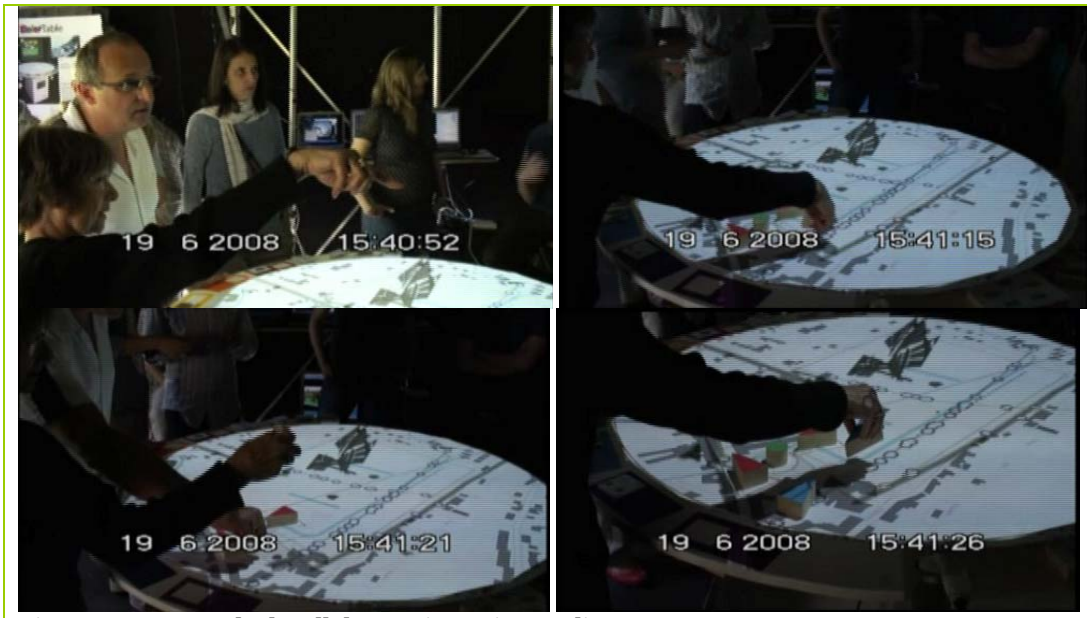


Figure 117: EV and Ch collaborate in setting 3D line

EV fetches light blue triangle – in the following scene she and Ch close collaborate
FC15:41:23 EV discusses with Ch: *Do we place them (the green arches) along the pedestrian path, the large alley behind the cars, at the exit from the alley? – Now, I don't know where to place them because this is the river … Ah yes, the alley passes there, so we could place them*… - both are concentrating on the location on the map, pointing with their fingers – EV looks from time to time on the screen to check
FC15:41:44 EV verifies: *This is the pedestrian path* – points again with her finger on the map, then

with her arm onto the screen – she now wants to place the tokens
FC15:41:55 EV asking: *Comme ca, comme ça* … - she lifts token up again – Ch helps her
15:41:18 EV now wants to place the 'tunnel de verdure' – here we see her a) pointing again at the screen, with Ch watching; b) approaching her hand with the blue token to the map without finishing her gesture: *And if we placed the ' tunnels de verdure' there, like this?* ; c) Ch hand comes in touching a token and then performing a quick tracing gesture; d) EV now placing the blue token.

Here EV takes the lead in placing a 3D line of objects (green arches) with Ch helping her and the others being more or less observers (Figure 117). This activity involves a lot of 'mapping' – EV with the blue token in her right hand alternately points at map and at screen. The four images then show details of this collaboration, with EV starting to place, still insecure, and Ch coming in with a comment and gestures until EV finally places the token where it seems right.

Clearly, artefacts play a central role in participants' collaboration in the MR-Tent. Many researchers have addressed the crucial role of material artefacts in cooperative work. They have studied how artefacts are created and shared as part of collaborative activities. Schmidt and Wagner (2004) talk about the crucial part representational artefacts, such as CAD plans, scale models, samples of building materials, 3D visualizations, have in making the invisible visible, specifying, making public, persuading others (of a design idea), enabling designers to explore, evaluate options, and so forth. They also point at the multiplicity, multimediality, multimodality, and openness of many of these design artefacts. In the MR-Tent collaboration is supported by a diversity of artefacts: the physical map serves as a place for planning and performing interventions; the different tangibles enable participants to implement their plans but also to explore, evaluate options, and so forth.

As we have seen, the manipulation of objects on the CT is coupled with the manipulation of projected images (and sound) against different backgrounds – building a scene involves the negotiation of these modes of expression. Lee (2007) introduced the notion of *boundary negotiation artefacts*, arguing that negotiating boundaries may be considered a special form of cooperative work, where actors discover, test and push boundaries. When creating MR scenes, which consist of sets of tokens on a physical map and their corresponding virtual elements, participants negotiate boundaries between different representations of their ideas: physical and projected, embedded in different backgrounds, seen from different viewpoints, and so forth. Exploring these boundaries plays a large role in participants' collaborations. Let us look again at the scene in which EV, with the help of Ch, places a line of green arches. There are multiple negotiations going on: 'mapping' places on the map (the large alley behind the cars, the river) with places on the screen; finding the exact endpoints for the 3D line, also in relation to the other objects that have been already placed; and later also the size and spacing of these objects in relation to a diversity of urban issues they are discussing and that find expression in the place the chairs get as part of the whole composition of the scene.

5.2 Quantitative video analysis

A quantitative analysis of the video material from the second workshop day provides further insight into several research questions. Table 2 gives an overview of the categories

Gestures - type	Gestures – direction Activities - area	Activities
Double Point Encircling Iconic Gesture Personal Pointing Tracing	Air Flow Map Outside Person Projection screen Table not Map Token Card Whiteboard Barcode See Through	Assigning (content) Changing Background Changing Map Color (changing color of an object) Freeze Handing over (Token or Card) Lowering (virtual object) Moving (Token or Card) Placing (Token) Removing (Token or Card) Rotate (view) Scale (object) Spacing (object) Zoom (View)

Table 2: Overview of categories for quantitative analysis

Figure 118 gives an overview of how much time participants spent with each of the four activity categories. We can see that 40% of the time was spent with planning an intervention and a little more than 20% for performing an intervention and understanding an MR scene (often involves evaluating).

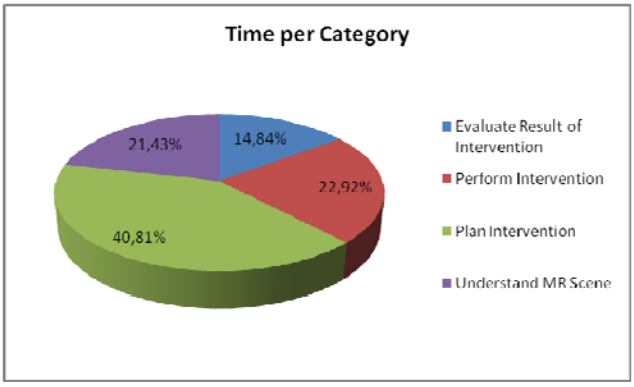


Figure 118: Time per activity category

Next we have a look at the distribution and types of gestures. Most of the gestures take place during planning, which mostly takes place on the physical map (Figure 119).

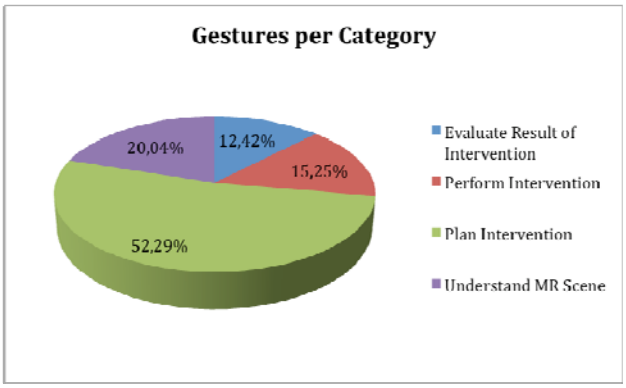


Figure 119: Gestures per activity category

When we look at the different types of gestures we see some interesting differences in frequency per activity. Pointing gestures are the most frequent ones across categories. Tracing gestures, which are mostly performed on the physical map, are prevalent during the planning phase. Dual or relational pointing (e.g. connecting a place n the map with a place in the projection) becomes more frequent when participants engage in understanding an MR scene or evaluate he result of an intervention (Figure 120).

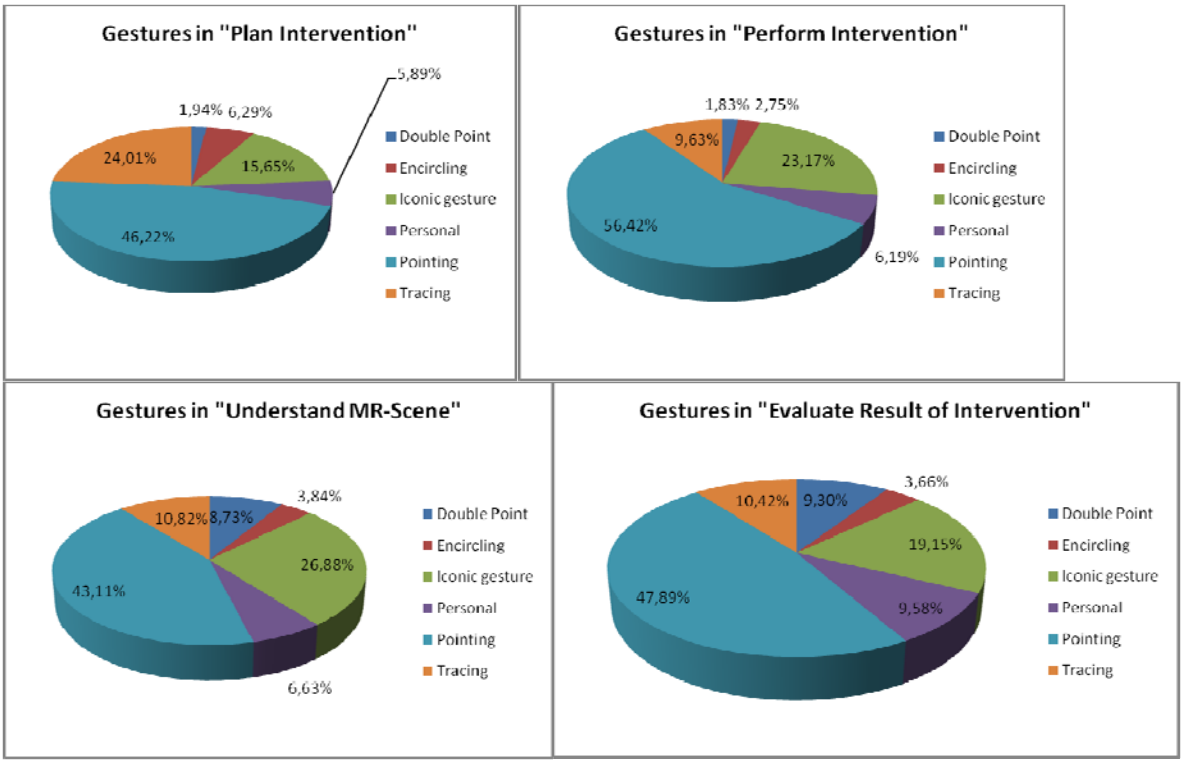


Figure 120: Types of gestures per activity

During planning gestures are mostly performed ‘in the air’ or directed at the map, scarcely involving the projection screen. When performing an intervention participants’ bodily attention moves to the screen and is more evenly distributed between ‘air’, map and screen. Evaluating involves an even stronger focus on the projection screen (Figure 121).

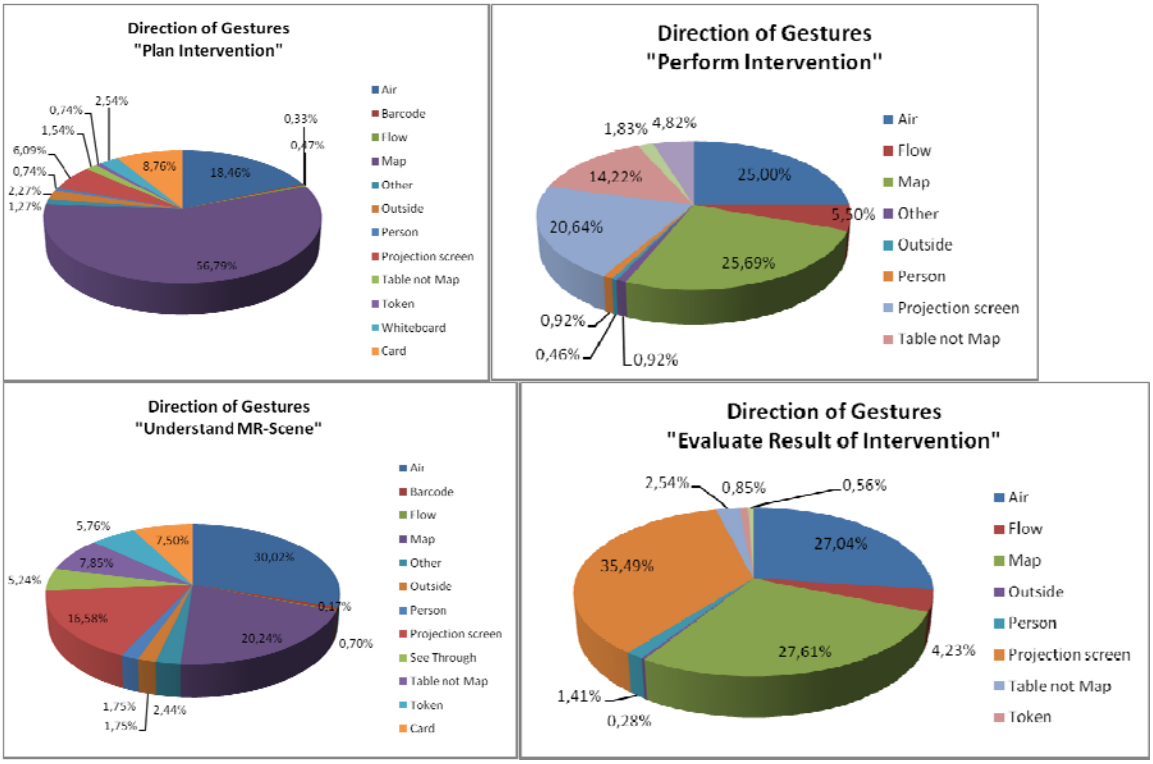


Figure 121: Direction of gestures per activity

Figure 122 gives an overview of time spent on different object manipulations when performing a intervention. Here moving token or (content or command) card is the activity participants spend most of half of the time with. Change scale, rotate and hand over token or card occupy around 5% of participants' time. This means that when participants perform an intervention interacting with haptic elements (tokens, cards) is in the foreground.

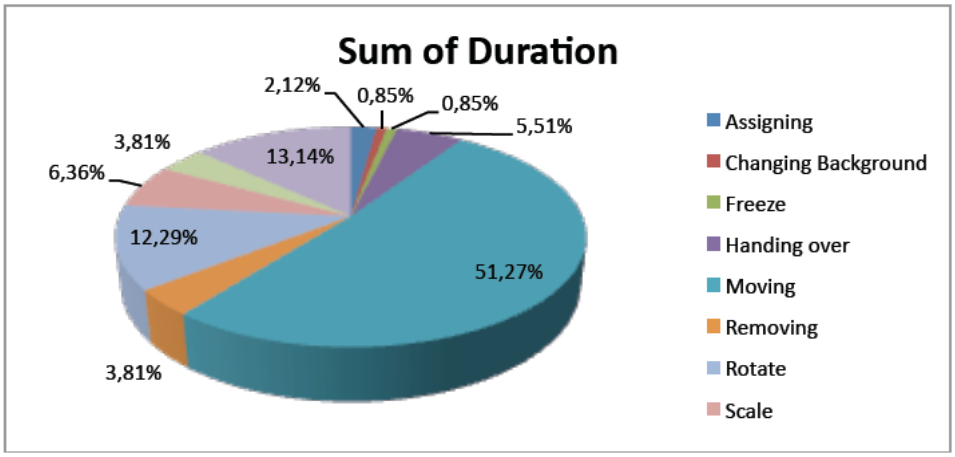


Figure 122: Time spent on different object manipulations when performing intervention

Figure 123 shows time spent on different areas of intervention or points of attention. When performing an intervention, most of the attention time is on selecting, looking at and handling(content or command) cards, followed by setting flows and manipulating tokens

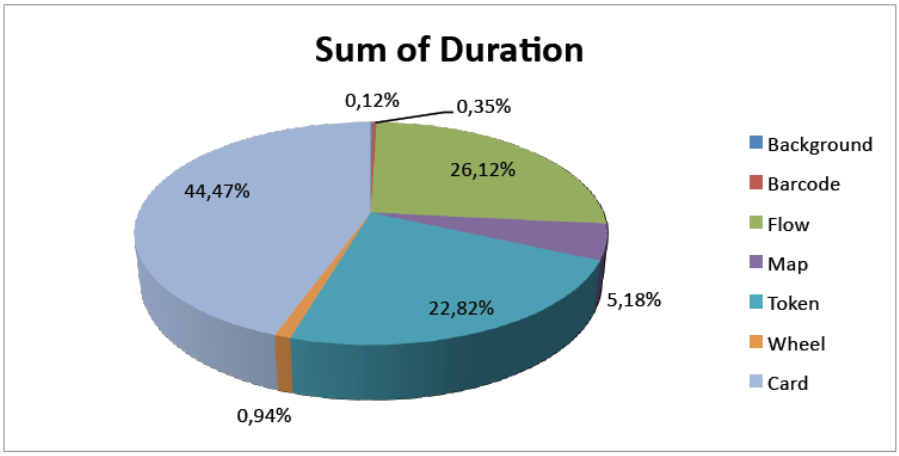


Figure 123: Area of intervention

5.3 Pontoise: evaluation of workshop results from an urbanist perspective

This evaluation addresses the two workshops organised in 2009, the preliminary urban workshop in May and the MR workshop in June. It has been conducted using the basic IPCity methodology adapted for the final report. The two workshops have been studied to identify different actions and to break up the activity into steps and specific tasks. It has been observed that the steps and the tasks undertaken in the two workshops are similar. These have then been analysed through questions pertaining to the project negotiation process, criteria concerning representation, relationships among stakeholders and urban topics discussed during the sessions as schematically detailed below.

Steps of the project

From an urban perspective, the activities of the participants of the workshops can be characterized as follows: (Figure 124)

- Understanding space: identifying urban issues (centralities, flows, landmarks, etc.), relating to places, occupying.
- Manipulating space: define objectives, confronting ideas, annotating, negotiating.
- Augmenting space: putting together, creating urban scenes, presenting, and communicating.

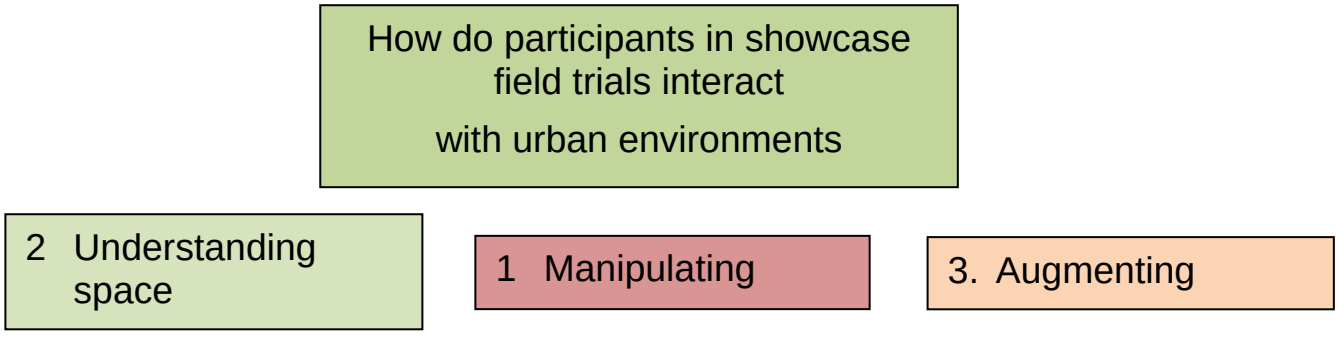


Figure 124 : Overview of urban evaluation approach

These three moments should not be considered as linear steps of a work process, participants moving continuously and iteratively from one to the other. More specifically the activity “Relating to Urban space” is strongly present during the first step “Understanding” but appears during all the key moments of the urban project process.

These three steps have been used as the basis of an analysis based on questions related to urban issues. Modes of representation, semiotic resources and communication media arise as important issues in a collaborative environment that brings together people from different backgrounds, professions and know-how. The role that technologies play in finding a new equilibrium between written, oral and visual media is our main question. The relationship among stakeholders is another issue of importance for the same reason. In which way the technologies influence the power structure between specialists and non-specialists, public authorities and civil organisations? Main topics of discussion and the role the technologies play in their formulation is the last question addressed. Which themes emerge as important and how do the technologies empower the participants in their approach?

Modes of representation, semiotic resources and the communication media

From an urban perspective, the representation issues related to MR technologies concern the interaction in the urban process. From the comparison between traditional and MR oriented workshops emerge a whole range of semiotic resources and communication media:

- Visual supports: maps, geo-referenced maps, photos, videos, panoramas;
- Engaging media: sketches, annotations, writing, working with objects;
- Oral expression and gestures: discussing, negotiating, pointing and miming.

Relationship among stakeholders

Stakeholders who participated to the workshops have different backgrounds, professions, know-how and interests/stakes which influence their contribution and the role that they adopt in a multi-actor process. We observe that the technologies allow the users to bypass the characteristics that govern their behaviour and responses and go beyond the limits of the initial typology of participants as we know and observe it in everyday life. The use of simple and playful technologies seems to weaken the usual behaviour patterns and allow participants to adopt different roles when faced with different questions. A director from the regional authority may very well adopt the role of “user of the city” when faced with a question that would affect his everyday life, act as an urban planner when he is faced with a question concerning his profession and readopt his primary role when asked about the final decision of the regional council with a lot of ease when he is “playing” with the technologies.

The observed workshops reproduce typical complex multi-actor urban project process. In spite of the large diversity of participants, we consider 3 categories of stakeholders with specific skills and know-how, co-constructing a project in a collaborative way:

- Ordinary citizens;
- Decision-makers, clients, politicians;
- Urban planners and designers.

Main topics of discussion

Urban space is one of the principal components of the workshop. The technologies allow participants to address urban space in different ways, decompose it in its different elements, add different meanings and modify it thus creating a new space and a new language that is accessible only through the use of the technologies. In doing so, they modify the user’s perception of his city and his immediate surroundings that we call “augmenting”.

The workshops have given the opportunity to progressively complete and restructure our recurrent urban concepts (cf. IPCity Concept map):

- Experiences, memory, traces, etc.
- Limits, boundaries, layers, scales, ambiances, etc.

- Artefacts, concepts, buildings, flow, etc.

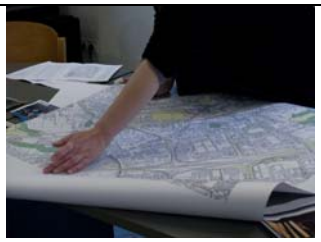
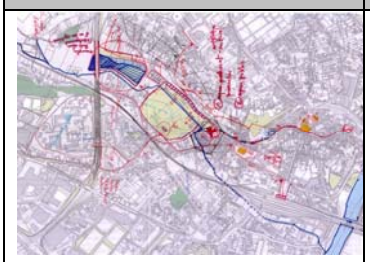
5.3.1 May preliminary urban workshop and June MR workshop

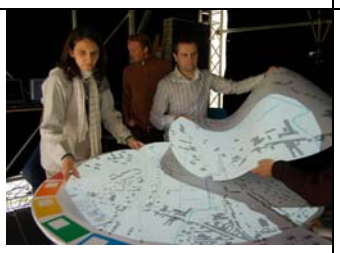
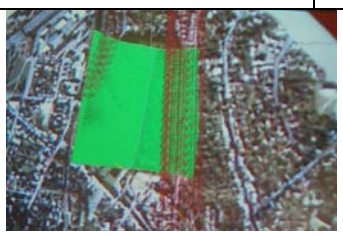
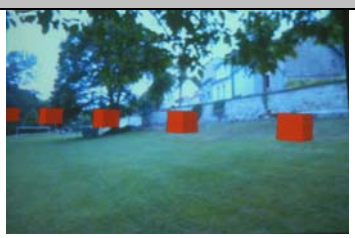
In the table below, we have put together and confronted pictures from May preparatory urban workshop and from June MR workshop. It is interesting to observe and, if possible, compare the differences and the similarities of behaviors of the participants who were mostly the same people in both workshops.

The media (visual, written, sketching, oral), gestures and behaviors were also comparable, although MR technologies offered participants new modes of representation and empowered them to look for novel expressions.

Comparisons on the collaborative approach of each workshop

- The participation and negotiation of the stakeholders before decision-making and design process.
- The use of multi-sensitive modes of representation and communication media (visual, sound, written, oral, annotated, etc.)
- The possibility to create various types of relations among stakeholders and to empower non experts
- The capacity to debate on up to date themes like public-private boundaries, ambiances, environmental awareness, etc. that are difficult to represent with traditional tools

WP6	MAY : URBAN WORKSHOP		
	VISUAL SUPPORT	**ENGAGING MEDIAS**	**ORAL/GESTURES**
UNDERSTANDING **IDENTIFYING ISSUES** **RELATING TO URBAN SPACE** **OCCUPYING THE WORK SPACE** **APPREHENDING THE TECHNIQUES**			
	UNDERSTAND SCALES	**IDENTIFY CENTRALITIES**	**EXCHANGE EXPERIENCE**
			
	UNDERSTAND CONTEXT	**ANNOTATE MAPS**	**CREATE CONTENTS**
MANIPULATING **CHOOSING CONTENT** **CONFRONTING IDEAS** **NEGOTIATING WITH OTHERS**			
	CONFRONT IMAGES	**ANNOTATE DOCUMENTS**	**NEGOTIATE**
			
	CHOOSE IMAGES	**NEGOTIATE IDEAS**	**CONFRONT IDEAS**
AUGMENTING **PUTTING TOGETHER** **PRESENTING IDEAS** **COMMUNICATING SOLUTIONS**			
	COLLAGE PROPOSAL	**COLLAGE PROPOSAL**	**PRESENT RESULTS**
			
	PLAN PROPOSAL	**SKETCH PROPOSAL**	**PRESENT A SOLUTION**

WP6	JUNE : IPCITY WORKSHOP		
	VISUAL SUPPORT	**ENGAGING MEDIAS**	**ORAL/GESTURES**
UNDERSTANDING **IDENTIFYING ISSUES** **RELATING TO URBAN SPACE** **OCCUPYING THE WORK SPACE** **APPREHENDING THE TECHNIQUES**			
	CHANGE SCALE	**DEFINE BOUNDERIES**	**IDENTIFY CENTRALITIES**
			
	DEFINE BOUNDERIES	**TEST BUILDING SHAPES**	**IDENTIFY FLOWS**
MANIPULATING **CHOOSING CONTENT** **CONFRONTING IDEAS** **NEGOTIATING WITH OTHERS**			
	NEGOTIATE CONTENTS	**NEGOTIATE IDEAS**	**CONFRONT IDEAS**
			
	CHOOSE CONTENTS	**SKETCH**	**CONFRONT IDEAS**
AUGMENTING **PUTTING TOGETHER** **PRESENTATING IDEAS** **COMMUNICATING SOLUTIONS**			
	PRESENT A SCENE	**SKETCH PROPOSAL**	**PRESENT AN IDEA**
			
	MAP PROPOSAL	**SKETCH PROPOSAL**	**PRESENT A SOLUTION**

5.3.2 Sequential analysis of the workshop, June 18

For June 18, for technical reasons, it is not possible to identify in the transcriptions the people speaking

1st SEQUENCE

Step of the project process: Understanding

Description of the sequence: The participants begin to work on a large scale map about main elements of and around the site, as well as about connexions. Performing some actions with the technologies arises the need for clarification about more general issues (*are we working with the existing or do we create new, imaginary elements?*) and about the purpose they aim. Regularly, enacting a new action with technologies (essentially placing flows) opens up to sequences of new topics, like chains of discussions. The collective conversation around the table is so absorbing that the participants forget the presence of the screen (they turn their back on it) and the moderator invites them to check on the screen the results of their actions onto the map (Figure 125).

Figure 125 : Understanding

Transcription (hour: 13h05)

Yes, it's true, we had evoked those connexions, from the garden to the city.
There is one there above, it's a small path (sente…) which is absolutely not used because people don't walk in Pontoise. (…)
So we could imagine a peripheral axe over there or rather over here.
Go ahead.
I don't know, what's written?
« Sentier pédestre à faible densité » (low density footpath), « …à forte densité » (high density), and then « piste cyclable à forte/ faible densité » (cycle track at high/ low density).
That's it.
From the station, from here and from there. And we had said from Marcouville, too. They're cycle tracks and the rest, so how do we do?
There are cubes and we put one to connect places, don't we? (…)
Colour rectangles.
We must take the orange one, mustn't we? (…)
The footpath is a little more far away, over there.
No, but we don't talk about what exists. We are evoking imagination…
Improving connections.
So there will be a tramway or maybe a cableway as you has said. Where would it be?
We must connect this point to that point. (…)
The idea is to use the CCIV as stop.
The idea, however, is not to set up in the middle of the garden with material, it makes no sense. (…)
The footpath exists already. There is one going that way : the one that was already used, could be reused.
We can make curve lines using angles.
…So people walking could arrive in the middle of the garden while from other sides they could arrive there, you see. So that could be the idea. (…)
And at the same time, why calling into question this footpath?

Without calling it into question, keeping what exists.
Go ahead, try it.
Well, I thought we were here to imagine connexions and indeed to allow people to move around more easily, to discover, to make connections among neighbourhoods, etc.
Actually, in my opinion, the existing footpath, le Ruel des Poulies, it exists, we won't erase it. We keep it, but we can also try to find something else to improve.
Ok, I think it's important to say that the existing paths, we leave them for the residents, and we create paths with a better status as public spaces, connexions…
I think that the strategy for the city design is interesting rather than congesting with things that already create conflicts with residents, we should have more categorical things.
I would rather defend the opposite point of view by saying that for this footpath, the idea is to increase its size, to improve it as strolling space, much more than…
No way for it to become a boulevard!
…since to create something else, the problem is that contour lines. And we cannot speak about boulevard since it's only pedestrian.
No, but to have more people. (…)
Ok, but we shouldn't put a path, then. (…)
I think you are right: the path is where it is. We had said we would connect it with a tramway. (…)
Well, I bring your attention that behind you, you have a aerial map which should reproduce what you are drawing. That, you have put it outside, too far away.

Modes of representation, semiotic resources and communication media: The starting point is identifying the existing network of footpaths on the map, which the participants redesign using flow tokens and the different possibilities those offer in terms of diversity of transportation means, speed and layout (straight or curve line…).

Relationship between stakeholders: A few participants use the technologies at this stage but most of them participate to the oral exchanges. Placing a flow on a map is the pretext for a collective discussion on larger urban issues, making different points of view emerge, finding agreement on priorities but also generating controversies.

Main topics of discussion: The discussion about pedestrian paths (*sentes*) rises attention about issues relating to the steep slopes between different parts of the city (the site is at the lower level of the creek Viosne comparing to the historical centre, which is on a hill). This gives the opportunity both to better understand, visualise the site and to discuss about existing and imagined elements, to be created. A controversy emerges: should the existing be kept and eventually enlarged, reinforced or should a new network be created? Which balance between animation and calm? A tramway or a funicular are also foreseen to connect different levels and this leads to think about the location of stops (for example near the CCIV building).

Evaluation: This sequence allows both to get operational with technologies and to generate collective oral dynamics. Focusing essentially on flows (and the elements they connect) allows the participants to orientate themselves through the map and to share their vision for the site. Main orientations emerge through the exploration of different options which are progressively consolidated.

2nd SEQUENCE

Step of the project process: Understanding - Manipulating

Description of the sequence: The main activity of the sequence concerns zoning. The first step is identifying a pertinent zone (and marking it with appropriate token), the second consists in qualifying it. This activity corresponds to the definition of the main working space. The possibility of changing scale (for a clearer and more detailed vision) is evoked but not yet enacted. The technical activity takes some time and energy, but the sense of the actions is progressively clarified in a learning by doing process (Figure 126).

Figure 126 : Understanding and manipulating

Transcription: (hour: 13h20)

Where is the castle?
(The participants remember how to create a zoning, how to define the perimeter by using mobility axes and boundaries, existing or to be created)
But can't we enlarge the zone? (…) I'd see it on this perimeter, castle included.
We had talked about the retention pool and all the rest, we wanted it to go until the road. Is there enough space?
(…they ask how to manipulate textures)
There are green textures, grass, mineral, and then we can get into details.
(…They decide for) a green zone, with transparency. (…)
Actually now we must qualify this green space. So we could have a cultural pole here and goes up there, with a mobility pole (…)
So how do we do? We must simply change scale now that we have said that should be dedicated to green space with leisure tents (…)
There is the castle, the CAUE. We are in a zone, it could be that zone. (…)
And we could create other activity poles. Activities, it includes a lot of things. So maybe along the pedestrian axe over there or along that one.
In between.
Not bad.
Yes, you have invented something new, that was not programmed.
(The participants duplicate the word "activités" and place it onto the green zone. Then, the discuss about the possibility to change scale to see more details, but they finally continue a little longer on the same map)
That's good, approximately the good scale. There is a panel with red LED and one can send sms…
Words race out of control. The system has not been programmed for that so now you transform words into an avenue, but it's not bad, it's interesting.

Modes of representation, semiotic resources and communication media: The participants work at the city scale on the table and with the aerial view on the screen, which is at a slightly larger scale and on a aerial photo support. The two maps show different aspects of the site: the former being a coded representation, with more details and a smaller visible area; the latter – a more realistic representation, with less details but a larger vision of

the site. Moreover, the first one is the support for enacting the negotiation process, while the second shows the result, the production.

Concerning the texture of the area, the participants prefer a pure colour with symbolic value (green) to more realistic possibilities available (grass, for ex.). They ask for transparency (even if they do not really work on it) which is necessary to keep seeing what is in the zone covered by the texture.

Then, a second qualification is added concerning activities in the defined green area by placing the word “activités” and multiplying it in a row (which is a new use of the technical possibilities).

Relationship between stakeholders: The discussion is collective but one person is in charge of enacting the choice with the technologies, eventually helped by others to recall the technical procedure, to point relevant elements, to comment or to adjust the choices made.

Topics of discussion: After having worked on flows and connexions, the participants think about zoning and the kind of activities that should be in the areas to define. The technology invites to think about the nature of the borders (transportation axes, existing boundaries or limits to be created). Once the zone defined, it is qualified (green area) and then the activities that could take place in it are discussed. The technical solution adopted aims at creating multifunctionnality. The participants also discuss about animation and ambience. The choice of the pertinent scale of visualisation also appears as an issue, in particular because the maps are saturated (the tokens take some space on the table before freezing and the aerial view is less detailed). However a complete cycle of discussion-enacting must be accomplished before the participants are ready to change scale.

Evaluation: The zoning activity is a pretext to qualify the green space in a multifunctional way and arousing discussion about ambience and animation of the site. The visible production does not show the complexity of the topics evoked, more or less explicitly. The richness of the negotiation can only appear from the combination between visual support and production, oral expression and gestures of the people gathered around the table.

3rd SEQUENCE

Step of the project process: Manipulating

Description of the sequence: Actually, 2 sequences are connected, since they refer to the same

landmark, seen from different viewpoints (different panoramas and turning inside the panorama). In the first step, the participants chose, place and scale a tower in the CCIV site. After a while, they change panorama and chose a view where the tower is visible, they place ranges of trees and turn the panorama to operate in a different area of the site (Figure 127).

Figure 127 : Manipulating

Transcription: (hours: 12h30, 17h45)

Oh, the famous tower…
We replace the CCIV.
It's the future high school of Pontoise (…)
It doesn't "decrease" (in English in the discussion)
It does, but the program has stopped. Maybe we must take it away because it's already one meter.
It's not much, one meter. (…)
We make it 30m. (…)
It blocks the landscape.
It's rather 15m, 12-15m.
18, isn't it?
We can make it smaller then.
Yes, 30m, it's… maybe 2m per floor.
(Participants have changed panorama to work on another space, but always having the reference of the tower as landmark)
I think we must put some trees.
Mister gardener, pay attention: they put anything! (…)
I think that, since we have a background, we need trees… coloured species
Yes, yes
Take the orange tree…
Do we take this? Ok?
We put them all over, a range of trees. (…)
We should bring them closer, shouldn't we?
The trees, yes.
To reduce the gap.
Yes, to reduce the gap.
There, not to much. It's good like that.
It looks like in Kyoto, So now…
Now in the border we must place our playground. (…)
Sincerely, who reduced the gap between trees? It's a computer control ?
Yes
Actually, you're playing
Yes

Actually there is a card which says the incrementation between elements, so you play on distance, frequency.
Ok, it's good.
So now, the playground.

Modes of representation, semiotic resources and communication media: The scene visible in the first 2 screenshots includes flows created in a previous step of the process, at a larger scale, which organize the open space of the parking. Then the participants concentrate on the CCIV building, which has been erased from the panorama in order to allow them to work on a free space, keeping it open or, like in this case, replacing it by another kind of building. Both the function and the insertion in the city are discussed. The decision about the size refers to the skyline around, but also to intrinsic dimension (the reasonable height of each floor).

Concerning the range of trees, the choice is oriented by the ambience produced generically by trees in bloom. The kind of tree was not important at the moment of the choice, but when a range was placed, a participant identified a specific ambience: by the reference to Kyoto, he recognized the specificity of the content produced by the research team. The question of the orientation of the process by the production of content is not crucial since the metaphorical sense is prevalent in the choice of the object, but it can still appear as a secondary effect.

Moreover, after choosing, placing and discussing about the status of objects, they (both the tower and the ranges of trees) become landmarks in the urban scene created.

Relationship between stakeholders: When a proposition is accepted and implemented with the technologies, the adjustments are made collectively, calling on to each one's know-how. The moderator questions a participant (the "gardener" from the City of Pontoise) about his professional skill (for the choice of trees), but the process itself does not need the expression of such a technical expertise at this stage: the purpose for the moderator is essentially to help a shy person to participate to the discussion by pointing his possible contribution.

The playful dimension of the tools is also source of exchange among participants and collective learning.

Topics of discussion: After having acted decisions about flows, the discussion is orientated towards objects. The tower is approached with its function (the CCIV becomes a new high school), its appearance and insertion in the landscape, and therefore as a landmark. The range of trees participate to a chain of topics concerning animation and ambience in the site, which are searched for sensibly, by placing elements in the scene (trees, and later playgrounds) and adjusting them (by scaling, making the range denser, etc.).

Evaluation: It is interesting to connect several sequences because all along the workshop the participants proceed through chains of topics that they develop until a certain point and then they start with a new topic or come back to a previous scene, like in this case. It's a way of checking the work done at different scales and from different perspectives.

Moreover, the elements are positioned in space in different panoramas in a process that can be compared to a creative composition (like a piece of art, with a kind of aesthetics) and the construction of a scenario (what the participants wish to experience).

Collective learning of technologies generates a kind of solidarity which facilitates the discussion and which can defuse possible tensions in the negotiation.

4th SEQUENCE

Step of the project process: Manipulating and Augmenting

Description of the sequence: The participants discuss about an object which is not present in the database, so they decide to use a content card similar in shape, which they adapt to the function they want to make it stand for. They try to find the most appropriated place for the object they want to create. Afterwards, scaling is the main action of the sequence, and it has different purposes: search for realism, insertion in the landscape and visibility (Figure 128).

Figure 128 : Manipulating and augmenting

Transcription: (hour: 16h25)

Voilà. And this thing about the aeolian mill?
Ah, yes, on the creek Viosne. We should use the area where the current is stronger, under the bridge.
Tiny aeolian mills, then. (…)
No, aeolian mills, they work with the wind.
I was talking about the turbine.
Either in the building…
Yes, but there is not much current. (…)
Yes, there is the exit of the basin. (…)
The question is… The flow is the same at each moment of the river, so it's more a question of width…
We can put it where we want, actually, technically it's the same. (…)
We should put a very small wheel in water. And we could put it there, where there is current.
Yes but there are fichers, they will shout on you. They do their fishing competition there. (…)
Otherwise there are two places where it would be logical to place it. It's here, there is already a mill.
After the bend, there?
So we could imagine energy production from the mill.
We should put the wheel back.
It's blue. We'll put it there, just to see.
Yes, but you're not on the good panorama. We must turn the view.
Yes, we'll be fine there. There are lots of trees. Oh, this is nice!
We'll make it smaller. (…)
That's too much. There, it should be at the right place. Simply (...) we're gonna lose it in the trees, in my opinion. (…)
We'll work it out in order to see it. It's not the good one.
You know what we could do? We put a real big wheel with a paddle to collect water and the other paddle for passangers.
Yes, you give them a snorkel and…
And they wear bathing suit?
Yes, it's for fun and at the same time it produces energy.
(Attempts to place the wheel)
No, it's not in water. CAUE is further up.
Never mind: we aim at water in the image otherwise we won't see anything.
We're not in the good panorama. (…)
There, we should turn it to see it.

There's Denis' truck. No, we don't see the wheel.
It's because it's very small! If you make it bigger, it's there.
Yes, but if we make it bigger, it's no more an hydraulic wheel, it's…
Didn't you see where it was? Look, it's there.
It's approximately in the Viosne. (…)
We don't need to see it entirely.
We keep it like that, we keep the idea. Otherwise we won't manage.
Anyway it's not the final project, is it?
It's kind of refined, honestly!
Is the size good?
Yes, I like it. It's just a little behind the tree, like this. I find it… voilà!
Here you go, freeze!
It's good there: you cannot see the people any more, but you see that there is a wheel in the Viosne.

Modes of representation, semiotic resources and communication media: Talking about clean energy, the idea emerges to put a water turbine in the Viosne. Since this particular object is not available among the content cards, the participants decide to use a panoramic wheel in a diverted way, by analogy in shape and kind of movement. The perspective in the panorama does not make it easy to place it along the water and to combine realistic and visible size. The final choice is a compromise and leads to a symbolic use of the content. At the same time, the unrealistic size and the diverted object make then appear new options, first through a "boutade", which opens up to a potential real subject: a technical device (the turbine) open to the public for an animation purpose (the original function of the panoramic wheel). Moreover, a certain form of aesthetics also appears in the choice.

Relationship between stakeholders: The variety of the participants' skills appears with the theme of energy, which is both symbolic (wish for a sustainable approach) and technical. The main expert of technical issues brings up a useful piece of information: the whole group can then replace the discussion in a more global context of urban issues and are ready for decision-making.

One of the participants uses humour as a provocation (and this is facilitated by the playful character of the tools) but his joke allows to explore unexpected topics (mixing a technical device with an equipment for public use and animation, in the provocative awareness perspective, Gaver 2002), the whole in relation with actual trends on sustainable development (giving value to the small creek Viosne).

Topics of discussion: The participants want to introduce equipment producing clean energy with the power of the creek Viosne in sustainable perspective. They discuss about the most pertinent position from a technical point of view (using the current) which appears to be in conflict with other uses (fishing). The size is a technical issue that leads to other questions, such as visibility and multifunctionnality.

Evaluation: This sequence is significant for both constraints and creative opportunities for the negotiation process due to the characteristics of the device: the choice of panoramas, the way they are created and they can be manipulated with the technologies induce questioning about existing, to be demolished and potential, about hidden and visible, about the choice of viewpoints and of the pertinent scale. A visualisation constraint can lead the discussion to a standstill but it can also make new ideas appear. The way to get out of a difficult situation (lack of available content, problems in visibility) is often to resort to metaphorical use or diversion. The scene is therefore composed by elements with different status (realistic and metaphorical) and can be distinguished in this sense from technical design. The ephemeral and collective character of the production in the workshop session makes this ambiguity acceptable. Similar kinds of production would be much more difficult to understand when they are submitted by professionals in an official negotiation context because they need interpretation.

5.3.3 1.8.3. Sequential analysis of the workshop, June 19

1st SEQUENCE

Step of the project process: Understanding

Description of the sequence: The participants start on the second day working on the site outside of the tent without the technologies. They look through the work that has been produced during the may workshop, discuss on the site and themes of interest. They decide to implement the decisions that they seem to agree on and to elaborate on those issues that are controversial using the technologies (Figure 129).

Figure 129 : Understanding

Transcription: The discussions of this sequence have not been recorded and the following has been constructed on the notes taken by the researchers.

Modes of representation, semiotic resources and communication media: Participants look through the documents that the two groups who have participated to the may workshop have produced (most have participated to the first day and do not know the material produced on the second day): this is mostly visual documents with annotations, collages, drawings, plans (drawings made on transparencies placed on the map) and perspectives that highlight the site at different scales. These documents are co-produced and summarise experiences, reflections and ideas that have been addressed in May. The viewing of these documents is accompanied with discussions on what has been discussed and accomplished in May enriched by new suggestions and topics. To do this participants often refer to their surroundings, they point out sites and connections.

Relationship between stakeholders: Those who have been present during the two days share their experience with the others. They continue then to discuss on the site, share their know-how, experiences and thoughts orally. Those who work in the municipality and have knowledge on different projects share this information. The director of green spaces gives information concerning the number of people who visit the park of Marcouville for example. Ev who is the representative of the chamber of commerce explains that they are thinking on regrouping the artisants of the city in one place: why not here? Others who live on the site or use it describe their daily life and the difficulties that they encounter. There are certain, such as S (an artist who lives on the site) who try to impose the ideas that has been developed in May. This is limited by others, such as Ev who proposes to continue discussing on these ideas with the help of the technologies.

Main topics of discussion: The documents produced in May have shaped the topics of the discussion in the beginning. They have discussed on the characteristics of the site (of different centres of attraction, different zones, roads, entrances, etc.), of the problems that are reencountered (such as accessibility, transport, activities, etc.) and the solutions that have been proposed. (such as the creation of new connections and transportation modes, the implantation of new activities and the transformation of certain buildings such as the CCVI building.) Main themes of controversy are: (1) creating connections versus creating

centralities, (2) what to do with the CCI building, (3) the question of use. Participants discuss on the consequences of having a well connected site and this they do not seem to want. The nature should not be disnatured and people should be able to stay and breath in this place. Some problems and propositions have been accepted without any resistance (such as making a big painting out of the viaduct proposed by S, preserving the road of Etannets which is an important part of collective memory and rendering accessible the site to disabled people). Other ideas meet with resistance. Participants decide to conclude these discussions with the help of the technologies.

Evaluation : This stage has helped understand the importance of being on the site of the project. Participants have taken the time to orient themselves in relation to the environment and the documents (the map) by pointing out other centres of interest and helping each other identify their surrounding. This has allowed them to constitute a collective knowledge about the site that they have often mobilised all along the day. They have nevertheless needed to take the time to familiarise themselves with the map, to orient themselves in relation to the site, the panoramas and the map once inside the tent. These are not aligned to facilitate the understanding and the relation between them is difficult to construct for those who are not used to using this kind of media.

2nd SEQUENCE

Step of the project process: Understanding

Description of the sequence: After implementing certain ideas developed in May with the technologies such as painting the viaduct with the urban sketcher, the participants decide to work on the map (medium scale) where they discuss on the creation of a passage that connects the road of Etannets to the chateau. The idea is to allow old people (they insist on the fact that the population of the city of Pontoise is getting older) as well as families with children and disabled people to reach the chateau and its grounds easily (Figure 130).

Figure 130 : Understanding

Transcription (**hour: 12h25)**

G: We had discussed about a passage at the end of … is this the path of Auge ? To climb down, we need to pass by the road of Pontoise, the road of Saint-Jean and the road of Poulies.
Christian : Here it is, it is not bad as a line. (Christian chooses a flow type from the white board, places it on the map and refers to its appearance on the map.)
M : You should not base yourselves only on the map. You should look at the panorama.
Ev : It is good like this.
Ch : Here you are, it arrives at the château like this. (they try collectively to connect the road to the château.) (…)
Ev: We had also talked about creating pedestrian roads that go in this direction. (She points out the direction on the map.)
G : Do we really need to create new pedestrian roads or are the existing ones sufficient?
M : You could also mark (highlight) the existing ones.
Ev : We have two ways, on here and one here. (She points out the different axes on the map.)
M : Do you want to have bicycles on these roads ?
Ev : On the road of Etannets we can have bicycles (…) We can open these two roads to the circulation of cars, bicycles and pedestrians.
S : These roads exist, we do this to put the accent on it.
Ch: (goes to the white board to choose the content cards to place the flows on the roads and asks the others to confirm …) it is a road at low density, no ?
Ev : Yes, that is it. (…) ohh, we see it appear on the scene. (She looks at the panorama.)

Modes of representation, semiotic resources and communication media: The medium scales map (participants do not during this time change the scale of the map.), the panorama (the one across from the chateau) and flows are used at this stage. The map serves mainly to identify areas of interest in the city and the connections (for example, participants name roads to evoke a series of city spaces through which to pass to arrive in the gardens.) This then serves to discuss on the new connections they want to create and their positioning. This is done mainly by gesturing and pointing out places on the map: participants point out at the same time around themselves (towards the real space around them) to position other areas of interest in relation to themselves and the tent. The type of flow they want to place is not a subject of discussion: Ch chooses among the different possibilities the one with the pedestrians and places it on the table. Its exact positioning seems however to evoke interest and participants take the time to place it as they want. The articulation between the panorama and the map is not naturally done at this point and it is at the mediator's

suggestion that participants start using the panorama to insert the flows into the landscape. The highlighting of existing flows with the help of technologies is also done at the suggestion of the mediator: this is because users seem to encounter problems passing into action and seem to be content to communicate at an oral level.

Relationship between stakeholders: The participants collaborate and try and constitute a collective knowledge of the site: they are also already working on the site by putting in flows. The most active participants at this stage are Ch (director of green spaces, City of Pontoise), G (rents a plot of land in the family gardens) and Ev (staff in the CCVI). It is interesting to note that the urban specialists do not intervene at this time. There are certain propositions that seem to be foregone and do not necessitate discussion: the definition of the passage as a pedestrian passage or the choice of creating a low density road does not generate discussions. Those who make the choice on the white board collaborate with their co-workers, demanding their confirmation. The mediator (who is an urban specialist) makes suggestions from time to time in relation to the use of technologies: she also relaunches from time to time certain ideas that have already been evoked when there seems to be blackouts. The participants evaluate her suggestions and do not hesitate to contest: when she reminds them that they had wanted to create new pedestrian roads for example G questions the use of creating new roads asking if we do not already have a sufficient number of pedestrian connections. This confirms partially our hypothesis concerning the empowering nature of the work environment and the technologies. These interventions decrease in number as participants become more familiar with the technologies and more involved in their work.

Topics of discussion: Different elements that make up the city and the project site constitute the main topics of discussion and allow participants to define a set of references which allows them to communicate better. Accessibility, connections and types of flows are the other themes that have been discussed on. These are broached in a piecemeal approach where participants offer small bits of information and question the pertinence of certain propositions: these contributions chain up to construct a coherent structure through questioning and trial. The technologies seem to be adapted to this process and allow participants to test certain ideas. Other propositions such as “don’t we have enough pedestrian roads as it is?” are treated at an oral level. It could be interesting to have feedback to help answer these kinds of questions on a more technical level in further development. (For example, the technologies may allow participants to visualise existing pedestrian roads on the map and the panoramas to help the discussion.)

Evaluation: The difficulties encountered by participants at the beginning to pass into action (they seem to find it easy to discuss, but have difficulties implementing a suggestion or decisions such as putting in flows with the help of the technologies) must be partially due to the fact that they work with people they do not know, on themes they are not used to express themselves using interfaces they are not familiar with. These difficulties decrease all along the day. This difficulty has also been observed during the May workshop where mediators have been obliged to intervene and ask participants to draw and annotate the ideas that have been discussed. Participants have nevertheless continued to have difficulties and urban specialists have been obliged to finalise the visual material at the end of the day. (This observation does not concern the second day of the workshop where artists have worked with a lot of ease with traditional tools.) The difference observed between the two workshops seems to validate our hypothesis concerning the tent and the possibilities of the technologies which are easy to appropriate. These empower the participants and allow them to express themselves visually (using visual material) with ease through the composition or mixed reality scenes.

3rd SEQUENCE

Step of the project process: Understanding, Manipulating

Description of the sequence: The participants place different paths that connect the different parts of the garden and the chateau to the road of Etannets, a bridge over the creek that passes between the garden of Lavandières and the chateau grounds and a staircase that allows pedestrians to descend from the passage into the garden. They then decide to modify the scale of interrogation (Figure 131)**.**

Figure 131 : Understanding and manipulating

Transcription: (hour : 12h45)

M :…You have placed stairs, the passage and some paths… would it interest you to continue discussing using a smaller scaled map ? You had discussed about connecting the site all the way to the Notre Dame church ?
Ev : We should perhaps settle this problem first. What do you think ? (…)
S : Can we have a map that is more detailed than this one? (…)
Ev : Yes, we should use a bigger scale, on the contrary…the scale that allows us to have a better vision of the building. And the bridge, … is it not important if we cannot place it exactly where we want it?
M : When you pass to the detailed map , you can place it better. (participants change the map where their actions are reproduced)
Ch : (…) Look, it is there at the end of the road, at the angle of the road of Etannets and the passage. (He looks at the panorama and points out the building.)

Modes of representation, semiotic resources and communication media: It is the limits of one scale of intervention –the paper map- which bring about the necessity to use another one. Participants do not realise at first that it is the scale of the document that does not correspond to their needs and need to discuss between them to define the need and the action. They then replace the existing map with another.

Relationship between stakeholders: It is the moderator who reminds the participants of the possibility to change the scale of the paper map: she proposes the use of a smaller scale map at city scale which would allow them to make the connection between the park and the city centre. It is however the participants who discuss on the pertinence of this proposal and decide on another solution where a map at a bigger scale is chosen to continue with the discussion. This points out once more to the empowering effects of the tools which allow participants to override the proposition of an urban specialist who is also the mediator.

Topics of discussion: The appropriateness of the scale of the map and the use participants want to make of it are the principal themes of discussion. The placement of content with less or more precision is another subject addressed. The intervention of the mediator on the use of different scales (when you pass to the detailed map, you can place it better) allows them to manipulate these scales with more ease for the rest of the day.

Evaluation: Participants seem to modify the scale of intervention for two reasons, (1) to have a more global view of the site which allows them to discuss on the different centralities in relation with others and the connections between they favour the smaller scale (2) to discuss on detail on one element of the site such as the CCVI building or the chateau, they prefer the bigger scale map which allows them to implement their ideas with more exactitude. The placement of different content within the scene, the relation of this content with its surroundings and other content material seem to preoccupy most of the participants who make an effort to make coherent compositions out of these elements. This is why the size of the tokens which does not allow participants to refine the position of content with more precision seems to be a problem. This does not nevertheless seem to reduce the motivation of participants who are aware of the fact that the results are approximate.

4th SEQUENCE

Step of the project process: Manipulating and Augmenting

Description of the sequence: Participants discuss on the question of connectivity and accessibility of the site in relation to the centre. They have recreated the CCVI building using the urban sketcher painting it in blue in accordance with the proposal of Silvio (Figure 132).

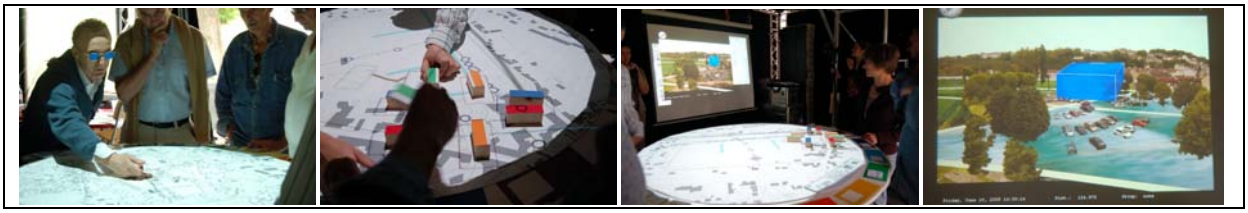


Figure 132 : Manipulating and augmenting

Transcription: (hour: 14h25)

Ev : This morning we had this idea, we wanted to fluidify the passages using the building of CCVI by creating an open gallery when people can go around, visit expositions and do … it is a multifunctional building.
Ch : Multifunctional, but consecrated mostly to arts, to theatre …
Ev : The idea was also to make a passage in the lower part with small commercial spaces where artists and artisans with a vocation expose and sell their work…
J : Does this mean that we change the vocation and the use of the CCVI ? (…)
Ch : It is true that even if we make a hole to see Notre Damme like we have discussed … the other buildings prevent us from having a view… we would have to remake the place (square).
J : All this is urbanised, there are buildings and houses.
Ch : These can be dismantled.
S : Where will you put the people ? There is a parking place here. The passage can be like this, between the parking and the (…) To make the passage towards the CCVI, we can organise the exit towards the parking … this can be the entrance and the exit of the parking. (…)
Ch : We can on the detailed map leave the parking and draw the pedestrian passage by here and here.
M : So we have to change the scale. Which one do you want?
Ch : The more detailed I think. (they change the physical map)
Ev : We will work on this and then discuss on the Notre Damme at a different scale.
Ch : Can we mark the parking place with a zone, a ring? (…) Do you have the red triangle to mark the space ? We can then add a background and then the sound of cars.
M : You should do lines that cross to define a zone.
(?) : We have to find a texture for this.
(Participants define a zone with the help of Maria and Ina.)
M : Does this correspond to what you wanted to do ?
Ev : It changes completely the configuration of the neighbourhood because the building is not at its place.
M : We can put it in its place. (…)
Ev : Everything depends on what we want to accomplish… Do we want to stay in touch with the reality or do we want to evolve in another direction? It is the group who has to decide collectively on this. (…)
S : We should look at the volume and the concept in general, when we concentrate on the details … the rest will follow.

Modes of representation, semiotic resources and communication media: Participants use maps at different scales, 3D volumes created by the urban sketcher to represent the CCVI building, tokens to define zones (the parking area in this case), textures and the panorama which is best suited to their intervention (the one that overlooks the parking area). The first texture that they use (the colour blue) does not please certain who think that this

looks like there is water: they change the texture and choose one that is more “realistic” (the colour grey). This shows that participants are sensitive to content and the significations they might have (blue is generally used to represent water, the use of this colour would make people think that they propose to put in a lake, for example) on others. The objective seems to be able to communicate an idea or a proposition directly without causing misunderstandings. This hypothesis is confirmed by the use participants make of 2D content. They decide to discuss on the development of different open air activities for open spaces for example and gather around the whiteboard to choose content: they evoke the necessity to have benches and armchairs, look for such urban furniture among the content material and choose the first ones they spot. The content serves within this case as a simple tool to express one’s ideas. Participants see other content such as “people doing tai chi” while they are looking for benches among content and decide that this is a good activity to develop in the gardens. The content inspires in this case the participants and allows them to continue with their discussion, by offering alternatives. The importance attributed to content material seems to take another dimension while participants are composing mixed reality scenes: the size and the location of different content within the landscape and with other content seem to be of importance for most of the participants who take the necessary time to refine their propositions. The technologies do not allow them to go as far as they wish and the scenes rest approximate. This obliges the participants to rest at the stage of the general concept as S remarks.

Relationship between stakeholders: The modifications that the participants want to implement on the CCVI building and the parking space seem to be a controversial theme. J (who lives near the gardens and is a member of the neighbourhood association) has an approach founded on restrictions more than the possibilities: the built environment has a material value, urban projects need financing and the modifications discussed by the other participants seem to be far fetched and not realistic. Ch is less reluctant and seems to have the support of Ev who insists on the fact that their approach depends on the strategy that is collectively adopted by the participants: “do we want to stay in touch with the reality or do we want to evolve in another direction?” Ev and Ch are the ones who are actively taking decisions with G and S during the work while J stays in the background: this give Ev and Ch the possibility to overlook his comments and to move forward. They do not take the time to discuss on these issues of importance with Jacques. The role that the difficulties J has while using the ColorTable (he is older and seems to find it more difficult to adopt himself to the interface) in his staying in the background during the discussions must be studied. S who supports the transformation of the CCVI building into a cultural centre is less enthusiastic when the discussion evolves around the possibility of demolishing the parking space. It seems that he hesitates between the two kinds of know-how, the knowledge that the development of a cultural centre will modify considerably his activity as an artist and the knowledge that the demolishing of the parking space will render daily life difficult for the citizens.

Topics of discussion: The transformation of the CCVI building, its spatial characteristics (opening up of the ground floor to fluidify the passages) as well as future functions that it might contain (cultural centre with multiple uses) are the main topics of discussion. Defining the limits of the parking place and using the zoning tool and the textures to discuss possible uses for different parts pf the place are other themes. This technique is very similar to zoning techniques that are usually used in project making. The proposals made by participants are always accompanied by an evaluation of the possible results of their action in two ways: (1) will the action taken result in the realisation of the initial objective (for example, making a gallery on the ground floor will not suffice to create a visual corridor between the park and the city centre) and (2) does it modify the site and its use in general? (taking away the parking will disturb the actual running of the site) : this evaluation seems to help accept or refuse a proposition or to make small adjustments.

Evaluation : One of the challenges of traditional communication medium used in urban projects is the fact that it plays an important role in the distribution of roles between different stakeholders. The technical dimension of the documents and the language codes that are mobilised make it difficult for non-design oriented stakeholders to participate in the proceedings and shift the balance in favour of the technical team. This influences the distribution of roles between different stakeholders and the power structure between the participants. (Söderström & Zepf 1998) The interfaces used in the WP6 showcase are designed to be easily appropriated with the idea to render them equally accessible to all. Some participants seem nonetheless to have more facility than others with the interface and this seems to influence their participation and their role and influence within the group. This is, it seems, due to the time reserved for the tutorial and the work, which is qualified as too short by certain participants. A longer period of work should allow them to be more at an equal standing concerning the utilisation of the interface.

5th SEQUENCE

Step of the project process: Manipulating and Augmenting

Description of the sequence: After a long discussion on the different activities that can be developed in the park, the participants want to see the results of their work on the live streaming camera. They then decide to work on the 3D blue volume that they had put into the panoramas to represent the CCVI building (Figure 133).

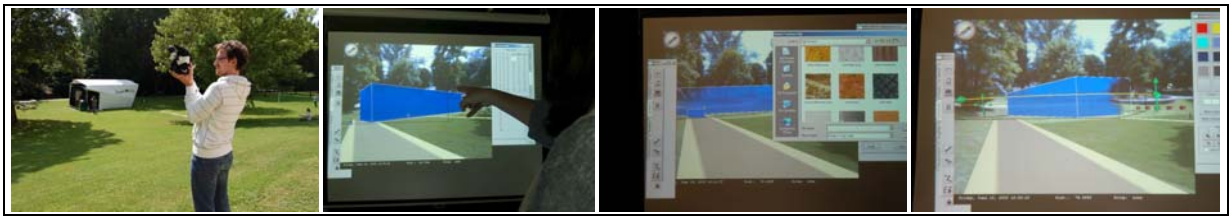


Figure 133 : Manipulating and Augmenting

Transcription (hour: 16h01)

M : There we have the video from the fixed camera on the outside…
Ev : This is extraordinary.
M : We see the armchairs that you have placed and hear the birds sing.
Ev : We have too many armchairs … we should organise open air concerts (…) The blending of the real and the virtual is extraordinary.
(Participants modify the view of the camera with the joystick, have zoomed in and out. The camera is then replaced by the scout that can move freely on the site and go where the participants want. M reintroduces the theme that has been discussed on the connection between the site and the city and demands if the participants want to create this passage.)
M: You can tell the scout where you want him to go and where you want him to look (...) a little more to the right – M tells the scout (…) here are the cabins (…) Can we make a hole in the CCVI building ? (M asks Mk if this is possible? …)
JJ : Can the building be higher with a hole in the middle ?
Mk : Yes. (Mk starts manipulating the urban sketcher to modify the height of the building.) Is this OK?
Ch : Yes, it is good like this.
Ev : It should be higher no? (…)
M : (…) and if we wanted to make a hole in the building so that people can go inside. The idea is to allow the path to pass through the building.
Mk : This is difficult.
JJ : Paint it in white, only the hole (…)
M : A big forged door, a little like in Bercy.
Ev : The result is better than we have imagined. (…)
JJ : Ahh, this is not bad, it is a little like the ports of Egyptian temples.

Modes of representation, semiotic resources and communication media: The panoramas are first replaced by the fixed camera where the live streaming video is used to look through what they have already done, ie. the activities and the flows that they have placed on the site. Participants decide then to use the scout which allows them to have an unlimited access to the site. This allows participants to work on the CCVI building. These modes of “representation” seem to incite more interest for the participants who are surprised by the results, “this is extraordinary”. The live streaming seems to allow for a real appreciation of the mixing of “real” and “virtual environments”: as some have said, “the blending of the real and virtual is extraordinary”. This fascination does not seem to abstract from their work as they continue with the evaluation of what they have already done. (We have too many chairs, we should organise open air concerts.) Participants then use the scout view to work on the CCVI building. This is a simple 3D volume that has been produced in

real time using the Urban Sketcher. The path that connects the park to the building is the one that is supposed to go through the building to reach the urban centre. Participants try, once more to attain a certain realism during this phase where they want to modify the size of the building (it should be higher, non?), its place and its relation with the path. They also try to make a hole in the CCVI building, but adopt an easier way of highlighting the idea of a passage; they paint a door on the cube. The Urban sketcher that is used through these modifications has been manipulated by Mk (a member of the research team) as the interface is not easy to manipulate: he uses the computer screen to realise the modifications that are asked for by the participants. This shows that the urban sketcher is an interesting tool and allows participants to produce content in real time: the interface that is proposed should nevertheless be improved to make it easier to interact with.

Relationship between stakeholders: The use of the scout necessitates the intervention of the mediator who makes the translation between the researchers and the participants. This seems to structure the discussion. The use of the Urban Sketcher by Mk accentuated the dominance of the researchers in this part of the workshop. It is nevertheless the participants who decide on the actions. The urban specialists intervene from time to time to offer alternative solutions to problems. For example, when participants want to make a passage through the CCVI building and Mk explains that this is difficult, it is one of the urban specialists who proposes to paint on the passage to highlight the idea.

Topics of discussion: This is the evaluation phase where participants observe their work and comment on its impact. They then go on to refine their idea on the CCVI building, something that they could not do using the panoramas. It is the question of size (height), positioning as well as the composition of different elements that have been used, the relation between the path and the building, that are the main questions. The discussions show that participants work through layers of interrogation and refine their propositions in time. They decide for example that the passage between the park and the city is not well defined, they decide to make the connection through the creation of a new activity in the CCVI building, they discuss on the best way of connecting these two centres of interest, they decide on where to put the building, where to position the path, they discuss on the relation between the two and they decide in the end to highlight this idea by creating a real passage through the building. The technologies, the content material provided, the possibility to refer to different scales (scales of map) and different views (panoramas, see-through and video streaming) seem to allow for this kind of consecutive interrogation even though the tools do not allow participants to go as much in detail as they might wish.

Evaluation: The use of video streaming (scout) has been evaluated as interesting for evaluation purposes, but not very useful during work. This must be due to the fact that the quality of the view is not yet very high, the camera is not steady and does not allow participants to work with it in a lasting way. This is found to be interesting when working with other medium of visualisation such as the panoramas which seem to be the most appropriated visualisation medium. The possibility to change from point of view to another, to zoom and to control the angle of view are characteristics which seem to be easily understood and applied.

5.3.4 Conclusions

The Pontoise workshop allows several conclusions, which open new perspectives for the representation of urban environments in the perspective of a multi-actors co-constructed project. The traditional representation tools used for city making are efficient but not adapted to this kind of collaboration which necessitates a space of narration, of sharing and of negotiation before decision-making and design. We will within the framework of this text summarise the main findings of the different workshops which were organised between 2006 and 2009 on the design process, on representations modes and communication media, on the relationship between stakeholders and the main themes that emerge as essential to the project process.

Design process

The virtual -as potential- object of planning gets its actual -and yet not final- meaning through a process of multiple interactions among the various agents (professionals and non-professionals, specialised ones or not, referring to different temporal or spatial scales, representing various cultures) participating in the urban project definition process. Three issues emerge as principal findings concerning the design process:

1. The work evolves in series of consecutive questioning, enacting and evaluation. Once the participants start discussing on the site and/or a theme, they start enacting their discussions and decisions on the Color Table: the physical map is used to point out the different characteristics of the site, it is augmented and/or modified by placing flows and colored tokens representing content and by defining zones. Scenario building is mainly done around the table and on the physical map. The screen projections are used to evaluate the effects of the intervention and to refine the proposition. This cycle is repeated throughout the day where new themes are addressed or an already discussed theme is reintroduced into the discussion to refine certain points. The technologies facilitate the construction of this process in real time and allow the participants to interact directly with the scenes (the plan and the projection), to modify and to evaluate. This is different than the traditional approaches where these modifications are realized by urban specialists in another time period and the stakeholders do not have the possibility to interact in real time with different communication media. The possibility to do this seems to empower the participants and allows full cycles of discussion to be put in place.
2. The possibility to keep the traces of former decisions while passing from one scale of interrogation to another and the possibility to come back on past decisions facilitates the work and allows to make the leaps that participants seem to need between different themes and scales during work. This is not possible using traditional tools of representation and communication media which hinders the development of such an approach.
3. The workshops have shown that general strategies of development seem to concern and mobilise stakeholders more than design questions. This is why the results are approximate and summarize a number of development strategies which might serve urban specialists as guidelines for further development. The results are scenarios accompanied with visual compositions which depict the ambiances. Being the results of the stakeholders' collaborative work, they are appropriated as such.

Modes of representation, semiotic resources and communication media

IPCity allows a fusion between the real scene of the city virtual objects of different kinds. This mode of representation brings into a direct and tight relation the present reality (the site, the landscape, the ambiances, the connectivity, but also the memory of the site, the knowledge of the people, etc.) and a virtual potentiality (the project, the design, the transformation process, the strategies, the stakeholders, etc.) The urban project figuring as both the negotiation object and the support of negotiation process signifies that it can be regarded as

a mixed-reality system where real-actual and virtual-potential through an interactive process reach eventually a certain balance and produce the tangible urban environment.

The dominance of visual media in such environments is considered to be a challenge and may hinder the transmission of information as well as communication and brings about the possibility of false consensus. (Al-Kodmany 1999) This arises at the same time ethical questions on the subjectivity of the production and mobilisation of such media where the objective is to convince, to please and to seduce and rarely to inform and to sustain participative work environments. (Paquot & Younès 2000, Estevez 2001) This is why one of the objectives is to diminish the importance of visual media in relation to oral and written expression: it would be used as a means to express one's self and represent one's ideas, but not as the backbone of all discussion. (Basile, Ozdirlik, Terrin 2009)

The interactive, mobile and in situ MR technologies developed in the frame of WP6 should facilitate the creation and use of a multi-sensitive common language thanks to their ergonomic interfaces and their accessibility to ordinary users in which the visual plays an important role but which mobilises other senses: the oral exchanges, the sounds, the writing, the gestures, etc. By merging the present reality of an urban situation with the virtual potential of its future development, stakeholders can debate concepts as comfort or security, communicate sensations, express ambiences, and share these experiences.

The virtual objects, created on the base of shared references, eventually get their real and concrete form through the conceptual process (programming, design, negotiation, management, etc.) that results to the "incarnated" urban project through construction, management and animation of the built environment. The interactions that occur among the carriers of implicit and explicit know-how (specifications, references, conflicts, convergences, etc.) builds up the virtual-potential capital, propagates the passage from the individual creation to the "collective intelligence" appropriate for the urban project and makes translating shared values and goals into formal design possible and real solutions.

The physical map, the panoramas and the video streaming are representations of the project site and allow participants to have access to the site, to verify information, to orient themselves and to co-construct a narration concerning the site. They are also used to discuss about problems and possible solutions, to define limits, areas and connections, to implement some of their decisions, evaluate their consequences on the site and to refine their propositions. The visual content provided to participants is used on this last stage of implementation. The participants use it to express ideas and implement propositions. The images are either objects (such as chairs and trees) and are used as simple tools to express one's ideas or are inspirational objects which feeds the discussion by offering alternative ideas. They may at the same time be used in a metaphoric way to represent other things in which case the meaning put behind the image is collectively constructed. These combinations contribute to the constitution of a common vocabulary that is shared by the actors of the negotiation.

The different visual content is used much like Legos to compose scenes. It is while composing these scenes that the visual characteristics of the scene become important where participants insist on a certain level of coherence and exactitude.

Relationship between stakeholders

Three types of stakeholders participate to the workshop: some are oriented on long term issues (politicians, urban technicians) and decision making, some on short term (architects, urban planners, landscape architects) and design issues, and some on daily experiences, uses and behaviors (inhabitants, associations). Generally there is a distinction, some times a dislocation between experts and uninitiated participants, the late being disadvantaged by the lack of understanding of concepts and means of representation. The workshop situation opens up the possibility for different distributions of roles among these 3 categories of stakeholders, facilitating the empowerment of lay users. The sequences chosen reveal

different dynamics of negotiation, collective dynamics and expression modes articulating visual, oral and written as seen above.

Main topics of discussion

While working on the specifications of the IP City technologies and on interaction and presence issues, we have developed and selected several Urban concepts: scale of the site and of the observation, temporalities in the city, limits and boundaries, layers in uses and in administrative issues, fuzziness of the representation, ambiances and mobility. Centralities and flows are recurring themes, often related to activities more than to objects (like buildings). Sometimes discussing about apparently trivial topics, actually connects to larger debates, and in particular to issues connected to sustainable development or mixed used of space.

Working with sequences was a way of revealing series of topics, which were interconnected in the different moments of the workshops.

6 The evolution of technologies and practices: the story of the MR-Tent

6.1 The design perspective

Throughout the four years of development, the ColorTable evolved from an early technology probe with a few simple interaction possibilities to a complex urban planning tool. In the following, we point out important design decisions of individual prototypes and how they lead to set of aspects to be thought through while designing tangible tabletop systems.

6.1.1 The different prototypes

The first ColorTable prototype was modelled on a worlds in miniature (WIM) approach, where the table and the color objects serve as representations of different elements of a mixed reality world. The basic interaction consisted of picking up one of the colored objects, assigning an image or sound file using the barcode interface and placing it in onto the table. The composed scene can be viewed on an additional screen, showing a perspective view. The surface of the ColorTable represents a top view of the environment.

While developing the first prototypes, we experimented with different methods and designs to support this basic interaction, as well as with new possibilities to increase the range of functionalities provided by the TUI. We summarize here modifications and insights concerning the main interaction modules of these early prototypes.

Positioning module

Throughout the first implementations, we kept the same principle of positioning virtual objects by placing colored tokens onto the ColorTable. We however experimented with the design of the tokens to support different interactions (Figure 134).

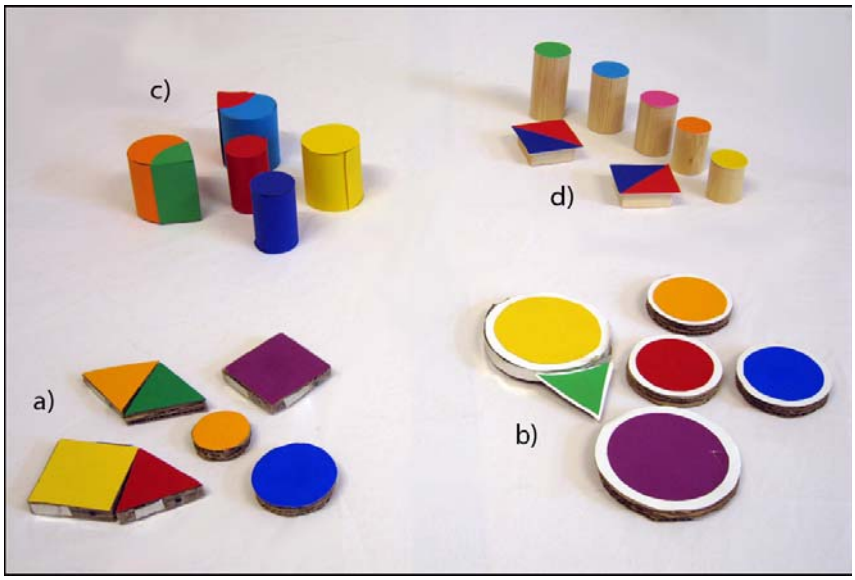


Figure 134 : Four different designs of colored tokens for the ColorTable

The objects in a) are shaped differently as circles, squares and triangles. Magnets are embedded on the sides and encourage users to attach shapes to each other. In b), the objects each have a white border around them. This constraint imposes a minimum distance between two colored regions, to prevent users from placing two adjacent objects. In c) the colored shapes are designed as cylinders. It is possible to place several objects adjoining, the round shape however does not encourage users to do so. d) shows a set of colored shapes with two types of shapes. Simple cylinders of different colors represent entire objects, two-colored squarish tokens represent a

vertex of a polygon.

Selection module

To select a color, we first developed a simple *configuration area*, a rectangular area within the surface of the ColorTable. When placing a colored object in this area, the color is selected and according objects can be modified. To decouple this selection module from the interactive top view, we developed a *tangible selector*, a small rotating disk with illustrations of the different colored objects. The tangible selector is based on RFID and can therefore be placed outside the tracking area (Figure 135).

Figure 135 : Selecting a color with the config area (left) or with the tangible selector (right).

To simplify the workflow, we re-designed this module in the last prototype, and integrated it into the association module by introducing the RFID board. Users select a color at the same time when assigning content to it.

Association module

To associate content to colored objects we first used *content boxes* with small content cards. Each of the cards had a thumbnail of its content, along with a barcode. By reading the barcode the content is associated to the currently selected color. An attempt to support users in organizing the available contents was the introduction of a *content booklet*.

In our last prototype, we introduced the RFID board showing rectangular areas for each of the available colors. To assign a specific content to a colored object, users place the content card onto the respective colored area which is captured by RFID (Figure 136).

Figure 136 : Associating content by reading a barcode (left) or by placing a content card onto a colored area.

Modification module

Our first approach to modify the virtual elements was to use the size of the colored objects. These can be combined to create a bigger color area, which in turn increases the size of the virtual representation in the MR scene.

As this method was far too imprecise we introduced *command posters.* These listed barcodes for a set of available sizes, transparencies and colors.

Although users were able to scale and manipulate objects to specific values, the barcode handling was experimented as cumbersome. In combination with the RFID board, we therefore introduced attribute cards. To change such a value, users place the card onto the respective color area, triggering automatic incremental increasing or decreasing of the value (Figure 137).

Figure 137 : Increasing size by combining tokens (left), by reading barcodes (middle) or using the RFID board (right).

Navigation module

The first prototype supported to placement of urban elements onto a still photograph with no navigation facilities. We improved this module by introducing the rotating ColorTable along with a 360° panorama image. By turning the whole surface of the *ColorTable,* the viewpoint can be rotated around a same position at the center of the table. The viewing cone that is projected onto the table remains fixed while a projected map and the physical objects turn around.

A further improvement of the navigation module consisted in the introduction of a physical map and several viewpoints. The paper map provides a much higher resolution and increases the map area. Barcodes are attached onto the different viewpoint positions on the paper map and users can switch them by reading the barcode. Along with this re-design step we also decoupled the rotating mechanism and the top view by introducing a rotating disk being placed next to the ColorTable surface. This was a requirement for introducing several viewpoints that may not necessarily be at the center of the table.

For the last prototypes, we kept this approach, but improved size, (round) shape and numbers of maps (using up to 3 in different scales) and integrated the rotating wheel directly under the surface of the ColorTable.

Each of these re-design steps increased the area where users can place objects while seeing them in the perspective view. It therefore also increased the precision of the positioning tool.

6.1.2 Discussion

Manipulating objects

Our strongest evidence in favor of the color objects is our observation of how individual participants used them in search of meaningful interventions, holding an object while observing from a peripheral position and thinking. One participant expressly talked about the color objects as 'thinking tools'. We conclude from this that the color objects are easy to understand, invite participation, and are sufficiently neutral so as not to privilege particular perspectives onto an urban project. They can be used by expert and non-expert users alike.

The size and the weight of the tokens were important to reach, hold and manipulate the object with a natural grasp. In addition, their size and shape need to be carefully adjusted to the tracking possibilities in order to enable smooth and stable interaction. These requirements however may present some conflicts for the context of urban renewal. Being physical objects, they do not change in their appearance to reflect the size of their assigned content. So depending on the available contents and the chosen scale of the map, a token

could represent a bench in the perspective view, but blocking an area on the map in the size of a river. The users confirmed this problem and gave feedback that the tokens were hiding too much of the underlying site map.

The problem could be downsized by increasing the interaction space. The introduction of several viewpoints and maps in several scales provided users with more possibilities to position objects by changing map scale or switching to a closer viewpoint.

We learned the importance of material and form and to use the design of three-dimensional objects to develop tactile, acoustical and visual user guidance. One user in one of our workshops was a non-seeing participant. Therefore the focus on hapticity was enhanced and we made use of different materials (wood, Plexiglas, cork) to distinguish the different types of tokens - in addition to color and shape.

The tokens and other mobile physical objects needed for interaction have been passed around excessive. As they did not have a dedicated position, people felt free to place them everywhere around the table. In our latest prototype we provided space for each of the objects and distributed the spaces all around the table. We could observe how participants distributed around the table and manipulated or passed around objects and interaction components being within their reach.

Use of space

During our participatory workshops we gained deep insights in how people used the MR tent. We observed their use of space and various body configurations around the interfaces to learn more about the issues of redesign of the ColorTable and its distributed parts. Significant was to understand the types of body positions and its movements in relation to participants attentions, whether distributed or not. Complex interactions often called for distributed attention: the arm/hand movement and the body position with head movement and gaze were not aligned in the same direction. Diverse action and attention often was carried out simultaneous.

Due to the size of the tent and the ColorTable, the space in the tent and around the table was limited to a small amount of users being able to interact. Generally they arranged around the front half of the table, anxious not to block the projection of the scene. They occupied the limited environment depending on the communication and interaction.

The prototype for the participatory workshop in Cergy 2008 included an info screen (flat screen) situated at the back of the ColorTable to show basic information about the content assigned to tokens and the objects in the scene. The large panorama was projected on a white surface hanging close to the tent wall at the back. Participants had to adjust their head movement and gaze depending on the visual feedback they needed (Figure 138).

Figure 138 : Left: overview of the MR tent inside. People gather around round table with info screen at the back of the ColorTable and the projection at the background. Middle: participants look at the info screen to gain feedback about the assigned content (e.g.: if assigning worked and what size, color and transparency the default objects has). Right: Participants look at the projection to see the objects in the panorama.

In our last prototype for the participatory workshop in Pontoise 2009 we reduced the number of screens and projections and used only one projection where users can switch between the different views. In addition we integrated the information showed on the info screen into the top projection shown on the table. These modifications enabled participants' free movement in the tent and around the table and clarified the directions for getting feedback (Figure 139).

Figure 139 : Left: overview of the MR tent inside: People gather around round table with projection at the background. Middle: participants look down on the map to place objects and interact with the cards and tokens. Right: Participants look at the projection to see the objects in the panorama.

Managing the workflow

The workflow depends upon the chains of actions users have to carry out to do the different interactions of the *ColorTable*. Each workflow uses a set of devices or objects, which can each be found on specific locations. In our development process we experimented with different components and combination of components to provide the tools for doing complex urban planning modifications. Each of our prototypes therefore required a different workflow that users had to learn and carry out.

An example for such a workflow is the placement of content into the scene. In the former prototypes this interaction required a long chain of actions for the user. The single steps were: Selecting content at the content board, selecting an unused token, selecting the color on the tangible selector, assigning the content to the token color by reading the barcode and placing the token on the tabletop (Figure 140). The system provides feedback concerning the success of the different steps, in most cases on the info screen. Users thus have to manage 5 different steps, whereas each needs to be carried out on a different location, and feedback is provided on even an additional space. Our observations have shown that the users are helping each other out along the steps, sometimes alternating at each step. Nevertheless, users happened to forget individual steps (e.g. select the color with the tangible selector) and therefore performed an unmeant interaction.

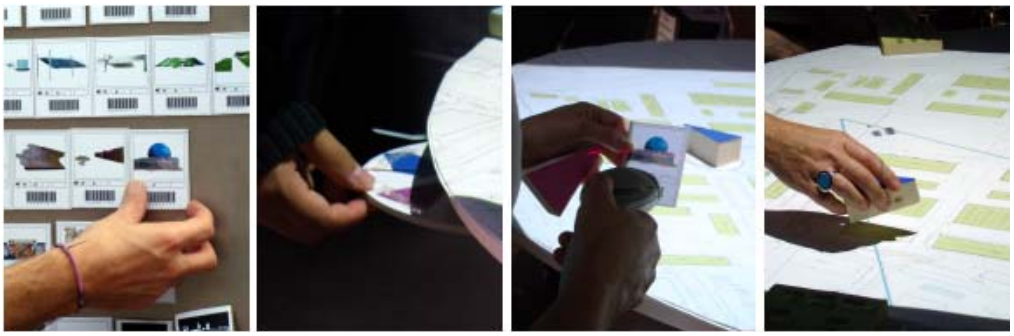


Figure 140 : Chain of actions to add an object to the scene: 1. selecting content (a), 2. selecting a token, 3. selecting the color (b), 4. assigning the content (c) and 5. placing the token (d).

In our latest prototype, we re-designed these different components and introduced the RFID board to associate and modify content. This modification modified the chain of actions, which are now: Selecting content at the content board, selecting an unused token, assigning the content to the token color by placing the card on the RFID spot, placing the token on the tabletop and optional changing the content attributes (Figure 141). The info area is now shown directly on the surface of the table, next to the RFID board. This modification shortened the chains of actions, decreased the number of objects and devices needed for interaction and integrated some of the elements in one common space.

Figure 141 : Re-designed chain of actions to add an object to the scene: 1. selecting content (a), 2. selecting a token, 3. assigning the content (b) and 4. placing the token (c).

Organizing the workspace

The high number of physical objects and interaction modules of the ColorTable stressed the importance of organizing the workspace. All the material and devices needed should be within reach but not in the way. Our observations in multiple workshops showed that users had often troubles to organize the placement of the diverse objects. They were placed at every possible spot around the tabletop and blocking tracking and free interaction. We therefore experimented with different possibilities to guide users in this spatial organization.

The first attempts to solve this problem were to create additional workspaces providing dedicated space for the objects. In the third prototype, we introduced an additional working layer, attached above the map area of the ColorTable. Although this workspace provided enough space for placing all objects, it blocked the access to the map area and therefore discouraged people in interacting and discussing around the top view of the site.

The physical ColorTable of the fifth prototype had two retractable side frames for placing tokens and barcode trays. It also integrated rotating viewpoint and tangible selector directly into the surface of the table. It ensured good access and view onto the map, and had specific positions for the other tangible objects. It however turned out that all objects on the side tables were not visible to the users standing in front of the table. The table itself was blocking the view onto these objects and users had to bend down to find the needed objects. To make these objects more accessible, participants placed the inactive tokens or barcode trays into the unprojected area of the table.

Our last design of the ColorTable provided a slightly displaced side frame, enabling users to better find and reach the colored tokens and barcode frames (Figure 142).

Figure 142 : Organization of the workspace of the third prototype and the fifth prototype.

Throughout the different re-designs of the workspace it became a necessity to clearly distinguish between the individual interactions and create a “place” for each of them. An important question to solve is which “places” can be integrated and which ones should be clearly separated.

Conclusion

The different cycles of design-evaluation-feedback-redesign stressed the importance of elaborate thinking concerning a number of aspects of the ColorTable:

- the use and number of physical objects and their various materials and surfaces especially as tactile guidance and clues for usage
- complex steps of interaction and chains of action and the interactive workflow with the interface
- the arrangement of additional devices, artifacts and the occupied space
- the simplicity of the workspace and an understandable workflow.

6.2 The urbanist perspective

The research team has based his work strategy on the organisation of workshops that address ongoing urban projects addressing specific urban issues. The objective is to bring together stakeholders who are involved or are concerned by the project to discuss on the project site/theme, thereby simulating negotiation processes. Workshops have been organised on different sites and in collaboration with the public authorities in charge of the project (urban planning services). Participants have been chosen to constitute a representative group of existing stakeholders: representatives of public authorities, urban specialists, private stakeholders, NGO and citizens involved in the ongoing project have been invited for their professional as well as their personal competence and knowledge of the site Special emphasis has been given in each workshop to citizen participation.

These workshops has served to test the relevance of MR technologies in different contexts and in relation to a diversity of urban issues and to redefine the guidelines shaping technological development. In this incremental approach, the results and evaluation of each workshop have been taken into account in the choice of the project theme, site and the urban context for the following workshop.

Five such field trials have been organized in France with the participation of public authorities between 2006 and 2009.

The first and second workshop (2006-07) addresses an architectural dilemma that has impacts on neighbourhood scale: the opening up of the gardens of the psychiatric hospital of Sainte-Anne in Paris to public use. The project was at this time in a very early programmatic stage. This is why project proposals developed by students in architecture have been used as the basis of the workshop and the debate between stakeholders. The external wall of the hospital has been the main object of discussions between the direction of the hospital and their architects, representatives of the city in charge of urban heritage, and people living in the neighbourhood.

These two first workshops have been based on simple scenarios, asking the resolution of simple tasks, but still in a real environment.

- Understand the technology probes and their capacity to respond to questions concerning the built environment and support a discussion;
- Study the relation to physical space ;
- First test of an experimental tent ;
- Set up of technical and methodological procedures and specifications.

The third workshop (2007) discusses the implementation of a large scale community facility, the new Paris courthouse, “Tribunal de Grande Instance” (TGI), in the Parisian cityscape. The project was at this time in a competition phase. The workshop has brought together public authorities representing the city of Paris and those responsible for the project at the

ministry of Justice in order to compare architectural solutions and their impact on the urban fabric.

This third workshop has been based on a very classical scenario and addresses the question of comparison of different architectural proposals and their insertion in a site.

- Apprehension of a complex situation, integrating architectural drawings and models, mixing virtual architectural objects and a complex urban scene
- Introduction of the question of mobility and testing of first flow representations
- Specification of the use of 3D panoramas, selection of point of views of the site, role of mobile cameras and scouts.

The forth workshop (2008) concerns the requalification of a formerly military site, the Quartier Bossut in Cergy-Pontoise and its integration within the urban context. The project has at this stage been in its very early stages where public authorities are discussing the feasibility of such an urban undertaking. The workshop has addressed the creation of a new centrality on the site, how the planned neighbourhood should be connected with the other parts of the city. The different kinds of ambiences that could be generated by using urban forms, and activities and by resizing the public space are other questions that are addressed. Individual preliminary interviews, using Cultural probes approach, helped participants to express their visions of the site and facilitated the collection of ideas and contents for the workshop.

This forth workshop was based on a large site with various scale and connectivity issues regarding the neighbourhood, the district, the whole city and even the nearby cities. The scenario necessitated the organisation of a typical participatory discussion and the debate involved professionals, political decision makers together with citizens and various actors of the urban life.

- Apprehension of large scale questions, complex flow networks, ambience and activities on the site, multiple content for discussion
- Organizing and running a debate that is similar to real professional processes;
- First set up and use of the MR Tent in a workshop context;
- Specification of the use of tools on an urban point of view (annotation with urban sketcher, connection between ColorTable and Urban Sketcher, etc.);
- Test of the ergonomic improvement of the ColorTable;
- Introduction of sound issues.

The fifth workshop (June 2009) addresses the constitution of a greenway in the city of Pontoise and the future role of the public gardens of Lavandières in such a scheme. The scenario did not include any project and the task given to the participants was to build and discuss the principles of a potential urban development. The main purpose of the workshop was to bring together diverse stakeholders and inhabitants of the neighbourhood and have them discuss on their vision of the future of this site.

This last workshop was based on a scenario very close to a real urban situation. Stakeholders were debating on the future of a sensible site and were very concerned by its eventual transformation. A preliminary urban workshop allowed to collaborate with the participants on urban issues and to compare more traditional collaborative processes with the possibilities offered by the MR Tent technologies.

- Apprehend conceptual and immaterial aspects of the urban context like scales, boundaries, ambiances, sensitive perception, etc.
- Create and transform content, manipulate numerous multi sensitive objects and ideas;
- Test of the Urban sketcher and the mobile cameras on the site;

- Evaluation of the production and the results of the workshop from an urban point of view.

In conclusion:

- Progressively, the object of the workshops has shifted toward the preliminary phases of the urban project process. This is because the question of project proposals does not seem to interest nor give rise to discussion among the stakeholders. Interviews realised with participants have helped the team to redefine the main them as general strategies of development rather than design issues.
- The content material has evolved in relation with this from sophisticated 3D models to more inspirational objects. Workshops have shown that the use of architectural renderings leave those participants who are not design oriented unresponsive: the finished quality of the 3D architectural renderings makes them difficult to understand, to examine and to appropriate.
- The technologies have at the end evolved beyond their ability to mix real and virtual environments and have served as a common ground that facilitates collaborative work as the analysis done by UMLV on the Pontoise workshop affirms.
- The dynamic and mobility dimension has increased from a workshop to the other.
- The number of view points, the change of scales the demand for mobile cameras sending images from different places on the site have progressively been multiplied.

7 Key evaluation results and conclusions

The role of gestures

RQs and findings	Design guidelines
RQ1: In which ways do participants' gestures contribute to achieving an understanding of the site, explain and plan transformations of the site?	
Most pointing gestures take place on the physical map and as part of planning an intervention. Participants use them to explain, designate a place for intervention, trace a path or direct action. They are complemented by iconic gestures describing objects or concepts. Understanding a scene involves a lot of pointing at the screen.	Provide a map space 'within reach' for communicating urban issues with gestures that also supports the public visibility of action. Think about the spatial layout of projection so as to avoid shadows on screen.
RQ2: Which role do gestures play in the mapping of events in the RE and the VE?	
Participants perform mapping through relational gestures (connecting events on the CT, the screen, and also the physical site), talking, gaze, and bodily orientation within the MR-Tent.	Account for participants having to simultaneously orient themselves in the different representations of the site (map, different viewpoints) and having to relate real and virtual.

Body postures and use of space

RQs and findings		Design guidelines
RQ3: Which body configurations, boundary crossings and collaborative modes does the MR-Tent enable?		
Body configurations	The most frequent uses of space in and around the MR Tent are: • Row/line formation e.g. lining up to watch somebody drawing with the Urban Sketcher. • Circle/curve formation e.g. to collaborate at the ColorTable and manipulate tokens. • Triangle formation e.g. to discuss a specific issue in detail in a close group. In case of complex interactions, gaze and head movement are distributed between action on the table and projection on the screen.	Plan and design adequate open space for participants to move freely around the interface or between separated parts of the interface depending on the maximum number of users at the same time. Provide enough space for the group of participants to split up and use the distributed parts of the interface at the same time in various forms of collaboration.
MR boundary crossings	Crossing MR boundaries forms an integral part of participants' understanding the urban site and their interventions.	Explore different ways of relating real and virtual in a complex interface, including visual openings to the real site and sound.

	Participants actively scrutinize and negotiate boundaries between different representations of the site and of their ideas: physical and projected, embedded in different 'backgrounds', and seen from different viewpoints. Being on-site enables direct connections between MR scenes and the reality of the site; so does the fact that the tent opens up to the site. Sound plays a large role in this process, often confusing boundaries between virtual and real.	
Collaborative modes	Collaboration in the MR-Tent is supported by the shape and size of the CT, which invites participants to gather around the table and perform interventions collaboratively. Modes of collaboration depend on the type of activity. Specific patterns we identified are: - Distributed collaboration; e.g. some participants perform interaction while others continue discussion; - Dyadic patterns of collaboration, e.g. setting flows or 3D lines and changing object size are usually performed by two hands or two participants; - Triadic patterns of collaboration, e.g. two participants performing an intervention a third is directing or helping prepare.	Provide a round tabletop interface large enough to ensure that participants need to collaborate at least for some complex interactions. Think about the possibilities of distributed collaboration within the interaction space, e.g. the space for participants to reconfigure collaboration patterns, as the changing tasks are demanding. Account for collaborative aspects in design of interactions, e.g. interactions that require at least two people to perform.

Interaction design

RQs and findings		Design guidelines
RQ4: In how far does the design of interactions contribute to participants' ability to co-construct a scene?		
Select, assign, place content	The clearly arranged white board and configuration area with the colour zones, along with the small and handy physical objects (content cards and tokens) provide the possibility to select, assign and place content into the scene. The usage of RFID readers and	Use small physical objects out of different materials that can be hold in one hand and clear areas to present provided and show active content simultaneously viewed for all participants. Use the same content assigning interaction for all content and

	tags provided an accessible configuration area around the ColorTable.	command cards.
Manipulate content	The free and simple movement of one or several colored tokens at the same time support participants in jointly repositioning urban elements until perfectly put in place on one of the views. The usage of RFID tags as well for the command cards to change size, offset and scale the urban elements on the configuration area enables participants to adapt these values in relation to the background.	Use multiple handles and free movements to support collaborative repositioning. Use the same interaction ways for manipulating content. Use incremental manipulations in combination with feedback on the perspective view.
UrbanSktecher manipulations	Complex, but precise possibilities of screen manipulations provide backup solution for ideas that cannot be done with the ColorTable.	Provide additional complex but less constrained solutions to be able to realize each of participants' ideas.
Paper sketching	Participants add user-generated content by sketching their ideas on provided A4 sheets and inserting them as 2D images in the perspective view to define, share and discuss their visions.	Provide a simple way of inserting user generated multimedia content during a participatory workshop.
Manipulate scene	Large physical maps in several scales, in combination with multiple viewpoints considerably increase the area where users can place objects. Free rotating and zooming, along with several viewpoints allows users to explore and understand the scene they are creating.	Use large physical maps to support collaborative discussion. Provide multiple and continuous possibilities for navigation.
Organize workspace	Organizing the workspace is done collaboratively in the group several times during the workshop as temporary completions, when the group reaches intermediate solutions.	Provide space for each of the objects and devices near the interface. Visibly separate spaces for interaction (e.g. table surface) and storage (e.g. side trays).
RQ5: What are the specific social qualities of haptic engagement?		
	Arrangement of and interaction with physical objects signal forthcoming action in a way visible to all. Interaction with physical objects may assume a strong expressive dimension visible in the quality of participants' gestures.	Design possibilities to touch, feel and hold objects of various materials and forms. Support multiple and creative ways for people to enact and interact with them.

	The physicality of the map invites grown practices of touching, pointing, and annotating that support the focused attention of all on an area of intervention.	

Visual content and sound

RQs and findings		Design guidelines
RQ6: How do different types of visual and sound content enable participants to express and experience their ideas?		
Impression of realness	The 'right size' of an object is not necessarily determined by 'realness' as is the case with objects with a strong symbolic meaning or the power to transform a scene. Dynamic representations, sound, colour, as well as the size of objects and their relative positioning strongly influence the impression of 'realness' of the MR scene.	Provide possibility of changing size continuously. Provide sufficient modality markers (e.g. the possibility to change colour, to emphasize ambience by sound) for participants to compose a scene expressive of their ideas.
Narrativity	The narrative elements of a scene are strengthened by dynamic content (e.g. flows), 3D lines textures, and expressive content (e.g. representing activities).	Provide dynamic and expressive content for participants to be able to create narrative structures. Think of simple ways of enabling user-generated content, e.g. by sketching (see PaperSketcher) or uploading sound files from a mobile phone.
Composition	Framing of the screen space is achieved by introducing flows, 3D lines, textures and large objects – these help participants structure the site, mark borders, etc.	Provide means for creating structures, inserting borders, etc.
RQ7: How does switching between scales and different representations of the site contribute to participants' understanding?		
Switching representations	Participants switch representation when changing: - the focus of their work (e.g. from planning to performing); - the theme of their intervention (e.g. from making connections to placing objects); - the specific location of their intervention.	Provide a sufficient number of representations that together cover the whole site, thereby enriching the opportunities for participants to realize interventions. Permit that the same area or spot can be seen in different representations and from different viewpoints.
Characteristics of types of representations	The availability of different forms of representations is a key feature of the MR-Tent; it offers participants different possibilities for	When editing the panorama think about how to provide space for interventions (e.g. remove a building that should be replaced or

	constructing, understanding, and evaluating MR scenes. The physical map lends itself to planning and performing intervention at different scales. The panoramas are edited views of the site with the advantage of providing a 360° view and space for interventions. It is mostly used for constructing scenes. Both real time video streams, fixed camera and scout, have a special 'realness' quality, but there is a lack of ambience and sense of space. The camera views bring the site outside to the immediate attention of participants and make them engage more explicitly with this outside. The see-through involves the most immediate mixing of real and virtual as seen through a window. As with the real time video stream, the virtual overlay diminishes the 'realness' of the place.	trees) but also pay attention to preserving the characteristics of the real place. Think about the 'realness' an animated space creates (e.g. traffic, people passing by, children at play). Be aware of the sensitivity of the see-through view to the outdoors lighting conditions, as well as of the characteristics of different materials.
Rotate/zoom	Rotating/changing viewing angle allows participants explore compositional aspects and make modifications. Rotating brings a dynamic element into the scene. Zooming is done to improve the perspective onto a scene; It may strengthen the sense of place.	Provide for the possibility to continuously 'move' in the scene (rotate, zoom). Provide a wide enough view onto the site.
Screen size	A large screen invites bodily engagement; e.g. some of the pointing that may take place on the map is shifted to the screen and the screen is more directly involved in object manipulations, such as positioning an object.	Consider screen size as an important aspect of 'immersion'. Provide for easy accessibility of the screen and avoid shadows on the projection (projection angle).
RQ9: How does sound contribute to participants' engaging with a scene?		
	Sound is a key element of the participant experience, pervading what they discuss, see and do. Sound - contributes to the blurring of MR boundaries; - strengthens immersion into a MR scene; - contributes to the experience of	Consider importance of inserting user-generated sound in a simple way. Consider the importance of the real sound at different viewpoints (e.g. add panorama sound; transmit the sound of the AR View of the Scout) as increasing the sense of realness and immersion. Create surround sound to

	spatial transformation; - evokes ambiences, thereby influencing action; - particular interventions trigger engagement with sound.	strengthen immersion.

8 Dissemination (all four years)

Publications related to WP6

Boerner A., Maquil V. (2009) Enhancing synergies between computer science and urban disciplines: Semi-automated applications for tangible user interfaces, a case study. In: CAAD futures 2009.

Basile M., Ozdirlik B., Terrin JJ. (2010) IPCity: une recherché sur la place des technologies de réalité mixte dans les représentations du projet urbain. In : Les premières journées du Pôle Ville de l'Université Paris-Est. Champs-sur-Marne, 21-23 January 2010

Basile M., Terrin JJ. (2009) Le projet IP City. Une recherche sur la place des technologies de réalité mixte dans les représentations du projet urbain. In : Flux (Oct-Dec 2009)

Basile M., Ozdirlik B., Terrin JJ. (2009) Urban Projects and Multi-actor collaboration processes using mixed reality technologies. In : International Symposium on revitalising built environments: requalifying old places for new uses. IAPS-CSBE "Culture &Space in the built environment network" and the IAPS-Housing Network, Istanbul, 12-16 October 2009

Basile M., Bourdin A. (2007) Transformations des usages de la ville : TIC et utilisation des technologies de la réalité augmentée. In : Hyperurbain : Technologies de l'Information et de la Communication en milieu urbain : quel impact sur la ville sociale ? Université de Paris 8, 29 March 2007

Basile, M. (2007) IP City : la réalité mixte au service du débat dans le projet urbain. In : SCAN'07 séminaire de conception architecturale, Université de Liège, 10 May 2007

Nuojua J., Juustila A., Räisänen T., Kuutti K., Soudunsaari L. (2008) Exploring Web-based Participation Methods for Urban Planning. In: PDC 2008, Bloomington, Indiana, USA, 30 September – 4 October, 2008

Nuojua J. (2008) Communication Based Web Mapping: A New Approach for Acquisition of Local Knowledge. MindTrek 2008, Bonn, February 18 and 21, 2008

Maquil, Valérie, Psik, Thomas, Wagner, Ina, Mira Wagner (2007) Expressive Interactions Supporting Collaboration in Urban Design. In: Proceedings of GROUP 2007, Nov 4 - 7, Sanibel Island, Florida, USA

Maquil, Valérie, Psik, Thomas, Wagner, Ina (2008) The ColorTable – A Design Story. Tangible and Embedded Interaction 2008, Bonn, February 18 and 21, 2008.

Maquil V, Sareika M, Schmalstieg D., Wagner I. (2009) MR Tent: A Place for Co-Constructing Mixed Realities in Urban Planning. GI 2009.

Ozdirlik B., Vardouli S. (2009) Developing Mixed Reality Technologies for Urban Environments: communication bridges. In: Transilient Boundaries In/Of Architecture Conference, Edinburgh 30-31 March 2009

Sareika, Markus, Schmalstieg, Dieter (2008) Urban Sketcher: Mixing Realities in the Urban Planning and Design Process. Workshop paper, CHI 2008.

Sareika, Markus, Schmalstieg, Dieter (2008) Urban Sketcher: Mixed Reality on Site for Urban Planning and Architecture. In: Proceedings of ISMAR 2007.

Wagner I., Basile M., Ehrenstrasser L., Maquil V., Terrin J., Wagner M. (2009) Supporting the Formation of Communities of Practice: Urban Planning in the MR-Tent. In: C&T 2009.

Workshops and other dissemination events

The IPCity project, WP6 and the technologies were presented at a number of workshops and events:

- Ste. Anne, Paris, Workshop (June 15th-16th, 2006)
- GB16, Vienna, Workshop (September 25th-26th, 2006)
- MCIS, Venice, Workshop (October 8th, 2006)
- Vienna, Workshop with architects (December 1st -2nd, 2006)
- Ste. Anne, Paris, Workshop (March 19th–20th, 2007)
- Paris, Workshop (September 18th – 19th , 2007)
- Vienna, Exhibition ‚Draussen in der Stadt' (October 4th, 2007)
- Vienna, Workshop ‚Urban density' (December 13th, 2007)
- Vienna, Workshop ‚Reachability' (June 19th, 2008)
- Pontoise (F), Workshop (September 10th -13th, 2008)
- Paris, Exhibition ‚European City of Science' (November 14th -16th, 2008)
- Paris, Dissemination Workshop (February 13th, 2009)
- Pontoise (F), Urban Workshop (4th-5th May, 2009)
- Pontoise (F), Workshop (June 17th – 19th , 2009)
- Vienna, Masterclass in ECSCW '09 (September 7th, 2009)
- Vienna, IPCity Summerschool (September 22nd -25th , 2009)
- Université de Paris Ouest Nanterre La Défense /Agorà (F), Workshop in the Research Program PIRVE / CNRS « Environnement et co-production de projets : échanges franco-italiens » (October 22nd, 2009)
- Oslo, Workshop (November 26th – 27th , 2009)
- Paris, Dissemination Workshop (December 11th, 2009)

Moreover dissemination seminars have been organised each year in UMLV partners' laboratories (LTMU, Lab'Urba) and MRTE (Cergy-Pontoise University)

9 References

Al-Kodmany K, 1999, “Using visualization techniques for enhancing public participation in planning and design: process, implementation, and evaluation”, in *Landscape and Urban Planning*, **45** 37-45

Basile M., Ozdirlik B., Terrin JJ. 2009. « Multiactor decision making using mixed-reality technologies » in Revitalising Built Environments: Requalifying Old Places for New Uses, International Symposium jointly organised by IAPS-CSBE ‘Culture&Space in the built environment network in the IAPS-Housing Network’, Istanbul, 12-16 October 2009

Benford, S., H. Schnadelbach, B. Koleva, B. Gaver, A. Schmidt, A. Boucher, A. Steed, R. Anastasi, C. Greenhalgh, T. Rodden, and H. Gellersen, Sensible, sensable and desirable: a framework for designing physical interfaces, Technical Report EQUATOR-03-003, School of Computer Science & IT, Nottingham University, 2003.

Buur J., Jensen M. V., and Djajadiningrat T.. Hands-only scenarios and video action walls: novel methods for tangible user interaction design. In Proc. Of DIS ’04, pages 185–192, New York, NY, USA, 2004. ACM.

Gaver B, 2002. “Provocative Awareness”, in *Computer Supported Cooperative Work* 11: 475-493

Gerhard M., Moore D., Hobbs D. *Embodiment and copresence in collaborative interfaces;* International Journal of Human-Computer Studies; Volume 61, Issue 4, Pages 453-480; Elsevier Science Ltd 2004.

Estevez D, 2001, Dessin d’architecture et Infographie. L’évolution contemporaine des pratiques graphiques (CNRS éditions, Paris)

Goodwin, Charles (1998). Pointing as Situated Practice. In S. Kita (Ed) *Where Language, Culture and Cognition Meet*. Lawrence Erlbaum Associates.

Guse D Tangible Factory Planning, Diploma Thesis, 2007 , http://www.danielguse.de/tangibletable.php

Hauert S., Reichmuth D., Böhm V. instant city: a music building game table June 2007 NIME '07: Proceedings of the 7th international conference on New interfaces for musical expression

Haviland, John B. (2000). Pointing, gesture spaces, and mental maps. In D. McNeill (Ed) *Language and Gesture*. Cambridge UK, Cambridge University Press: 13-46.

Patrick G.T. Healey, Joe Leach, and Nick Bryan-Kinns. Inter-Play: Understanding Group Music Improvisation as a Form of Everyday Interaction http://scholar.google.at/scholar?cluster=5567332340511431994&hl=de&as_sdt=2000

Hindmarsh, J. and Pilnick. A. (2002) The Tacit Order of Teamwork: Collaboration and Embodied Conduct in Anesthesia . The Sociological Quarterly, Vol. 43, No. 2 (Spring, 2002), pp. 139-164

Hollan J., Hutchins E., Kirsh D. *Distributed cognition: toward a new foundation for human-computer interaction research*; Transactions on Computer-Human Interaction (TOCHI) Volume 7 , Issue 2; Special issue on human-computer interaction in the new millennium, Pages: 174 – 196; ACM 2000.
Hornecker, E., Buur, J. Getting a Grip on Tangible Interaction: A Framework on Physical Space and Social Interaction. *CHI 2006*, ACM Press, pp. 437-446

Ishii H., Eran B.-J., Underkoffler J., Yeung L., Chak D., Kanji Z., Piper B. Augmented Urban Planning Workbench: Overlaying Drawings, Physical Models and Digital Simulation September 2002 ISMAR '02: Proceedings of the 1st International Symposium on Mixed and Augmented Reality

Ishii H. The tangible user interface and its evolution June 2008 Communications of the ACM , Volume 51 Issue 6

Jensen M. V., Buur J., and Djajadiningrat T.. Designing the user actions in tangible interaction. In Proc. of CC ’05, pages 9–18, New York, NY, USA, ACM, 2005.

Jordà S., Geiger G., Alonso M., Kaltenbrunner M. The reacTable: exploring the synergy between live music performance and tabletop tangible interfaces February 2007 TEI '07: Proceedings of the 1st international conference on Tangible and embedded interaction

Kaltenbrunner M., Bencina R. reacTIVision: a computer-vision framework for table-based tangible interaction February 2007 TEI '07: Proceedings of the 1st international conference on Tangible and embedded interaction

Kendon, A.: Conducting Interaction: Patterns of Behaviour in Focused Encounters. Cambridge University Press (1996)

Kendon, A.: Conducting Interaction: Patterns of Behaviour in Focused Encounters. Cambridge University Press (1996)

Kirsh D. *The intelligent use of space;* Journal of Artificial Intelligence; Volume 73 , Issue 1-2 ; Special volume on computational research on interaction and agency, Pages: 31 – 68; ACM, Elsevier Science Ltd. 1995

Kobayashi, K., Kakizaki, T., Narita, A., Hirano, M., and Kase, I. Tangible user interface for supporting disaster education August 2007 SIGGRAPH '07: SIGGRAPH 2007 posters

Kress, G., and Van Leeuwen, T. (1996) *Reading Images. The Grammar of Visual Design. Routledge, London.*

Larssen A. T., Robertson T., and Edwards J.. The feel dimension of technology interaction: exploring tangibles through movement and touch. In Proc. of TEI ’07, pages 271–278. ACM, 2007

Lynch, K., The image of the City, Massachusetts, The MIT Press, 1960.

Murphy, Keith M. (2003) Building Meaning in Interaction: Rethinking Gesture Classifications. Crossroads of Language, Interaction, and Culture. Vol. 5, p. 29-47.

O'Halloran, Kay L. (2008). Systemic functional-multimodal discourse analysis (SF-MDA): constructing ideational meaning using language and visual imagery. *Visual Communication* 7(4), 443-475.

Paquot T, Younés C. (eds), 2000, Ethique, architecture urbain (La Découverte, Paris)

Piper B., Ratti C., Ishii H. Illuminating clay: a 3-D tangible interface for landscape analysis April 2002 CHI '02: Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves

Smith. G. C. The marble answering machine. In The Hand That Rocks the Cradle, pages 60--65, May/June 1995.

Söderström O., Zepf M., 1998, “L’image négociée”, in DISP 134 12-19

Stenglin, Maree Kristen (2009). Space odyssey: towards a social semiotic model of three-dimensional space. *Visual Communication* 8(1), 35-64.

Tang J.C., Minneman S.L. *VideoDraw: A Video Interface for Collaborative Drawing;* Transactions on Information Systems (TOIS); Volume 9, Issue 2; ACM 1991.

Underkoffler J., Ishii H. Urp: a luminous-tangible workbench for urban planning and design May 1999 CHI '99: Proceedings of the SIGCHI conference on Human factors in computing systems

Verbeek, P.-P. and P. Kockelkoren The Things That Matter. *Design Issues* 14(3), 1998, 28-47.

Wall J. Demo I Microsoft Surface and the Single View Platform May 2009 CTS '09: Proceedings of the 2009 International Symposium on Collaborative Technologies and Systems

Weber J., Wolter A. Interactive Table with reactiVision : ImpulsBauhaus http://impuls-bauhaus.de/

Wisneski c., Ishii H., Dahley A., Gorbet M., Brave S., Ullmer B., Yarin P. *Ambient Displays: Turning Architectural Space into an Interface between People and Digital Information;* Proceedings of the First International Workshop on Cooperative Buildings (CoBuild '98), Springer 1998.

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ipcity.eu