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Consolidated conceptual framework for presence and interaction

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Abstract

This deliverable presents research related to presence and interaction in mixed-reality environments undertaken in project Phase II.

- The state-of-the-art of research on presence and interaction in mixed-reality environments has been reviewed and extended, including the critical discussion of presence issues within the research community and the urban planner's view on presence, with the notion of ‚the project' as mixed-reality, the approach to designing for experience, as well as intervention as an urban strategy.
- All four showcases carried out field trials, according to the agreed upon evaluation approach (described in the revised version of D3.2). The results of these field trials regarding presence and interaction in mixed-reality environments are presented and analyzed with a view onto a focal point common to all: to understand users' interweaving and connecting of the real world and events in it with the constructed ‚virtual' world, be it a game experience, interactions on a multi-touch screen, or the imagining and experiencing of changes to a real place.
- The Chapter 'Emerging themes' contains research into sound and presence, with first results on how to make use of sound in the showcases, as well as research on spatial orientation with mobile maps.
- These research findings have been examined and used for further developing the concept map (presented in D3.2). Conceptual and design issues related to the renewed concept map are highlighted.

Finally, first experiences with regard to potential ethical issues are discussed.

Intended Audience

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

1 Workpackage Objectives

Objectives Phase II	• To define a set of multiple methods appropriate for triangulation in data collection on presence and interaction in MR environments • To analyze data from field trials in the four showcases, achieving a deeper understanding of how mixed reality environments influence the experience of presence and how this enables novel forms of social interaction, of exploration and understanding • To define a conceptual framework in support of designing 'technologies of presence' that inform the design of interface mechanisms in support of presence within the project and guide the integration of these technologies into real world settings • To evaluate this framework using data from field trials.
Results Phase II	• Experience with the agreed upon evaluation framework confirmed the aim to accentuate the different approaches in each showcase – from interventions in an urban environment to more playful forms of engagement as this enriches the project's perspectives on presence and interaction. • Joint analysis of field trial materials has confirmed the aim to place our emphasis on presence and user experience, on users actively creating connections between physical and digital spaces and how this is supported by IPCity technologies, as well as on the relationships between ‚existing' and ‚imagined' spaces. • The concept map guiding research on presence and interaction has been further developed and enriched so as to capture all relevant aspects. • Research on sound has confirmed its relevance for presence research and concepts for working with sound have been developed.
Objectives Phase III	• To deepen presence research in further field trials within all four showcases. • To continue sound research and work on first implementations of concepts. • To further improve the conceptual framework. • To systematically analyze examples of interface design for presence and interaction in mixed-reality environments with a view on guidelines.

2 State-of-the-Art

In this chapter an updated overview of the stat-of-the-art of research on presence and interaction is presented, including the critical discussion of philosophical-epistemological questions raised within the presence community. The chapter also presents a perspective on presence from the point of view of urban studies.

2.1 Defining Presence

At its most broad level sense of presence is the feeling of “being somewhere”, where that experience is real enough to give the person a true sense of being at a given location and possibly with others. As a result such a wide definition has encouraged a lively debate and consequently many different approaches being adopted. However the conceptual foundation of ‘mainstream’ presence research (see Figure 1) is widely accepted and unchallenged: “There is consensus that the experience of presence is a complex, multidimensional perception, formed through an interplay of raw (multi-)sensory data and various cognitive processes” (Ijsselstein and Riva 2003, p. 5).

Much of the early presence research has arisen from work on robotics and telepresence; where people controlled robots at remote locations. This also gave rise to the term tele-presence (meaning remote presence) and in turn helps to define the term itself. This it was noted by Floridi (2007) allows us to divide presence into two categories:

- Forward: this is essentially taking people to another location, e.g. controlling a bomb disposal robot at a remote location.
- Backward presence: where the world is brought to the user, e.g. when using second life or a mixed reality system.

As noted by O’Neill (2005) the primary difference is agency, with forward presence supporting a degree of agency where as backward presence is a substantially more passive experience. He argues that combining forward and backward presence is the primary challenge for developers of virtual, mixed and augmented reality systems and to date most systems primarily support backward presence and that this is perhaps why breaks in presence and other problems occur.

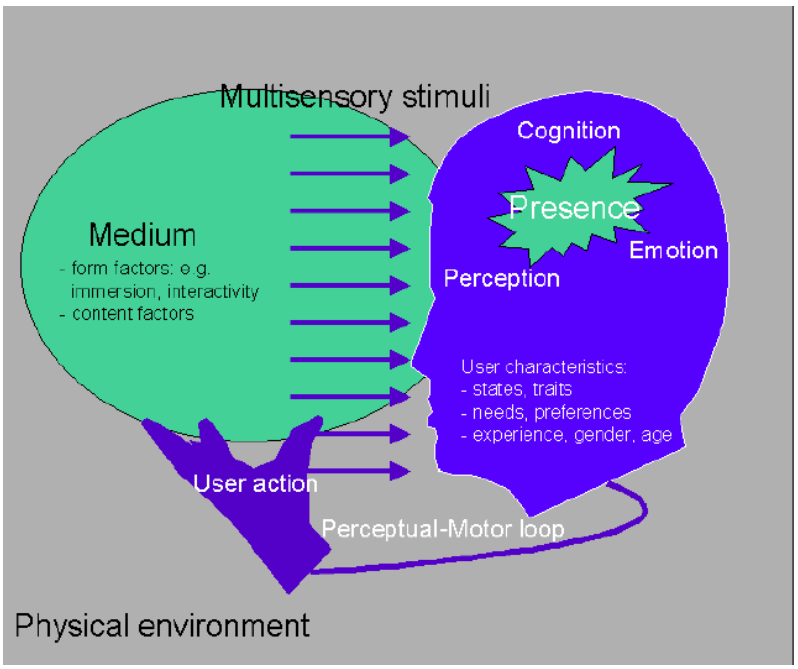


Figure 1: General framework of presence (Ijsselstein and Riva 2003, p. 6.)

In order to support this idea of combining forward and backward presence it is important to explore further the many definitions which currently exist. One such definition revolves around how people perceive the medium and is "the perceptual illusion of non-mediation" (Lombard and Ditton, 1997) – or if a theoretical 100% sense of presence were to be achieved in such a mediated environment then the user would be unaware of the system and would perceive everything as real. Assuming such a result is desirable then it is also essential to understand the key dimensions of presence which must be supported. According to current research these key dimensions are: spatial, social and co-presence (e.g. Ijsselstein et al, 2000; Insko, 2003; Lombard and Ditton, 1997; Schubert et al, 2001; Witmer and Singer, 1998). Spatial (physical) presence is the feeling of "being there" in a mediated environment. It also includes a psychological component (feeling immersed, engrossed, engaged). Social presence implies "being together with another" or a sense of being together (DeGreef and Ijsselstein, 2000; Biocca, Harms and Burgoon, 2003). Co-presence is a subdivision of social presence and defined as "being socially present with another person" (Sallnass, Rassmus-Grohn and Sjostrom, 2000). It has the implication that people are physically separated from others but still feel a sense of togetherness in an electronic communication network. Other decompositions distinguish: spatial presence or presence in a physical space (e.g., perceptual immersion, sense of being there), sensory presence (perceptual realism), engagement (involvement), social presence (co-presence), where co-presence is a subdivision of social presence. Moreover Slater (1994) proposes another dimension of decomposition into behavioural (physical) and subjective (psychological).

Within the definitions noted above several articulations or decompositions have been attempted. Sheridan (1992) suggests: self as representation of self in the virtual environment, physical as the ability to be affected by or to affect the virtual environment, and social the ability to interact with other life forms. During a presentation at the PEACH 2007 summer school Waterworth also argued that presence is the relationship of the organism to the environment, and its ability to perceive self in relation to others and the environment. Interestingly this is very close to the sociological view of place advocated by Gustafson (2001) which has played a part in shaping work within some IPCity demonstrators.

Spatial presence is the most researched dimension of presence. It has been argued that spatial presence is necessary for effective performance in a computer-mediated world. With an increased feeling of presence the user is attending more intensively to the task at hand, and hence his/her performance is improved (e.g., Draper et al., 1998; Laarni et al 2004a). Although a complete sense of spatial presence may be elicited only by emerging technologies, such as virtual reality, more traditional media (e.g., television, video games) may create spatial presence to a lesser degree (Lombard, and Ditton, 1997; Steuer 1995).

Researchers have identified several formal characteristics of media as determinants of spatial presence: the number of human senses for which a medium provides stimulation (i.e. media sensory outputs), the consistency of sensory outputs, image quality, image size, motion, dimensionality, camera techniques, aural presentation characteristics, interactivity, obtrusiveness of a medium, and the number of people the user can (or must) encounter while using a medium (Lombard and Ditton, 1997; Heeter, 1992; Lombard et al, 2000). In addition, content features of a medium, such as social realism, use of media conventions, and the nature of task or activity, may exert an influence on spatial presence (Lombard and Ditton, 1997).

Drawing on the work of Copeland (1990) Salvani (2006) defines presence from a theatrical perspective namely stage presence i.e. being in the presence of and reciprocity. Stage presence is aspects derived from the performer based around attributes such as charisma, the ability to project fictional objects and the ability to reveal an authentic self. While being in the presence of someone, is based around the idea of sharing a space with and being able to touch someone. However he regards reciprocity as the key; namely how spaces encourage activities between actors.

There is also an ongoing debate into the relationship between culture and presence (Tost et. al, 2007; Riva, 2002), which Tost argues should give rise to the concept of cultural presence.

While according to Tost, Riva´s concept of cultural presence is hard to distinguish from social presence, it does help instigate a debate. For example Tost argues that a simple notion of being “there” is not relevant to cultural heritage as it is impossible to understand another culture simply by pointing at it. Furthermore although work by Macintyre et al(2004) points to the importance of understanding significances in shaping a persons aura of a space, the definitions are often too broad or vague to be useful. Feeling culturally present is one aspect of several IPCity systems for example within Street Beat the aim is to make people feel present in the underground culture of Berlin, while in Time Warp users travel to different time periods. Therefore sense of presence in both cases does (in part) perhaps depend on understanding the cultural aspects of the period, and representing these using mixed reality content and devices can be challenging (McCall et al, 2007).

> “Presence (a shortened version of the term "telepresence") is a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience. Except in the most extreme cases, the individual can indicate correctly that s/he is using the technology, but at *some level* and to *some degree*, her/his perceptions overlook that knowledge and objects, events, entities, and environments are perceived as if the technology was not involved in the experience. Experience is defined as a person's observation of and/or interaction with objects, entities, and/or events in her/his environment; perception, the result of perceiving, is defined as a meaningful interpretation of experience.” (Source: International Society for Presence Research, undated).

Floridi (2007) criticizes many aspects of current presence research in (in particular the almost standard definition – see quote above) on the grounds of its epistemic failure, arguing instead of focussing on purely internal psychological states which may give rise to a sense of presence, it is better to see presence as an objective observable experience. Indeed he argues that presence should be viewed in terms of levels of abstraction, and such a method also allows for clarifying the definition of presence as well as defining what experiences people are having when they allegedly feel “present” while reading books.

2.2 Presence: Form and Content

The definitions of social and physical presence outlined earlier to some extent mask the debate which is ongoing within the presence community. For example the “Urban Mixed Realities” (McCall et al, 2007) and “Presence Grand Challenges” (PEACH, 2007) panels during Presence 2007 illustrated the potential philosophical and methodological issues facing the presence community. Jones (2004) illustrates this by dividing the majority of research into two main camps (as outlined below).

- Body: External/Perceptual view as advocated by Waterworth and Waterworth (2001,2003,2003b)
- Mind: Internal/Conceptual view as advocated by Biocca at al(2003).

Researchers such as Waterworth and Waterworth (2001,2003,2003b) and Slater (2003) regard presence as being a primarily sensory experience. For example Mel Slater takes the view that presence in a virtual environment is about maximising the sense of immersion (i.e. replacing real with virtual sensory equivalents) and has no relation to content or style factors – he appears to have backtracked to some extent on his earlier views. Waterworth and Waterworth extend this by arguing that core consciousness (a property innate in all humans) is what drives presence, and that extended consciousness (which allows us to imagine or think) is not presence. They argue that this can be illustrated in abstract environments which require people to think more heavily about the content, and thus are less present in the actual physical or virtual experience. In essence these thoughts result in the person being absent from their immediate and sensory surroundings. This sensory stimulation view is also one of the driving factors in the exploration of neuroscience in the context of presence, for example exploring how different sensory experiences stimulate parts of the brain and how these in turn relate to the sense of presence.

As noted by Jones the external/perceptual view of presence ignores some key issues namely that conscious attention to something is the pre-condition of presence, thus leading to situations where in order not to be present requires a conscious decision to attend to something else. It also ignores human cognition and the different perceptions people can have of the same experience – although Waterworth, Jones notes does backtrack to some extent on this issue. Jones (2004) (and Lombard, 1997) proceeded to define a range of aspects which they argue influence sense of presence ranging from emotions and form factors through to style issues. They argue that presence is the act of being present within a mental model of a particular experience and it is this conscious act of interpreting the model which gives rise to presence.

In many ways Turner (2007) seeks to bridge the divide in the form vs. content debate, by arguing that there is no separation of body and mind and that this gives rise to the idea of the lived body – he explicitly discounts the Cartesian dualism approach which is at the heart of much presence research. Or rather that the body exists within the environment and this is how we experience the world. Within this framework he introduces the idea of intentionality which is the idea of intending to do something, intentions or motivations where everything is directed towards something. He goes onto illustrate four types of intentionality: corporeal (e.g. our body moves away from or towards something); social intentionality (e.g. understanding our own mental states and the states of others); affective intentionality (e.g. fear, boredom etc) and cognitive/perceptual intentionality (e.g. brain-mind link). He argues that this is heavily related to the idea of affordances, and that affordances and intentionality are on two sides of an arc and are the driving elements in the sense of presence.

It should be noted that in most of the research discussed earlier the emphasis was on purely virtual reality environments and it is only recently that attention has been given to AR systems (see Goldiez et al. 2004).

2.3 Measuring Presence

There are a range of techniques and methods which aim to measure presence, from subjective techniques (such as questionnaires, continuous assessment, qualitative, psycho physiological and subjective corroboration) through to objective measures including neural correlates and behavioural measures. Some research focuses on determining individual differences and factors influencing spatial presence, for example cognitive factors such as absorption, creative imagination empathy (Sas et al., 2003). Also personality, and willingness to suspend disbelief may have a considerable impact on the sense of spatial presence (Laarni et al, 2004b). In common with the form vs. content debate some methods such as the MEC (Vorderer et al, 2004) and ITC (Lessiter et al, 2001) specifically address content related issues (e.g. interest in the domain or negative content effects), where as the presence questionnaire does not (Witmer and Singer, 1998). Many questionnaires (Bailenson et al, 2001;Schroeder et al, 2001) also explore aspects related to social presence. Other subjective methods include the virtual reality Turing test (Schloerb, 1995), measuring when breaks in presence occur (Slater and Steed, 2000), time estimates (Ijsselsteijn, 2001) and analysis of place (Benyon et al. 2006) and spatial memory.

In contrast, objective measures attempt to remove the post-hoc, subjective nature of questionnaires and similar techniques. These while offering more concrete values e.g. heart rate (Dillon et al, 2000), skin conductance (Meehan et al, 2001) and more recently fMRI and EEG open up some questions on the relationship between observed phenomenon and the ill defined concept of presence. Other methods include: direct observation of movements and assessing whether these are similar to real life experiences. Mel Slater (Keho, 2007) takes the view that such observation techniques are far more useful than questionnaires as they are objective and lead to one benchmark for the presence experience namely if someone “behaves like it was real, then it is presence”. Which goes some way to explaining the rationale for the recent virtual Milgram tests where people found it difficult to electrocute a virtual person (Slater, undated).

However regardless of which measurement technique(s) are chosen the problem remains that there are often implicit theoretical stances which have been taken within such an approach, and that the precise definition of presence which is being measured often varies. The situation becomes even more problematic when dealing with issues relating to mixed reality, where (if we adopt the presence/absence background) then it becomes difficult to see exactly where someone is either present in or absent from.

2.4 Presence: critical discussion within the research community

When the research on presence has matured and its scope broadened, a critical thread has emerged in the discussions. This has been at least partially related to an increasing interest in other fields than original immersive telepresence and VR systems, like AR and mixed reality systems, and also to a movement out from the laboratory towards more real-life-like settings. This critical discussion can be divided into two threads: a general philosophical-epistemological one and more practical one interested in dealing with specific research issues.

2.4.1 Philosophical – epistemological discussion

The general theme of this discussion is that the "traditional" presence research has tacitly and unreflectively adopted some fundamental assumptions on humans which are severely limiting the research, and purpose of the papers is to show these assumptions and search alternative theoretical frameworks that could be used as the new foundation for presence research. This trend can be connected with the move from artificial laboratory experiments towards more real-life ones, and it echoes similar discussions in cognitive psychology and artificial intelligence during 1980s.

Like in the AI discussion in 1980s (see Winograd and Flores 1987), one of the recognized sources of criticism and potential alternative foundation is Heideggerian philosophy. Referring to Winograd and Flores, Zahorik and Jenison (1998) suggest a shift in ontological view from the prevailing rationalistic tradition, where the studies and systems of explanation are based on the separation between physical and psychological domains and on the relationship between them, towards a Heideggerian/Gibsonian view which addresses this ontological question differently. They see that the centrality of the representation of physical world in the mind puts an intractable problem in the heart of the enterprise: it can be never determined with certainty if the research can reliably uncover perceiver's phenomenal state. To avoid many of the problematic issues of this view, they suggest Heidegger's phenomenal existentialism based on „being-in-the-world" as an alternative. To characterise that they discuss about two Heideggerian concepts: „thrownness" and „readiness-to-hand". In the Heidegger's view the analytical detachment, modelling and reflective analysis of the world cannot be the source of our actions: we are „thrown" in the world and have to continuously interpret our surroundings and act in the situations without a possibility for stopping for analytical detachment and reflection, and this „being-in-the-world" is our primary and everyday mode of existence. Reflection is possible only in „breakdowns"; when something that has been and should be „ready-to-hand" in the flow of actions does no more function properly and the flow breaks down. Heidegger defines being in the terms of actions in the world. Following that, Zahorik and Jenison suggest that presence is tantamount to successfully supported action in the environment – whatever the environment may be.

Mantovani and Riva (1999) suggest that Gibson's ecological theory of perception would offer a better starting point than the mainstream position presented above. Gibson's view challenges many of the points of the mainstream position. According to Gibson

- Organism and environment are not separated but united in a reciprocal relationship
- Organism perceives in the environment features relevant for actions (affordances)
- Valid perception is what makes successful actions in the environment possible.

"I assume that affordances are not simply phenomenal qualities of subjective experience. I also assume that they are not simply the physical properties of things as now conceived by physical science. Instead, they are ecological, in the sense that they are properties of the environment relative to an animal. These assumptions are novel, and need to be discussed." (Gibson 1971a).

Affordance is a relational concept: it is not subjective but exist objectively in the environment. But neither it is a intrinsic feature of an environment: it can exist only for a subject which has both capability and need for a particular action. Thus most tables can have an affordance of sitting upon for an adult, but not for a small child.

The Gibsonian view on reality, knowledge and perception differs radically from that of the mainstream presence research. In the latter case, perception is valid to the extent it faithfully reproduces the "given" external environment, which is same to everyone. In Gibson's view valid perception is that which allows affordances that make successful actions possible in the environment, and this perception can vary from one person to another and from one moment to next, depending on what actions one needs to initiate.

If we accept Gibsonian view, there is no fundamental difference between 'real' and 'artificial' environment – both of them are mediated, we do not perceive either of the 'as such' but always filtered through the purpose of our actions where we are engaged. Instead of environment the origin of our perception is in our actions and purposes of them. According to Mantovani and Riva this means that there is always also a social and cultural dimension of presence: because our actions and needs for actions are socially motivated, what is 'real' for us is always co-constructed.

2.4.2 Practical criticism around more specific issues

Turner and Turner (2002, 2006) discuss about the importance of context of use in designing virtual environments. In their 2002 paper they compare two marine training simulators, one where a lot of emphasis has been put in the realistic visual rendition of a bridge of a ship, and another where there is no attempt towards visual realism, but where the focus has been on the number of contextual clues embedded in the situation. Despite the difference both are found to be effective in training. They believe that, contrary to the normally held belief, more improvement in engagement and presence can be gained by focusing on contextual cues external to the virtual environment instead of representational realism. In their 2006 paper Turner and Turner continue the contextual theme by a discussion about "places", particular spaces that are overlaid with meanings by individuals or groups. They discuss about a "sense of place" that can be seen as a prerequisite for presence, but which needs a personal and historical first-person relation to a particular space, which in turn is at odds with the objective and scientific measures of presence research.

Marsh (2003a, 2003b) is particularly interested in the continuity of experience, "staying there", which he assumes to be important for presence. He continues to specify further the action-based, socio-cultural approach to presence suggested by Mantovani and Riva (1999) using cultural-historical activity theory based on Leontjev's (1981) ideas, and also advances the topic of contextual continuity suggested by Turner and Turner. He develops concepts and models to describe user's activities from low-level operations to holistic level as an arena to reason bout experience in mediated environments, and also as a way of study the shifts in consciousness.

Rettie (2005) is focusing in mobile communication. To analyse it she has enriched Gibson's ecological psychology of affordances by comparing it with the concept of schemas developed by Goffman (1951) and the ideas of embodiment by Merleau-Ponty (1962).

Finally Spagnolli et al. (2003, 2005) try to find an alternative to mental, intimate models of presence, and they have developed an ethnographic, action-based approach to analyse presence as the ongoing result of the actions performed in an environment and the local and cultural resources deployed by actors.

2.5 The notion of presence in urban studies

In IPCity presence research is strongly connected to mixed reality applications in an urban context. Hence, our interest in integrating the perspective of urbanism on presence issues. As we will show, this perspective is particularly relevant for WP6 (Urban renewal) but also for WP7 with its focus on interventions in urban spaces.

An extended research in various relevant bibliographic resources revealed that there is no explicit reference to the notion of presence in the discourses and documents within urban studies. This does not necessarily mean that the concept of presence is not participating in the design process, the formation of emerging theories and the conceptual approaches explored by some contemporary architects, urban planners or researchers on urban issues as well as the urban environments themselves.

We should underline that, as a matter of fact, architects and urban planners have always been working on and with the virtuality of physical space and by extension of social space. We refer to the virtuality of space taking into consideration the definition of virtual by Deleuze which is prior to the emergence of the current technological understanding of virtuality. That is to say, in a nutshell, the virtual as a state of reality and opposed to the actual (Deleuze 1968). However, this definition of the virtual is not completely strange to the one in technological terms (Lévy 1995). And the idea of mixed reality seems to reinforce this idea (Manovich, 2003) At the same time, one could argue that architecture, as the discipline of representing and forming the spatial experience of everyday life, has always been exploring various forms of spatial and social presence.(Borradori, 2000) Moreover, two observations over the actual landscape in urban environments disciplines plead in favour of seeking indirect links. On the one hand, although the term presence is not actually used by the members of the academic and professional community, the development of cyberspace and the notion of telepresence is attracting a constantly increasing interest inciting new approaches to urban environments: practices and theories like transarchitectures (Novak, 1998; Brouwer, Mudler and Martz, 2002), visionary approaches (Mitchell, 1996; Boullier, 1999), theoretical questions on urban evolution and development (Castells, 1996; Graham, 2003) theories for the mutations of the notion of place (Augé, 1992; Ascher, 2000), artistic-architectural installations (Wilson, 2002; Urlberger, 2003), etc. On the other hand, the increasing concern for issues related to the notions of perception and interaction brought in foreground by researches in the field of urban and architectural ambiences (Amphoux, Thibaud and Chelkoff, 2004; Zardini, 2005) and the development of the information and communication technologies yield new perspectives for experimenting new ways of understanding architectural and urban space or conceiving and designing forms(Grozs, 2001) Nevertheless, it is evident that working through the indirect relations of the notion of presence and the urban environments would constitute an extremely large research theme by itself that overpasses the limits of the research conducted within the framework of IPCity. For the purposes of IPCity research project we limit ourselves to stating some of the axes that could be further explored.

2.5.1 The project as mixed-reality

ICT provide architects and urban planners with new and more effective ways to express and explore interactively the virtuality of the urban environment as well as to carry out complex tasks, through various means of representation and simulation (CADD, parametric design, photorealism, etc). Nevertheless, while the computational power is being exploited at a high degree, it seems that the communicational aspects of these new technologies is quite limited since it concerns those who are implicated directly in the design process and have special skills that permit them to be in some way “present” and intervene in these virtual environments.

But, as a matter of fact, the communicational dimension is extremely crucial in the urban project 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 and only as part of the real complex urban environment. Negotiation is the moment when information exchange and processing (stakes, objectives, technical specifications, visions, interests etc.), communication and interaction between the different stakeholders but also between them and the virtual object of urban development, reach a particularly crucial point. The project approach corresponds to the evolutions in the urban development field (sustainable development, incertitude, social representation, risk management, multiplication of stakeholders, etc.) that require negotiation and call for management methods that facilitate the constitution of multidisciplinary teams founded generally on public-private and local actors-global operators partnerships.(Callon, Lascoumes and Barthe, 2001; Bourdin, Lefeuvre and Melé, 2006) It gives hence rise to innovative practices that take into account a large spectrum of economic, social and environmental issues from the very early programming phase. The programming is developed gradually along with the conception advancement. In this way, little by little, through a progressive formalisation of the project sustained by the debates among elected, habitants and technicians, strategies get elaborate and objectives are validated or not. In other words, the negotiation scene brings together heterogeneous virtual presences in order to generate a real potential through the various interactions that take place. Thus, negotiation gives rise to the urban project while the urban project gives rise to the negotiation process.

The urban project figuring as both the negotiation object and the support of negotiation process signifies that it could 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.

2.5.2 Designing for experience

For architects and urban planners the urban planning project had always been the virtual-potential space where the future objects were conceived, questioned and tested. Since the command has changed nature -the urban planning project becoming the more “open” and complex urban project-, the process of conception is undergoing transformation. 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 explicit. This new perception of the urban project entails new languages of a strongly narrative character appealing to social imaginary and lying beyond the “traditional” representation methods (Terrin 2005)

Considering the urban project process as the multilayered interaction process explained above, addressing the question of presence while observing the urban project negotiation scene equals addressing the question of the project participants’ experience. In a conceptual approach, we could accept that the perceptions and interactions forming these experiences take place simultaneously along two axes evolving through time. The one refers to the perception the different partners involved directly or indirectly in the process of decision-making have of the actual urban environment and the other refers to the perception they have of the virtual urban project object always in relation to its real urban context (at once material and immaterial). The negotiation scene constitutes the space and time frame of bringing together these numerous “systems” where the new interactions raised up between the various participants necessitate a “*mise-en-scene*” in order to build up the shared virtual capital of the urban project stated earlier. Therefore, presence in the urban project negotiation context is examined in relation to the urban environment experience (virtual or actual and as a form perceived, conceived and represented) and to the social experience of participation in the negotiation scene which becomes a stage of multiple narrations.

From the urban studies point of view, the new trends in design practices (insisting on experience, ambience, users' and stakeholders' interactions, services rather than buildings etc.) converge with a broad vision of presence in mixed-reality environments as discussed above (e.g. sharing meaningful experiences and interaction spaces...).

2.5.3 Interventions as an urban strategy

Present tendencies within architectural, urban environmental and related disciplines provide various approaches to contextualize the mixed-reality system tools of IP-City. According to urban project negotiation scenes, its specific potential lies in the approximation of the professional perspective on the urban condition, and the emerging power of non-professional participants enhanced by communication technologies. The constitution of the space of negotiation raises the question of when and where to locate the virtual project in relation to what authors. Referring to the project database and with the appointment of various technologies to the architectural practice the project itself can become a *distributed being* with its own right to be (Oosterhuis 2003) Due to its mere existence and the incorporated technologies of representation, professionals and non-professionals are able to shape its virtual presence. Thus, although nobody owes the project, the persons involved accountably relate to it. This example points to a specific issue within the theoretical approach on the notion of presence in the urban studies, since the degree of integration of various participants is inevitability influenced by the sense of responsibility within the process of decision-making.

From a theoretical viewpoint, one could argue that technology itself serves as the least common denominator that elucidates the interlocking moments of the different presences, within the negotiation scene. The introduction of the notion of topology into the architectural and urban environmental discourse (Huber 2002), reflects the need of a new terminology for the comprehension of the fields of investigation within the professional practice. The recent research on urban design strategies incorporates the notion of topology in relation to the `net´ to enable a description of the actual urban condition that addresses its physiology, rather than its morphology (Michaeli 2004). This perspective offers a specific understanding of the relation between real and virtual spaces in relation to time, from which new instruments for urban planning strategies might evolve. The focus of investigation lies on the dynamic forces and processes of transformation, which form the larger material and immaterial environment, but which can be also detected at single spots.

Communication technologies also empower the formation of interest groups, which has an impact on the practice of architectural and urban development(Friedrich 2005, Uhlig 2007) Whereas at the same time, the notion of appropriation of urban spaces serves as field of investigation from the professional perspective, to develop strategies and tools that embed temporary usage into complex planning processes(STUDIO URBAN CATALYST et al. 2003) The recent practice and research on the city reinforces the discourse on "bottom up" approaches to supplement the traditional instruments of architecture and urban planning. The insertion of temporal usages, (Oswalt 2003) and the concept of urban acupuncture (Ascher 1995, Lerner et al. 2007, Lijn, 2007) refer to a concept of strategic interventions, which influence a larger (material or immaterial) context. They modify or animate the actual situation, thus serve as impulses for long-term developments of the specific site or a larger surrounding. These investigations relate neither to specific cultural environments, nor to a specific group or profession.

Intervening into the urban fabric in this way is also subject within the art scene, where the inserted objects serve as instruments give presence to the overlooked condition (Reiter 1999). They are even directly relatable to the urban environmental disciplines and designated as strategies for urban development (Stiftung Bauhaus 2007). By embedding intermediate interventions into the complex processes of urban development projects, the virtual presences of the heterogeneous group of participants can be stimulated, and balance the further negotiation.

Referring to the issue of appropriation of urban (public) spaces, various ways of temporal occupation raise further questions on the development of new tools for urban development. By using and investigating communication and visualization technologies, *the graffiti research lab* introduces ephemeral laser graffiti to transform the physical surface of the city into a kind of urban interface. By collecting individual messages that are sent via sms, the specific location where the event is performed could connect to the shared virtual capital of the urban project. Another emerging type of event is the spontaneous gathering of people. This not only has an enormous impact on the actual location, it also enhances the awareness of the virtual spaces of communication technologies, in relation to the urban environment, its material and immaterial networks and its geography of usage. For the concept of urban intervention strategies, the driving forces of these dynamics are of particular interest, since those places can be seen as strategic locations for interventions.

These evolving concepts and dynamics provide the breeding ground for new strategies and tools in the urban environmental disciplines. Using the application system tools of IP-City in terms of intervention strategies, will support the development of new instruments for urban planning. In this way, the heterogeneous virtual presences can be contextualized within the fabric of the urban environment and enhance the urban project negotiation scene.

2.6 Conclusions

This first section presented a revised review of traditional approaches to telepresence, as well as of the critical discussion of presence research within the presence community itself. As a result we can say that the special approach IPCity develops can build upon a rich and quite diverse discourse with the presence community.

The special contributions of IPCity to this debate are that it:

- translates these alterative methodological foundations of presence research into a research programme consisting of concepts and mixed reality tools in support of presence;
- taking account of insights from urban studies – urban themes (see D3.2.), the notion of the urban project as mixed reality, the use of interventions in urban spaces;
- studies the relationship between presence and user experience in real settings, focusing on how users actively construct and co-construct this experience through connecting activities in the digital/virtual space with activities in the real/physical environment;
- with the main attention point being on users' purposeful activities in MR environments – how they collaborate, dynamically enact ('dramatic presence'), and map activities and events;

The following section presents an analysis of data from each showcase from a presence and user experience point of view.

3 Evaluating Mixed Reality Experiences

In this chapter the different showcases present their evaluation of mixed reality experiences. They make use of material described in the respective showcase deliverable in different ways:

WP6: While part of the research in WP6 is design-oriented (describing and evaluating the Urban Renewal prototypes, identifying implications for re-design), the analysis presented here revisits the video observations and interviews carried out in two participatory workshops (Sainte-Anne and TGI de Paris), investigating observations relevant for a deeper understanding of presence and user experience, relating them to the presence literature and discussing implications for the common concept map.

WP7: Design Iteration process forms a large part of WP7 research on mobile, pervasive and installation applications. The major CityWall installation presented at Eurovision, Samba Carnival, Helsinki Festival, B2B Germany, 2007, implemented an array of evaluation techniques to further the research on presence within augmented mixed reality environments, building upon the existing literature and developing a permanent installation to allow access to persistent observational analysis.

WP8: The work presented in this section is based on the studies conducted in WP8. It primarily focuses on aspects of presence and place which were relevant to the study of the Time Warp demonstrator. In doing so it provides more detailed information relating to the theories, methods used results obtained. It then discusses these from the perspective of a number of user interface guidelines, moreover it also links these to the IPCity presence concept map.

WP9: An analysis of the Street beast application is presented, which summarizes some of the main observations and findings to then provide an interpretation that arranges user experiences relevant to presence in form of an onion diagram.

All four showcases close their analysis highlighting the implications of their findings for the common concept map.

3.1 WP6: Urban renewal

3.1.1 Background

After re-designing our early prototypes we in Phase II WP6 carried out two participatory workshops, again in the context of real urban planning projects. For the first of these workshops we returned to the premises of the psychiatric hospital Sainte-Anne in March 2007, installing the re-designed versions of our early prototypes in a rented tent. The second participatory workshop took place in September 2007 in Paris on the premises of a large urban renewal project – the planning of a new court house (TGI) close to the Seine and the Bibliothèque Nationale de France (BNF) (for a full description of both workshops see D 6.2).

For each workshop we had prepared scenarios a well as content – panoramas from different viewpoints (including one night panorama), architectural models from student projects (in the case of TGI de Paris), objects representing different materials and textures, exemplars of *art brut* and a set of towers with different textures (in the case of Sainte-Anne), as well as sound probes – for users to enact the mixed-reality scenarios and explore different (architectural) interventions.

Analysis of the workshop material (video observations and interviews) was guided by several research questions concerning presence and interaction. Our aim was to understand:

- How participants create and connect layers of real, virtual and ‘imagined’;
- Participants’ agency and the performative and expressive aspects of how they co-construct mixed-reality scenes as well as

- the role of the physical space, of materiality and of tangible objects.

3.1.2 Evaluation methodology for WP6

Participatory design is a philosophy, which encompasses the whole design cycle incorporating the user not only as an experimental subject but also as a member of the design team. Users are therefore active collaborators in the design process, rather than passive participants whose involvement is entirely governed by the developer. The argument is that users are experts in the work context and a design can only be effective within that context if these experts are allowed to contribute actively to the design. In addition, introduction of a new system is liable to change the work context and organizational processes, and will only be accepted if these changes are acceptable to the user. Participatory design therefore aims to refine systems requirements iteratively through a design process in which the user is actively involved.

Participatory design has three specific characteristics. It aims to improve the work environment and task by the introduction of the design. This makes design and evaluation context or work oriented rather than system oriented. Secondly, it is characterized by collaboration: the user is included in the design team and can contribute to every stage of the design. Finally the approach is iterative: the design is subject to evaluation and revision at each stage.

Participatory workshops include a set of activities:

- Preparation work - select project/site, select participants, prepare scenarios, prepare visual and sound content, photographic panoramas from different viewpoints, etc.
- Develop protocol for participatory sessions depending on scenario, planning for how to engage participants, encourage collaboration, and so forth
- Ethnographic methods - video observation, complemented by photographic pictures, saved images, and semi-structured interviews with a focus on presence issues
- Video logs (including transcripts) of significant scenes/interaction sequences
- Qualitative concept-driven analysis of field work with a focus on presence issues, urban themes, and collaboration/negotiation practices.
- As the number of users that can engage with the Urban Renewal prototypes in a participatory way, quantitative research methods (e.g. presence questionnaires) are not applicable. Instead we use feedback sessions with participants for intense conversations about presence related issues.

3.1.3 Evaluation

Creating and connecting layers of real and virtual

Some of the observations made at the TGI workshop help understand how participants connect the virtual scenes they compose with the reality represented by a panorama, life video and/or the look through the window onto the site. They also allow identify key factors in the creation of these real-virtual connections.

Scale, depth, as well as the precise positioning of objects have a high priority for architects. Visualizing scale and volume are seen as critical for getting a feeling for the impact of an intervention. Their primary concern is with achieving a correct spatial understanding and such an understanding is crucial to aligning the virtual with the real scene in a meaningful way. Making an object transparent adds to the spatial understanding, as it makes the background visible, anchoring virtual objects more firmly in the scene and providing additional depth information (Figure 2).

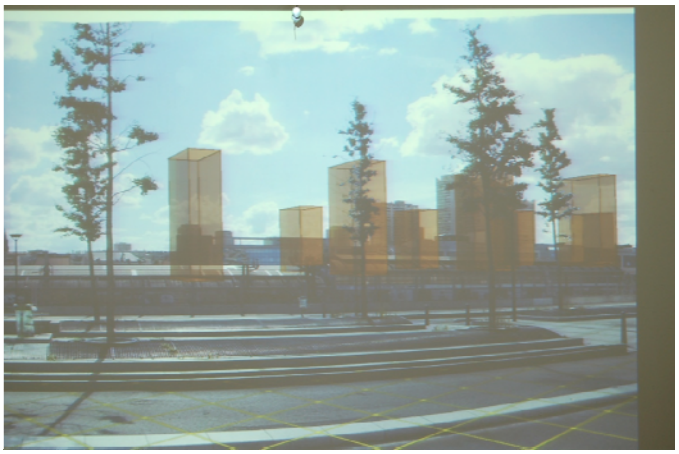


Figure 2: Several residential building blocks positioned in a photographic panorama and made transparent

Interestingly, also the spatial arrangement of *ColorTable* and projection screen is crucial for experiencing the mixed-reality configuration (Figure 3). For example, the map of the site that is projected onto the *ColorTable* has to be aligned with the projection screen in order for users to understand the projected scene and connecting the top view (colour objects placed on the map) with the perspective view turned out as not always easy even for architects.

Figure 3: Spatial arrangement of ColorTable and projection screen

Connecting the real with the virtual scene is facilitated by what we call dynamic representations. This holds for both, the real and the virtual. In a previous workshop (Maquil et al. 2007), where we experimented with a (at that time leased) tent that allowed close contact with the reality outside, we observed how much being exposed to a lively scene (in contrast to an empty, static one) of wind, humidity, smell, background noise, people/cars moving, and so forth, increased the reality element of the mixed-reality configuration.

Figure 4: Animating a mixed-reality scene with flows of abstract (blue) people of varying size mixing with 'real' people in a photographic panorama

At the TGI workshop we explored a simple way of animating the virtual scene, using a flow of people, varying their size, density, and enabling users to direct the flow by placing 'obstacles'

(colour objects) in their path (Figure 4). Seen against a panorama, the impression of people walking across, disappearing in an entrance, passing through a transparent building, turning round an obstacle was created. Abstract persons mixed with real persons in the panorama. Users saw the flows as introducing the human scale in the scene but also as animating it, making it more realistic, despite of its 'abstractness'. Again, the physical 'pendant' to the projected flow helped connect real and virtual. Participants' gaze drifted between the map view, where the flow was represented as moving dots, posing obstacles in their path, and the animated mixed-reality scene (Figure 5).

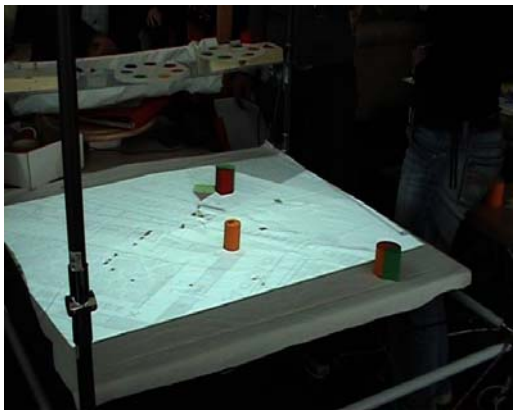


Figure 5: Moving dots on the projected map representing flows that can be directed by positioning colour objects in their path

A related observation is that the abstractness or 'fuzziness' of virtual objects actually may add to the liveliness and stimulating quality of a mixed-reality scene. Scenes that combine realistic and imagined elements exert a strong impression. As part of a photographic panorama, a 'fuzzy' (not detailed, blurred, and so forth) virtual object is contextualized. This invests it with some realism while at the same time leaving space for participants' imagination based on the ambiguity of the scene. We for example observed how the contrast of a high resolution, photorealistic panorama with more abstract virtual objects supports the interpretation of space (Figure 6). Scenes like the ones in can be seen as boundary objects (Lee 2007) presenting the opportunity to fill in different perspectives. Moreover, the distance from reality they create encourage reflexivity since they require users to actively construct and make sense.

Figure 6: An abstract virtual object of shapes of different colors, size and transparencies as seen in a photorealistic context (left) and life video (right)

At the same time, a high degree of abstraction, hence lack of telling detail, does not allow for a sense of place and culture to emerge. The visual scenes participants created were quite 'architectural', emulating ways of seeing and visualizing typical of professional planners. Were it not for participants speaking French, people who don't know the place may even abstract from the specifics of the panorama, imagining it to represent a typical urban scene. Absent from the scene are the people living and/or working in the place, their ethnicity, age, the shops and restaurants they frequent, and so forth. Again, it is not just the lack of socio-

cultural clues but also the absence of people's relationships to the place and their imagination how it could develop.

This was present in an earlier workshop in San Servolo, Venice, were we enacted mixed-reality scenes reflecting memories of the place's past as a psychiatric hospital. For this workshop we had provided content of an aesthetic/emotional quality (Figure 7). Participants created performances around particular themes, such as emptiness, nightmare, arrival, amnesia, metaphysics. They produced scripts with sequences of images and connected sound, movement, zooming, animation, which at that time could not be fully implemented due to the early status of the prototypes.

Figure 7: Expressional content

Another central observation is related to the dynamics of building and changing a mixed-reality scene. We for example noticed how participants first placed a building in the panorama view, observing how it melts with the city silhouette, in a next step making the building transparent with the background becoming visible. We interpret the dynamic element in participants' compositions as helping them attain a stronger connection of the virtual object with the real scene.

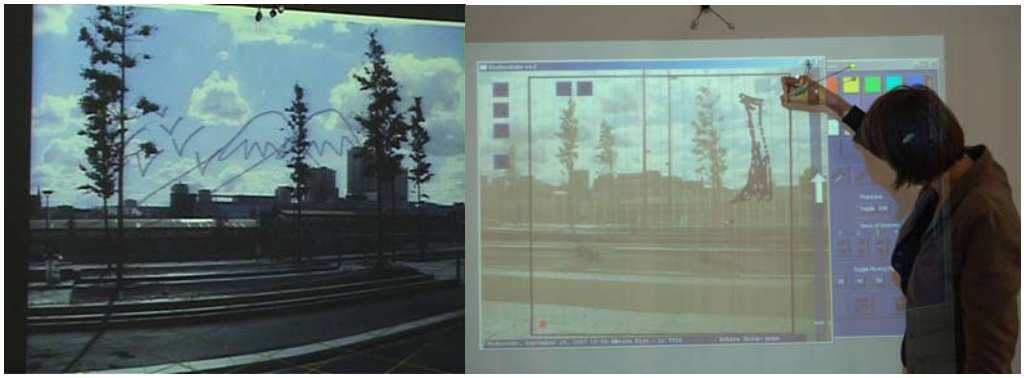


Figure 8: Sketching on a panorama (left) and on a life video (right)

Also, sketching on a scene means connecting what you imagine to be with what is there, anchoring it in the real scene (Figure 8). Participants created a sketch on paper, which was captured by a web cam, and then inserted it in the mixed-reality scene. They also sketched directly on the life video (a layer added to it) which enabled people to watch how the sketch grew and intervened in the mixed-reality scene. Again, the dynamic element reinforces the connection.

Our last observation is to do with connections to the world outdoors - for lack of a the tent mediated through large windows reaching down to the floor. There were moments when participants viewed the real scene and life video next to each other. We noticed for example how passers-by as seen through the window continued walking through the projected mixed-reality scene. This 'animation of a spatial collage' had a strong effect on participants' experience of the scene, making it more real on the one hand, introducing an impression of surrealistic on the other hand.

Co-constructing and performing mixed-reality scenes

In both workshops we observed in which ways the *ColorTable* – the tangible user interface for creating mixed-reality scenes affords simultaneous (embodied) interaction. In another paper (Maquil et al. 2008) we describe how participants through gesturing, placing tokens, rotating the table, and sketching on the projection screen 'perform' a mixed reality configuration (Figure 9).

Figure 9: Participants performing a visual scene through different modes of interacting with each other and with the physical artefacts of table, colour objects, barcodes, and so forth

We think that this observation reaches beyond mere 'social presence', which Biocca (1997) defines as 'being with another body'. It is an illustration of agency, in the sense O'Neill (2005) describes it, or users' purposeful activities.

Through activities, such as placing colour objects, moving them on the map, changing their parameters, directing flows on the map, and so forth, participants 'perform' a mixed reality configuration, adding a dynamic element to it. Participants communicate through participating in the construction of the visual scene, and this highly visible, expressive enactment of ideas is in turn an invitation to others to participate, co-experience, contribute to this dynamic enactment.

The rhythm of participants' interactions contributes to this expressivity. This became visible in how they constructed and directed the flow of people on the map, how they changed a building from opaque to transparent, how they switched between panoramas, hence viewpoints onto a scene, and so forth.

A key role in this is in the physical artefacts and the spatial arrangement that enable this experience. Here want to point in particular to the engaging capacity of the colour objects.

We could see how size and materiality influence the way people interact with them. In re-designing the objects we made them somewhat heavier so as to increase their hapticity, ameliorating the feeling users have when they pick them up and hold them in their hands (Figure 10). Through participants' interactions the colour objects become to represent people, interventions, and perspectives. Participants identified specific colour objects as their own and this seemed to enhance their sensitivity towards each other's perspectives. We

could observe how participants in search of meaningful interventions, holding a colour object while observing from a peripheral

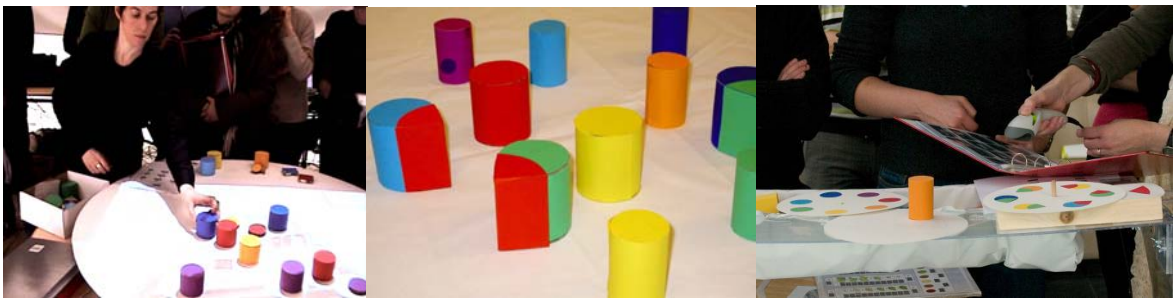


Figure 10: The engaging capacity of the colour objects

position and thinking. One of them talked about the colour objects as 'thinking tools'.

All this points to being in a physical space and interacting with tangible objects as an important part of expressing and experiencing a mixed-reality scene. Although participants' main task is to construct a mixed-reality scene, the 'dramatic' event unfolds in the real world.

3.1.4 Implications for the concept map

The field trials have helped elaborate several aspects of the concept map.

- *Users' purposeful activities*: One of the main contributions of WP6 are insights concerning users' purposeful activities. O'Neill (2004 and 2005) among others criticizes the 'illusion of non-mediation' that has guided much of technology development in support of telepresence, the main idea being that each medium by which the experience is conveyed be hidden or systematically removed from this experience (Bolter and Gromala 2003). The aim is to create a unified space of reality. Our observations support the criticism. Participants in our experimentations are fully aware of the mediation, they are actually co-constructing the scene, as we will show in the second vignette. But this does not obstruct the experience. On the contrary, the experience is in participants actively connecting the real (which itself is mediated) and the virtual.

  O'Neill also makes the distinction between inhabiting a scene, which requires agency, engaging in activities, and 'simply' representing. Our mixed-reality scenes are not just representational. There is the dynamic of change introduced by participants' activities and some of the scenes are 'hybrid' in the sense of passers-by walking through.

  There is a sense of *'dramatic presence'* in the sense of becoming emotionally involved with an imagined world; This can also be interpreted as an instantiation of 'dramatic presence' (Dow et al. 2007) in the sense of participants enacting an event. In their analysis of people engaging in an interactive drama in an AR environment they argue: "Whether emotional reactions or improvisations, these physical acts do more than illustrate the natural affordances of AR; they illustrate the physical involvement in the dramatic moment, leading players to perform actions (such as trying to push and pull the virtual characters) that would not have happened unless they were immersed in the physical context, "on stage" so to speak" (p. 1482). Enacting the 'drama' of interventions in an urban site can be seen in a similar way. Here participants don't interact with virtual characters but with each other, thereby creating expressions of ideas that become visible in the mixed-reality scene and mix with the ideas of others.

  Participants co-constructing and expressing results in what we can call, in a Dewey tradition aesthetic experience (Dewey 1934/1980). Aesthetic experiences are not instances of sheer pleasurable perception, but something that develops in the creative process over time and is both, intellectual and emotional. Participants' engagement with creating mixed-reality scenes is of this quality. As aesthetic quality

is something that we experience, it is bodily and sense anchored, and it is in our case not only a quality of the result – the mixed-reality scene – but also of the process of co-constructing and expressing.

- *Spatial aspects:* Physical space and material resources in this space are critical to the experience of presence - a correct spatial understanding is crucial to aligning virtual with the real scene; interacting with tangible objects is an important part in expressing and experiencing a mixed-reality scene; This confirms the argument brought forward by Spagnolli and Gamberini (2005) that the physical place in which the user is present and the material resources it offers is critical to the experience of presence. Users construct the mixed-reality space as part of the physical space they inhabit.
- *Multimodality:* Connecting the real with the virtual facilitated by *dynamic representations* – flows, sketching. The impression of people walking across lends a realist element to a rather abstract scene. Sketching helps anchoring the imagined with the real, observing how they interact in creating something new. Working with sound (see Chapter 4) will add to users' expressive potential.
- *Content:* Scenes that combine realistic with imagined elements exert a strong impression and the abstractness or 'fuzziness' of virtual objects adds to the liveliness and stimulating quality of a mixed-reality scene: Erickson (1995) talks about the 'roughness' of design representations that leave openings for discussion. Architects work with means such as modality (sketch, 3D rendering, photo), thickness of drawing line, movement and focus, textures, colour, transparencies, shadows. This also applies to the composition of mixed-reality scenes.
- *Ambience:* Narrative and expressive material plays an important role in participants connecting the real with the imagined, permitting them also to convey a sense of culture and place. On the other hand a high degree of abstraction/lack of telling detail do not allow for a *sense of place and culture* to emerge – there is a need for narrative and expressive material.

Our analysis of presence and user experience, while contributing to the concept map, also points to several interface design issues, concerning:

- Dynamic representations (flow, movement, sketching on a scene)
- Characteristics of the content (fuzziness, stimulating combinations of realistic and abstract, narrative and expressive content)
- Participants' purposeful activities (participants' co-constructing, performing, dynamically enacting MR scenes)
- Materiality (the engaging capacity of objects)
- Spatial aspects (spatial alignment of tools and views, scale/depth/volume, orientation, and so forth).
- Our preliminary experiences with these design issues guide the re-design of the Urban Renewal prototype (as described in D6.2). We expect that experiences with these re-designed prototypes will consolidate our exploratory work on designing mixed reality tools and will allow formulating more general design guidelines for the various elements of such tools.

3.2 WP7: Large scale events

3.2.1 Background

Evaluation of WP7 demonstrators and prototypes were done following the approach of Naturalistic Field Trials. Evaluations were done in summer 2007 at two large-scale events, the Eurovision Song Contest and the Helsinki Samba Carnaval, and analyzing the video material captured at the CityWall installation (which is described in more detail in D7.2).

Nokia N70 camera phones were given to three separate user groups attending the two large-scale events. The phones had the software ShoZu installed that uploaded the pictures the users took automatically to the CityWall multi-touch display placed in the city centre of Helsinki. The users were instructed to enjoy the event taking pictures when they felt like it. Users were not followed by a researcher in the events, but they were asked them to visit the CityWall a few times to allow the researcher to meet them and use a video camera to record their social interaction as they interacted with the pictures on the screen. The CityWall site acted also as a place where the users could change their phone batteries and ask for help if needed.

To gather data of everyday usage, we had also a webcam installed in the sunshade above the shop window where CityWall was installed, recording al interaction happening at the installation for one month during the summer

3.2.2 Evaluation methodology for WP7

To analyze the data gathered from users, the approach of Naturalistic Field Trials was followed as described in D3.2 and that was also used for evaluating CoMedia, the first prototype of WP7. The evaluation approach consisted of the following steps:

Background questionnaires were used to gather information on 1) what kind of communication technology the users were already familiar with and 2) to inform the users how the media content they submitted was going to be used.

Video observation. The users were videoed when they visited the CityWall to get an understanding how social interaction formulated within the user group and with other random CityWall users present at that time.

Interviews. Each user was interviewed privately after the event either face to face or via telephone. A semi-structured interview was used, which contained questions about CityWall usage, mobile camera phone usage and event participation in general. Each interview lasted approximately 15–20 minutes.

Content analysis. This included both the videos and interviews recorded. A written transcription of both video and audio data was generated. Also pictures taken by users and submitted to the CityWall were logged and categorized to get a general view of what things at the events were of most interest to the users.

Interaction logs. The videos of everyday use were first pre-processed with the help of interaction logs of the CityWall application, to leave out the video clips containing no active use. The eight last days of July were chosen for a more detailed analysis as this way both first time and returning users might be seen in the video. The video footage was divided into sessions of interaction, each session having a full episode of uninterrupted use, either by one or more users. This way we had an opportunity to analyze multi-user situations in which users may enter and leave the display at different times. If longer than a ten second gap between user interaction with the display or with each other (nobody using the wall) was noticed, then the usage was counted as a new interaction session.

Each session was manually coded to find out, (1) its duration, (2) number of active users who touched the display, and (3) the number of passive bystanders who were watching the active users. The installation window's reflection was helpful in determining the number of passive users, as it allowed seeing a large part of the area behind the camera as well.

The data of the first stage of coding was used for statistical investigations of use. Upon noticing the prevalence of multi-user interactions, this data was also used for two types of further analysis: 1) Multi-user instances of interaction were analyzed in more depth to show what group sizes were present at the display in these sessions. 2) The outcome from the first coding was also used for identifying the most interesting multi-user sessions for a qualitative analysis. This analysis focused on unfolding of events and interactions at the wall and the ways in which users displayed their understanding to others in these events. Material for this analysis was selected by the following selection criteria: a) the five sessions having the most

active users b) the five sessions having the most passive users c) the five sessions having the most people present in total. These sessions contained sessions from different days of the week and different hours of the day.

Many interesting results regarding the social interaction at the CityWall were observed. These are discussed in more detail in D7.2. We will now next review the conclusions of our field research evaluation.

3.2.3 Evaluation

Encounters and collective interactions at the display

Unlike in most of the settings in which public displays have been studied in previous research, a real urban environment is populated by individuals and groups that are strangers to each other. From the everyday use video data we observed how people were configured in groups of users and crowds of spectators rather than as individual users. They were able to use the display both in parallel and collectively by adopting different roles. That the use of the display was highly non-individualistic was evident both in statistics and in the analysis of the selected episodes of interaction. Pairs stopped at the display more often than individuals, and as a result, only 18% of use sessions consisted of only one user. CityWall provided a space for strangers to come into contact, for example users at the display attracted other users. However, strangers acted mostly separately but courteously in parallel, and interacted with one another mostly after a conflict (Figure 11).

We believe that learning from other users may be one of the key explanations for this. Different forms of learning took place when people were drawn to the display and, when actually using the system, they learned what to do by watching the others. The findings show that observing others' use of the display serves as an attractor for more users. Both stepwise entries (queuing for one's turn) and more direct entries (occupying a space while trying not to disturb the existing users) were observed. Previous research has reported similar cases on increasing numbers of people congregating around a display, but has not described in detail the patterns of engagement taking place between the people.

Figure 11: Teamwork at the CityWall

This non-individualistic perspective is important for future work on large public displays. We find it important to think design separately for small groups of users versus individual users. Design should be aimed at by supporting staging performances and facilitating role-taking, thus letting users to learn the opportunities for interaction from their peers. Previous work has highlighted the importance of the display to communicate its affordances for an individual user directly, but our study suggests that there may be ways to support social learning of these affordances. For one, CityWall's large physical size appeared to support making interactions visible to others when wished — both gesturally and as effects on the display. Large display size and visibility also supports immediate availability of content to interact with.

Interaction as a performance

As previously observed in studies on the use of tangible interfaces, users have the opportunity to engage in performative interactions. These configure a particular relationship between action and experience that is expressive, not only towards the system, but also

toward other participants. The particular size and interaction technology of the CityWall supports bodily interactions with the display. From the videos of everyday use we observed how these interactions turned out to be expressive towards other participants and helped to take up roles and negotiate turn-taking.

Content on the wall and features of the interface are used as resources to coordinate activity or to create eventful episodes. For example, gestures like photo-moving and scaling turned into games like Pong playing. Some gestures were made salient to others. “Grandiose gestures” and “pondering grips” were used to manifest the volume of user’s actions and her intentions to others, while also marking the boundaries of the workspace that the user felt she had claimed as her own. Also the presence of strangers — all the other people walking past the installation, sometimes stopping by to observe what the users are doing — have an effect on one’s activities at the CityWall, which can be perceived as a performance in the city space.

The contribution of this study to “interaction as performance” is to evidence how the size of the CityWall created a sufficient space for a “stage” for multiple users. As shown, users were able to adopt different roles: being teachers, apprentices, clowns, audience (Figure 12). In some cases, multiple activities were taking place at the same time at the display. Such asymmetric participation patterns have not been reported in this extent before. This shows yet another aspect of how a public display configures spaces and surfaces in support of social interaction. The multi-touch feature of the interface was central as it supported expressive gestures that helped participants in coordinating, acting out different roles, and communicating with each other.

Figure 12: Teacher-apprentice performances at the CityWall stage

Restructuring the space

While experimentation of “placing” public displays has been considered in previous work, it has focused mostly on private and semi-public settings. Previous work has also been free of theoretical considerations, such as how these interventions in urban settings become also architectural ones, restructuring the space and changing the way people behave around these installations.

CityWall was located in a central pedestrian area between bus and railway stations and important shopping centres. The space connects key locations in the city and offers several small shops and cafes. The space, like similar ones in other cities, is transformed during events. It hosts temporary attractions and gathers groups of passers by.

In our observations and interviews regarding the everyday use of the CityWall, we could see how the space is used by the widest variety of people that are strangers to each other. To repurpose an existing architectural element in this area we chose to install the CityWall on an existing shop front window, which was turned into an interactive display. This solution was very different from introducing in the space a new architectural element as a construct of its own. For example, “a box” would not only be more visible but would also change how people can move in the space.

Our architectural solution invites passers-by not so much because of its physical properties, but because of using different cultural references. As argued by architect Bernard Tschumi (1981, 162), we should not look at architecture as an object, but as “interaction of space and

events". People have been grouping around shop windows in situations before, for example to shelter from the rain, but new technology can be used to extend the bodily presence of people, and change how "bodies … generate spaces produced by and through the movements". It was not our intervention that created a new place, but the people themselves with their appropriation of the space surrounding the display.

Ubiquitous media at large-scale events: extending the event experience

CityWall multi-touch display technology combined with mobile camera phone and photo sharing services was found to be a way to enrich the experiences of groups of users attending two large-scale events and observed in the field. The users reported focusing on and being more present at the events through the use of the mobile cameras. Event experiences were relived and wrapped up in a fun way at the CityWall when users browsed through the pictures of the events afterwards together: in this way new technology can be used to transform spectators of events from passive observers to actors who participate in the events by (re)constructing the event with their own content. For example, one user from the Samba Carnival group commented that

> "I probably would've watched the event from a different location, from further away, but now we were in the front line. And I think we also watched more closely how the parade goes" .

The same user also said that

> "We were participating in the event more actively than we would have otherwise, and probably would have watched only half of the event without the phones and the wall."

A member of the Eurovision group commented that they

> "started taking pictures mostly when something was happening and not when we went to sit in McDonald's or anything. Mostly things related to the Eurovision as the whole week was filled with things related to it".

And another user from Eurovision group commented that

> "It was fun. It gave a different perspective. Otherwise I would have just watched. Since the images would go onto the CityWall and stay there for a while, they should be something not special but capture some point, so we started searching for these kinds of things. It was different".

More in general, this field study helped us better define what ubiquitous or urban multimedia could be in a large-scale event context. The visitor groups invested resources such as time, energy and money to co-experience something "extraordinary" set apart from their everyday life. The spectators observed in this study did much more than just "watch": with mobile devices it was possible to get more out of the immediate spectating experience and also gain a new kind of experience in reviewing the captured media at the wall.

The field studies in the large-scale events focused on supporting the following three aspects:

1) *Co-experience in a spectator group*. Participation in the event is a social experience, creating needs to maintain awareness of other group members, coordinate joint plans and convey expressions (verbal, mediated, embodied)
2) *Engaging with the event*. Passive observation of unfolding events can be turned into a social and cognitive experience by providing spectators with new means for participation. This includes for example enabling spectators capture important moments (both at the stage and within the group) and share them with others.
3) *Ubiquity and distribution of experience*. Spectatorship consists of a larger set of activities than just a participating in the main events. In the case of Eurovision Song Contest and Samba Carnaval, it also covered moments of eating, using public transportation, walking in city streets and so on.. Ubiquitous multimedia for events should take advantage of such moments.

These three aspects come together in the CityWall, which was an attempt to create urban multimedia beyond the personal media in mobile phones. To create successfully ubiquitous multimedia at events, we see at this point that the following two components are needed:

- A mobile component (such as the ShoZu) that runs on a mobile phone and allows its users to access and create situated media situated.
- An installation component (such as a large public display like CityWall) that enables the collective and collocated interaction with spectator created media. The public display provides a better means for spectators to interact, alleviating the limitations of small screen space of mobile devices.

To experiment with further possibilities of new technology, we are currently working on ambient and pervasive computing as a third component. Our aim is to investigate systems that require less explicit interaction with a device but still provide the users with an awareness of the ongoing social event.

"Placing" media: problems and opportunities

In our previous research on supporting spectators with mobile phones with the CoMedia prototype, we have noticed the importance of collocated (e.g., shoulder-to-shoulder) interaction in the creation of enjoyable experiences. When a mobile phone is circulated between group members and the content shown in the screen is discussed, ridiculed and reviewed, the media in the phone serves a natural part of shared social moments. This observation was one of the motivations to build a large media wall like the CityWall at which some of these activities could be better supported. However, while the mobile phone is always with the users and by this definition can be a platform for ubiquitous media creation, a public display as the CityWall needs to be "placed" in a specific location.

When deciding where to place such a public display one can consider at least two types of locations: 1) a central location of the event 2) a central location of the city. In our trials we chose a city central location between the bus and train station terminals. Our choice was determined partly by the city central location of the Helsinki Samba Carnaval, but also by the fact that the spectators of the Eurovision event spent only evenings at the non-centrally located concert venue, and would have had better access to the city centre at other times.

Participants observed that one of the motivations to take many pictures was the awareness that these would have been shown in a public space at another location. We see "placing" media also as an opportunity to create an alternative place in the city that provides awareness of events.

3.2.4 Implications for the concept map

Our field studies have shown how mixed-reality technology can be used in large-scale events to enhance urban presence and engage people more into the events happening in the city. The CityWall installation at Helsinki city centre was found out to be very popular and was widely used during all days of the week. From video observations and user interviews we could see that the CityWall formed a special kind of stage at the street restructuring the installation location to a place where strangers could meet and groups could together experience the city in a new way.

In mixed-reality applications we are not transferring users to some other virtual place not in connection to the reality they were before: in mixed-reality, the reality is enhanced with virtual creating something that is not purely real nor virtual, making invisible aspects visible. This mediated experience is constructed by the user in his mind. Being part of urban environment or a large-scale event is not something you can reduce to some physical parameters, it "requires awareness of the cultural web that makes it meaningful" as Mantovani and Riva (1999) have emphasized. Our study contributes to this understanding by showing how we can see people act and change the urban space.

Spatial aspects: When evaluating the user studies we've done in terms of the concept map we see how spatial aspects of the urban environment are essential parts of the user experience of our CityWall prototype: like in WP6 with the MR tent, users are working with virtual objects (pictures. By resizing a picture of some episode from an event really large, users can try to create their own point of view to the things they have witnessed this way also affecting the representations others have. This way an episode that might have been otherwise unnoticeable can be brought to the attention of the public.

Temporal aspects: This way also temporal aspects of the urban environment can be affected: some memorable moments can be frozen and displayed to the public eye. With the CityWall, the invisible can be made visible or the importance of occurring events can be emphasized by the participants. Our study also revealed that in an urban setting technology is in use around the clock as we witnessed also a lot of use during night time hours: when designing technology for the urban user, we have to be aware what kind of different possibilities and needs of use can manifest during different times of day. Also, what our public display installation is currently lacking is the power to visualize the future. This could be done in a form of an event calendar for example. Another temporal aspect is the duration of use: we observed many people just "trying out" the interface only briefly and not paying that much attention to the content itself and then just walking away. This is both a problem of mobility and immersion that are discussed later in this chapter.

Material aspects: Urban environment's material aspects were also an important factor in the CityWall design. The user interface was designed to be as direct to use as possible: photos on the display can be used with your bare hands without a mouse or keyboard, so you can grab them like they were real material objects. This kind of *tangible user interface* makes CityWall easy to use. Also the screen itself is a material object in the urban scenery: it resembles a regular shop window. Despite its large size many people passed by it without noticing the installation unless someone else was already using it. There are so many visual stimulus in the city landscape that many of us don't do not pay attention to things that are common and are not of interest to us (the CityWall can be seen as a normal video screen showing advertisements). This in mind CityWall's physical appearance could be redesigned to be more noticeable for a common passer by. This could be also done using audio and visual effects.

Mobility: Mobility is also an important aspect of urban experience: with mixed reality technology it allows to experience to happen anywhere the user feels like it. With CityWall the mobile component was the camera phone that was used for capturing images to the large public display. This is a very limited use of mobility as people can't experience the end result right away but they have to go to the CityWall first. Also a problem with static installations as discussed earlier is the fact that you cannot use it when you want: many people tried out the CityWall very briefly when passing by, but hurried then away, maybe because of lack of time. This is the issue that the MapLens application in development tries to solve by offering the user the possibility to augment the material aspects (real maps) with virtual elements in real-time with a mobile camera phone at anytime and anywhere they want it.

Ambience: Another key concept in urban situations is ambience, the sensations about the environment surrounding the person. The CityWall can be seen creating ambience in that way that it provides it's users a sense of what kind of place the city is and can be in different parts of the urban environment in different times. In a way it reflects the ambience of other locations, but it also can create its own when the CityWall itself acts as a stage for performances like seen in our studies. To study the effect of ambience to presence we have created the *Illuminate* prototype, that visualizes the presence of other people with changes in the lighting of the space.

User's purposeful activities: Between the urban environment and the mixed reality medium itself are user's purposeful activities. In our studies we saw lots of different styles of use and how the users together restructured the space where the CityWall was situated with their appropriation of the space surrounding the display: the CityWall acted as a stage where the

users could express themselves by not only selecting media they wanted to be shown on the display but also with their gestures they used in the interaction with the pictures and the other users.

Mixed-reality configuration: The mixed-reality configuration of the CityWall medium, the multi-touch public display, allowed users to have panorama view to the events happening in the city. This is not as direct as seeing things happening in real time in other places. Also the reality and immersion aspects of the configuration can be argued to be less vivid than with real-time video installation. As a one distracting factor can be seen the user interface: the technology was so remarkably new and fascinating, that people were more interested in it than in the *content* the installation was offering to them. Or maybe the content just wasn't interesting enough as it was mostly contributed by other users and not of professional level of photography. The content could have provided more actual information of the events than just the images and the tags people had attached to them. Only when people had taken the pictures by themselves we can say that people were truly immersed to the content and the events the pictures represented.

3.3 WP8: Time Warp

3.3.1 Background

Mixed reality (MR) environments combine real world and computer generated elements to create a multi-sensory user experience. Indeed as noted in a recent panel at the Presence 2007 Workshop, systems such as Time Warp force us to question issues such as place and presence (2). Such questions include "Where am I?" and from the system designers perspective "Where do I want the users to be?". Therefore as noted by Ciolfi and Bannon (2005) it is necessary to explore the real elements of mixed reality as much as the virtual aspects. As a result, the evaluation of Time Warp is very much driven by the need to explore presence in the context of "where". This in turn means that the work outlined here has the dual intention of evaluating Time Warp as well as to start developing methods which can explore where users feel in a mixed reality experience. Related to this overarching theme are a number of elements from the concept map and research questions, namely:

- *Spatial Aspects*: do users better understand the layers and borders of the city, and which elements of the city do people make use of?
- *Temporal Aspects*: what effect does long-term historical knowledge of the user's perception of place and does the user feel present in different time periods?
- *Users' purposeful activities*: what effect does knowledge of social change have on the user's sense of place and presence? How is sense of place shaped by the activities the user can undertake and interaction with others?
- *Ambience*: Does the virtual content change the "sensitivity" of a place?

Figure 13: A virtual character is situated within the real world.

Time Warp is a mixed reality game which takes place in the City of Cologne. The objective is for the players to travel to different time periods and visit local characters known as Heinzelmännchen (**Fehler! Verweisquelle konnte nicht gefunden werden.**). The players walk around within the real environment and the system augments the real location with virtual characters and objects as well as sound. The result is that they can see and hear objects and changes to buildings which reflect different time periods. While playing the game they also have to answer questions about the history of the city and undertake a range of tasks.

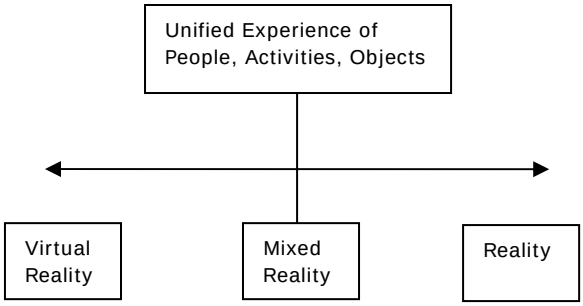


Figure 14: Balancing the relationship between real and virtual aspects of the space.

One of the main challenges within Time Warp is to create a unified sense of place and presence. By this we mean that the user feels as if the virtual elements are as real and natural as those from the real environment and that they are constantly within the *overall* MR experience (Figure 14). This definition has many commonalities with Gibson's concept of affordances (1979), where he sees no difference between real or virtual. Instead affordances arise due to the user's perception of the features in the environment. It has been argued by some that through these affordances the user interacts in the environment and thus feels present. In many ways this shares the definition of presence in virtual environments which Mel Slater described as (when interacting with virtual elements) "*If you respond as if it were real, then it is presence*." (Keho, 2007).

In Time Warp people are simultaneously present with real people and places, as well as virtual people and places. This also requires an examination of some of the elements contained within standard presence questionnaires such as attention, awareness, interest, engagement and involvement. For a unified experience to be created it would therefore be necessary to maintain the user's interest and attention in the experience even when there are little or no virtual aspects. Furthermore, as the experiences take place in reality the users should also posses some awareness of real people, places and objects. Therefore the sense of presence is co-constructed through the experience of real and virtual elements and as such understanding this relationship becomes critical.

By default all user experiences in Time Warp take place in a real space, which is augmented with virtual elements, and through the user's personal interpretation contains meanings and significances. This gives rise to the idea of places, and as noted by Relph (1976) a place is a combination of physical properties, activities and meanings. Tuan's (1977) conceptualization of place encompasses these aspects in a four layer model consisting of cultural significance as well as social, personal and physical aspects. Thus presence in the context of Time Warp becomes the relationship between the real and virtual elements (places), how these blend together and where problems arise - for example when the virtual elements ill fit the real environment.

3.3.2 Evaluation Methodology for WP8

As noted in the first part of this deliverable most of the current research on place and presence, as well as the subsequent methodologies are focussed on virtual environments. However as many of these methods do contain relevant issues it as decided to adopt and

modify existing approaches with particular emphasis on addressing the problem of “where” people feel. Additionally we also used interviews, questionnaires, observations and video analysis.

The primary challenge was to develop a questionnaire which would support assessment of physical presence (including where the user felt location in the mixed reality experience), social presence (with real and virtual people) and sense of place. Additionally we also had to explore if the users felt present in different time periods. For this task we chose to build upon the MEC spatial presence questionnaire (Vorderer et al, 2004) by adding questions specifically related to the issues already highlighted. MEC itself is broadly speaking based around the Lombard (1997) and Jones (2004) view of presence in that it considers content related issues such as interest in the topic and cognitive involvement (see below). We adopted the large MEC questionnaire, this had some drawbacks as the number of questions is very high but in common with the MEC researchers we felt it better to remove irrelevant aspects as the studies progressed. MEC also avoided the need ask a specific pre-use questionnaire exploring if users felt present in other, as this and other related information is contained towards the end of the questionnaire. Finally from the perspective of virtual environments it has been extensively validated and tested.

- *MEC Spatial Presence Questionnaire: Main Categories*
  - Process factors (Attention Allocation, Spatial Situation Model, Spatial Presence: Self Location, Spatial Presence: Possible Actions)
  - States and actions (Higher Cognitive Involvement, Suspension of Disbelief),
  - Personality characteristics (i.e., Domain Specific Interest, Visual Spatial Imagery, and Absorption)

The largest single change to the MEC took place in the first section of the questionnaire, where the scale was increased from five to seven points, to support a higher degree of granularity and instead of asking people if they felt present in the real or virtual experience they were asked to rate their experience on a scale from “Real only” through “Overall” to “Virtual Only”. Overall relates to if they felt present in a combination of the real and virtual elements. Throughout the remained of the questionnaire additional questions were added to the various questions specifically related to how the virtual and real elements compared to one another, for example “The virtual and real elements complemented one another”, “I felt in one environment during the experience” and “Different time periods altered my behaviour towards the environment”. Questions were also added to explore the interaction with real people and objects in the context of the game e.g. “Other people (non players) influenced my behaviour”. With the exception of the first section all questions asked the user to respond on a standard seven point Likert scale.

MEC itself was insufficient for exploring issues to do with social presence, in particular with respect to virtual characters. It was for this reason that we added questions from the Bielenson et. Al (2001) social presence questionnaire. Finally, we added some questions from the Place Probe (Benyon at. Al, 2006) to find out about which place(s) people felt they had visited as they took part in the experience, these were also modified to reflect aspects of Time Warp, in particular the temporal dimension.

We had explored the use of reparatory grids as a method of extracting information pertaining to relationships between the many aspects of the experience. However in the form used in the study it appeared to take too long, confuse participants and was dropped.

While the majority of users were video taped some were also observed as they took part in the game. For this we adapted an observation technique developed within IPeRG (Integrated Project on Pervasive Gaming), and used it to consider which notes were taken and also to act as a method of analysis for the videos. This observation technique focuses on the following areas:

- *Player-player interaction*

  - Non-verbal behaviour or communication e.g. gestures and other physical signs
  - Verbal Behaviour/language e.g. what kind of language to players employ
  - Technical supported interaction e.g. what methods are used between players
  - Roles and Teams e.g. if they meet another player what was the context and what happens
- *Player-Device Interaction*
  - E.g. why does this occur, what do they use and who interacts with who.
- Player- Spectator Interaction
  - E.g. do non-players stop the player, does the player notice any behaviours of the real people.
- *Player- Game Management Interaction*
  - E.g. returning to base to ask a question

The IPerG method proved useful while observing people although not all aspects were relevant, in particular player-player interaction which is not implemented at present.

As the intention was to inform design as well as provide a method of evaluation we used semi-structured interviews to drill down. The questions in the interview were often determined from interesting phenomenon observed during the trial or from data obtained in the questionnaire. These interviews tended to focus on the question of "where" people felt and in addition what cues or other aspects caused them to feel there.

3.3.3 Evaluation Results

Interaction with others

The feeling of being socially present within Time Warp varied in three distinct dimensions, (1) with non-game participants (2) with game participants (3) with in-game characters. The first category can be further subdivided into the presence felt by the participant of others and the sense of presence others had of the participant.

> "I felt like an alien… Sometimes you were involved in the game so much you did not notice them…." (LC, Female)
>
> "You feel kind of special" (CX, Male)

With respect to feeling present with non-game participants, there was minimal if any interaction with them during the game – a view echoed by LC & CX (see quotes above). This results in game players being disconnected from reality, and not feeling present with other people. Indeed as noted during the game they were partially aware of others (namely through trying to avoid them), or being aware that other people regarded them as different. Beyond these two aspects there was no real sense of being with or interacting with non-game participants.

> "Well people talked to me…. " (JH, Male)

The presence of game players within the city of Cologne had minimal impact on the general population, however their "presence" simply in the street did at times alter non-game participants behaviour. Many people were simply curious and would stop and ask the evaluators or the player (see quote by JH) what they were doing. Some would even shout jokes or gesture towards the players. Other people showed concern with respect to the equipment, with security guards at a number of high-end clothes and jewellery stores coming outside to investigate and making their somewhat solitary presence felt – at least to the evaluators; although it is difficult to note if the players responded to this in anyway. Other

people also displayed some concern, with people feeling to some extent that their privacy was being invaded and some stopping the evaluators to ask what was going on. It is therefore clear that the outward appearance of the technology coupled with the behaviour of the player altered the space in which they were interacting, and often the actions of the people within it. Therefore any feeling of presence is created by being different, rather than any actual participation in the gaming experience by non-game participants.

> "Somehow I knew they were not real" (LC, Interview – in response to a question about the virtual characters)

From the perspective of the in-game characters, the users felt little if any social presence towards them, although it was noted that body movements and behaviours would often change once players became aware that such a character was close-by. However when it came to interacting with the virtual characters users noted that they felt out of place or did not do very much. The sense of realism and interaction with the virtual characters also detracted from feelings of social presence.

The current version of Time Warp does not support communication between game players, although when game players met during a session they would often interact for a short while or carry out tasks together. This situation also opens up another interesting problem of how to deal with two players who are at the same location but in different time periods. Furthermore, it also raises questions as to how to support co-operation or competition between players. It is perhaps the lack of these elements which resulted in users not feeling particularly present with others.

Time and space

> "I did not notice any difference in time periods….. there are very few virtual objects." (JH, Male)

The quotation by JH perhaps best summarises the feelings of temporal presence experienced by end users. One particular problem faced by the early versions of Time Warp was the lack of content, either objects or sounds. This resulted in them only occasionally coming across objects which were from alternative time periods. Also, although the time portals provided strong cues towards the change of time period, on arrival often little would have changed. Thus there was a failure to reinforce the change, and therefore enhance temporal presence.

Switching between real and virtual

> "No real change, only saw augmented reality for a short time ". (TT, Male)

Interview responses and observation of behaviour led to the conclusion that for the most part the user's attention was focussed on the mixed reality elements of the experience, rather than the surrounding real environment. When observing them it appeared that they were involved and engaged in the scenario and their attention was focussed first on locating the virtual elements, then walking towards or interacting with them. It was noticeable that when undertaking certain tasks people almost totally ignored the surrounding space; this also led to some strange reactions from passers-by. Although further work is required it appears that the participants would constantly re-enter the virtual experience as they took part in the game, and would leave the game experience when there were insufficient elements. Thus there is a need to explore why people enter or leave the virtual experience and what elements of the real and virtual experience can be blended to create a unified mixed reality environment. If this can be achieved then it is likely also to strengthen the sense of temporal presence as people will no longer feel in one time period then another, it should also enhance the sense of spatial presence.

3.3.4 Conclusions

Based on the data obtained we decided to redesign may aspects of the Time Warp game. The changes were primarily drawn from the desire to improve user experience so that sense

of presence and place would be enhanced, in particular with respect to supporting features, which already existed within the real environment and making users more aware of temporal changes. As a result a number of basic redesign concepts/guidelines were devised. While these show many similarities with the work of Davidsson et al. (2004), specific information. However it should be noted that at this stage the concepts require further development and studies in order to be validated more thoroughly.

(1) Understand Attention Allocation

People are easily drawn to objects which engage them in some way, for example animations or those which appear out of place. Consider the impact on the users attention when introducing objects, in particular when you want attention focused more on virtual elements than real elements, also when to balance the two.

(2) Simplify the Interaction Scheme

Avoid using too many types of interaction devices or behaviours. In common with standard usability practice the interactions should be intuitive, for example, where appropriate be comparable to real world behaviours and should not be overly complex. Some of these issues can be overcome by providing training scenarios, however such scenarios should be an integral part of the game play and not separate.

(3) User Safety

Users often become so involved in the game experience that they fail to take into account roads and traffic. Avoid placing key or primarily virtual experiences near roads or other places likely to result in an accident.

(4) Design appropriate paths through the environment

Paths play a crucial role in shaping our perception of space, they can be used to pass-by and pass through spaces. Select routes through the environment which are interesting and terminate game aspects at interesting locations.

(5) Understand the Locale

Alexander (1977) provides a summary of common layouts used within environments e.g. Cafes and their uses. Locations can also play a part in creating game ambience.

(6) Interaction with Others

Where appropriate integrate non-game participants into the game. For example the player could ask a passer-by for advice.

(7) Seamful Design

Make use of environmental features within the game to overcome technical problems. As noted by Chalmers (2003)

, certain technologies for example GPS may not work at all given locations, hence when this is not the case use the problems to enhance the game experience.

(8) Use a combination of real and virtual objects

Use real objects within the game experience where they (1) provide a more intuitive form of interaction (2) can play a key part in the game play.

(9) Provide a continuous experience

It is important that game play is constant, for example people should not suddenly have to interact with virtual elements in one space then face a long walk to the next

experience. Therefore the game should make regular use of real and virtual objects so as to maintain the user's interest.

3.3.5 Implications for the concept map

In the context of the concept map the guidelines noted earlier are relevant to the following aspects:

- *Spatial Aspects*: there is a need to integrate more effectively aspects of reality into mixed reality experiences, for example allowing interaction with real objects as part of the game. Path structures and real world layouts also play an important role in assisting the creating of a narrative and providing a continuous experience. Real and virtual elements should complement one another.
- *Temporal aspects*: one of the main challenges is providing enough mixed reality content so that there is a clear change in the time periods. There is need to explore how this can be achieved either by providing stronger temporal cues or more content.
- *Users' purposeful activities*: socialising with other players, characters and non-players is essential to enriching the gaming experience. For example providing characters which are more clearly linked to the time period. Also interaction with virtual characters has to provide richer social cues – so that they can become more believable. There is also a need to see how non-game participants can be integrated into the experience.

3.4 WP9: City Tales – Street Beat

3.4.1 Background

The evaluation approach adopted within WP9 explicitly addresses a number of the issues within the presence concept map, with particular emphasis on how these issues shape the users' sense of where they are feeling present. The sense of where being taken to mean either the real, augmented elements or a combination of the two. The specific research questions in this showcase were:

- *Temporal Aspects*:
  - Memories and traces of the past: Street Beat, both from the content creation (Taking photographs) and end-user perspective (taking the tour), specifically aims to let users either create or experience traces of the past. Sense of presence in the memories of the various places has been explored within the measurement techniques.
  - Transformation of a physical site over time: Street Beat provides users with stories as to how places have changed over time.
  - Urban rhythms – movement, repetition and flow. As users take part in a tour (either creating or just viewing content) they experience the city streets, people and activities. The route used within Street Beat is in itself a narrative of the underground culture of Berlin.
- *Users' purposeful activities:*
  - Place making: sharing a sense of place with end users, even if that sense of place is somewhat different to that which would be experienced at the location during the present day.
- *Ambience*:
  - Perception and Interpretation: the feelings people have towards particular location, including their own preferences.
- *Co-Construction of Presence*:

  - Making the invisible visible: e.g. allowing people to see what it would be like to visit the many locations mentioned on the tour, or get a feeling of the kind of people who would visit these places.
- *Medium*:
  - Reality: how systems such as Street Beat play with the concept of reality, by linking to other ideas such as making invisible elements visible.
  - Immersion: whether users feel immersed in the content e.g. the stories and buildings described within them,
  - Geo-localised icons: the use of location aware cues such as narrative or music
  - Emotional cues: cues to stimulate emotional feelings

Based on the results of a pilot study the methods used were redesigned, primarily to draw upon existing knowledge and also to more accurately capture the user's responses. These are outlined below, however a more complete description can be found in D9.2.

3.4.2 Evaluation methodology for WP9

User profile: Each participant was asked to sign a liability waiver form, therefore excluding the evaluators from any responsibility during the trial. They were also asked to complete a short profile which contained information such as age, occupation and gender as well as experience of mobile phones, electronic tour guides and computer games.

Questionnaire: The questionnaire was designed to capture information about the relationships between properties of the experience and higher level issues. We adopted classic question type approaches for the basic issues such as asking people to describe their experience, in combination with Likert style responses and repertory grids. As well as the questionnaire containing examples of how to answer certain questions the evaluator also provided an explanation.

We explored a number of existing questionnaires for assessing presence, and none appeared to be directly relevant to the issues which were wished to explore within Street Beat. Therefore we adapted the MEC (Vorderer et al, 2004) spatial presence questionnaire, and combined this with the place probe (Benyon et al 2006). The modifications primarily reflected the desire to explore where the users felt, for example more in the real environment, more in the places as described on the mobile phone or in a combination of the two.

Free form content in the questionnaires was analysed using a grounded theory approach, where as for the numerical elements statistics were calculated. These took the form of looking for correlations between different aspects of the experience, e.g. the feeling of being inside somewhere related to the music being played.

Video analysis: The participants were video taped during the study. The objectives of the recoding the users was to capture where they walked and any specific problems they may have experienced, for example becoming lost or if the phone crashed. For the most part the recordings were taken at a distance from the participants, for example 3-5 meters in front or to the side. Hence they did not always capture what the participants said or were doing with the phone. However when problems arose the dialog was often recorded. Moreover, by video taping from further away it was possible to capture strange interesting events or people in the streets, for example the man wearing only underwear who began shouting at other people next to a café, hence distracting the participants. From an analysis perspective the data presented in this paper focuses on where they become lost, clearly observed problems, or comments made to the camera.

Trip notes: In addition to the video analysis each participant was observed by an evaluator and notes were taken. These notes included information such as problems encountered, questions asked and any other relevant information. While a large part of this information was also available from the videos the notes also provided a way to note down any issues which would be of interest during the later interviews, thus avoiding the need to review the videotapes prior to each interview.

Interviews: All participants were interviewed after their experience, the questions were based on any notes taken during the tour as well as data obtained from the questionnaires. This approach results in a situation where themes of particular relevance to the user would emerge and also for topics to be discussed which could not normally be identified either from the video tapes or video analysis. There were no time constraints on the interviews however they typically lasted around five minutes.

Participants: A total of thirteen participants took part over a one week period in Berlin during August 2007. The group consisted of 8 male and 5 female participants. All except one participant was a resident of Berlin. The group consisted of a mix of students and young professionals aged from 25 to 36. When undertaking the tour some participants did so by themselves and others in groups. They were not forced to take any particular route and assistance was provided only when required.

3.4.3 Evaluation

Main observations

We here summarize the main findings from our evaluation study with regard to presence and user experience.

> "Especially on locations like the Volksbühne a possibility to go inside would be very important because that would be much more interesting than only observing it from the outside." (participant number 4, translated from German).

The ability to feel present or have a strong sense of place was very much shaped by the amount of access people had to the given locations and the extent to which they felt able to participate or felt active. Most of the locations on the tour were off limits, however some such as Tacheles and House Schwarzenburg allowed users to walk around freely. Where this was the case they often rated more highly.

> "(I felt like) funny, somewhere else, a bit like in another world. I liked it." (participant 1, questionnaire).

> "I was more into the city then with a human guide or book…. Felt like in the underground of the real city." (participant 7, questionnaire)

Some users commented that during the trial they felt as if they were somewhere else, rather than just the streets round which they walked. This may in part be explained by the narratives and pictures which were used, which often encouraged people to imagine the types of people, events and other interesting aspects of the various locations. It was noted during the tour that people felt more inside locations if they were provided with richer information, in the case of one location (a theatre) it was noted that pictures of a performance would have substantially improved their sense of feeling inside.

> "Its like an old building, lots of people there, I don't know, full of life. I think that is what I like the most." (participant 2, interview)

Social aspects of the experience were also important. Whether this was being with others taking part in the tour, seeing people in the street or feeling like they were with people inside the various locations. For some how they shared the experience with other group members became quite important and the built-in snapshot facility on the mobile phones was a frequently used feature (Figure 15). In general the social connection seemed to be with others on the tour, or those in the street and to a lesser extent with those who were described within the various stories.

Figure 15: Selected Content Created by User B

During the study we left it up to the users to take pictures and by doing so leave traces of their experience behind. Users responded to that option differently some took no pictures, others just a view what appears to be pictures of their favourite spot e.g. many pictures have been taken of “Volksbühne” and “Tacheles” from different users. Other users have taken up to 24 pictures in a 1 hour tour, e.g. User D (Figure 16) who seems to have created a picture journal and left a remarkable trace behind, rather then just taking pictures of his favourite spots.

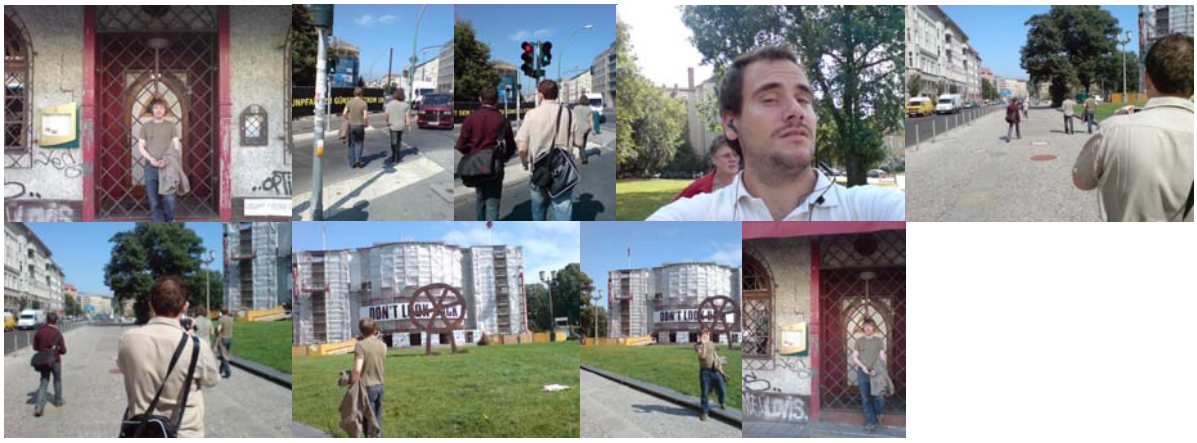


Figure 16: Content Created by User D

> “Tell some more stories, more particular stories, not such general information… more interviews of people who had participated. Other people who have had the experience… says ‘or I have to go tonight’… a little more actuality…. More like a radio feature would be nice” (participant 1, interview)
>
> “You have to make more interaction with the mobile, like a remote control” (participant 9, interview)

From the perspective of the actual content, it was noted by some that it was quite static and perhaps it needed to feel more spontaneous. Also the photographs were at times not very relevant and the relevancy of the music was also questioned.

In common with Macintyre et al (2004) we found that it is important to consider the impact of the mediating technology and its content on the sense of place and presence. For example it was found that the music had no impact on users self reports of place and presence. This was a surprising finding but may in part have been due to the fact that the music was only played between and not at specific locations. Moreover the measurement methodologies used also focussed on specific locations rather than the overall experience. The choice of pictures and nature and type of narrative also had an impact on the users, with some commenting that these were not always appropriate or could be improved.

Analysis

The onion diagram (Figure 17) represents a summary of the findings from the study, with particular emphasis on how content elements and aspects such as user interest in the content alter their sense of place and presence. Those elements at the centre of the onion are deemed to be the most relevant to enhancing sense of place and presence. For example where a space encourages a feeling of activity, being with others or participation then it increases the sense of place and presence. The next layer explores the level of interest and pleasantness, and the final layer the relationship between content elements and the feeling of place and presence. The diagram points to the importance of the properties of various locations being key as well as the users feeling of being with others.

From the perspective of traditional presence research the findings appear to agree with the position taken by Lombard (1997) and Jones (2004), that for people to experience presence (in the case of Street Beat within a cultural experience) there is a need to consider content

related issues. In the case of Street Beat the content is not only the music, pictures and narrative on the mobile phone but also the locations which form part of the tour. Level of interest and how pleasant the locations felt also had an impact on place and presence, which would appear to be in agreement with work by others such as Vorderer et al (2004) who pointed to domain specific interest being a key element in sense of presence.

Prior presence research (Waterworth and Waterworth, 2001-2003) and the work on place by Relph (1976) and Benyon et al (2006), have all pointed to the importance of activities in shaping the user experience – and ultimately the sense of place and presence. The results of the study also point to similar patterns emerging, with higher sense of place and presence, as well as preferences for locations being specifically linked to levels of participation and activity. This in turn would point to the need to consider which types of locations to use and also how to improve the feelings of activity and participation, either by including locations which people can actually enter or through encouraging them to interact with objects etc once there. As noted earlier understanding affordances (Gibson, 1979) and how they can be used to engender a feeling of presence remains a key aspect.

The current results also point to the importance of the social element in shaping the users sense of presence, however there is a need for further work in whether this was due to the social element of experiencing Street Beat with other users, or was with people described or actually present in the real locations.

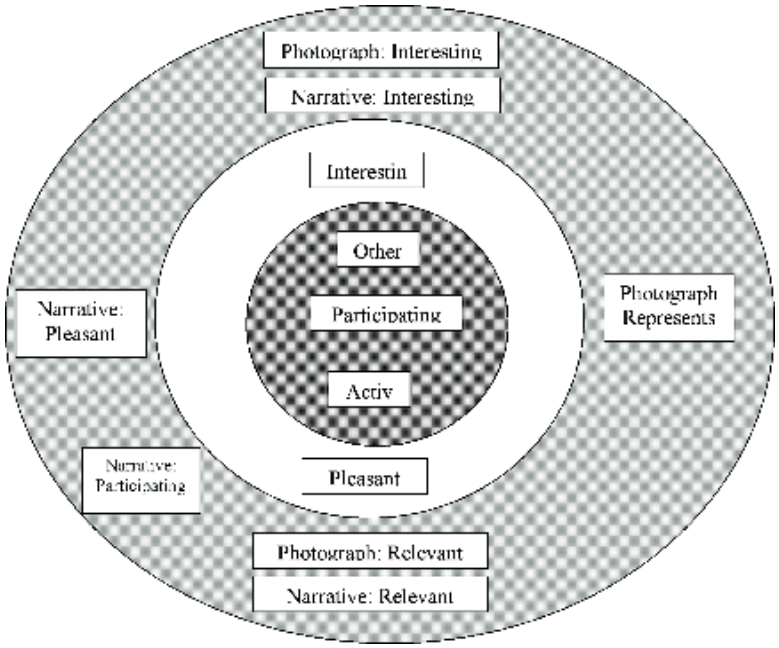


Figure 17: Onion diagram

3.4.4 Implications for the concept map

The study provided a number of interesting considerations with reference to the concept map:

- *Spatial* and *material aspects:* although not initially part of the concept map relating to WP9, there is clearly a need to explore the material aspects of the locations being visited, and for activities and other related aspects to be more heavily linked to the real space.
- *Temporal aspects:* richer content is required to enable people to feel more part of different time periods – although it is debatable whether this is a key aspect of the experience for example the intention is to make people feel part of the culture of the location not specifically a given time period; the user generated content aspect present the ability for people to share their view or experience and requires further

exploration; there is a need to more closely link content to the paths taken through the environment rather than just locations.

- *Users' purposeful activities:* interacting with other participants, in particular taking photographs and talking during the tour seems to be important; the user generated content is currently underutilised but support should be enhanced, perhaps by allowing participants to augment the tour content with photographs or their own narratives.
- *Ambience:* 'cultural presence' is one of the key elements of the experience in WP9, which seeks to provide users with a window to an invisible place. As noted by other researchers, this requires more than simply pointing at virtual content and then learning something about that location.
- *Awareness cues:* the invisible elements need to be more accurately reflected through the use of appropriate geo-localised icons.

4 Emerging themes

In this section we describe research that represent emerging themes for presence research. One of these themes is to do with sound, which has been strengthened as a new research topic in IPCity in both, a conceptual and instrumental level. The other theme touches special issues of mobile mixed reality interaction and their implications for presence research.

4.1 Research on sound

Referring to the broad meaning of presence as the feeling of “being somewhere” (see 2.1 defining presence) leads to a multi-sensorial approach of mixed-reality and urban environments. Most of IPCity tools are essentially visually oriented but their evolution opens up quite naturally to other senses, and in particular to sound, which can be integrated in multi-media tools more easily than smell, for example.

Different applications can be imagined depending on the showcases, but general considerations on the specificities of introducing sound can have a transversal value and make connections through presence research.

Once more, urban studies can contribute indirectly to this specific aspect of research since there is not explicit link to presence debate on sound but connections can easily be done to research on ambience in urban environments with the sound dimension.

4.1.1 State of the art in sound

Urban research on ambience is at the intersection of sensible, perceived and experienced. It orients spatial issues towards immaterial and sensorial aspects. This research field is particularly relevant in French research since the French term “ambiance” is semantically rich and covers aspects that can hardly be translated in a unified concept in other languages: environment, atmosphere, context, comfort, sensation, ambience etc.

The focus can be on different aspects - physical phenomena, sensible-physiological perception, socio cultural appropriation.

Sound contributes to qualify an urban situation in terms of ambience since the media through which it diffuses (i.e. the space and its shape, its open/closed character, the distances, the materials, etc.) is as important as the origin (the source) and the destination (the listener) of the signal. Crossing approaches is the most fruitful way of studying sound in urban situations. Research teams such as the CRESSON in Grenoble (www.cresson.archi.fr), CERMA in Nantes (www.cerma.archi.fr), and GRECAU (www.bordeaux.archi.fr/recherche/GRECAU/default.htm) in Toulouse and Bordeaux gather specialists of different origins.

A technical approach is developed by physicists and engineers specialized in acoustics modelling sound propagation in order to study noise pollution and its perception, to find ways of representing sound levels (indicators, noise maps according to European legislation, etc.) and to produce decision-making tools (Raimbault and Lavandier 2002). Applications fields are, for example, noise pollution in airport areas or, more generally, in urban contexts (Euronoise 2003). Such studies are done in immersive (laboratory simulation) or real environments (perception questionnaires). Sometimes the two situations are put in relation by comparing the perception of sounds on site to the same sound recorded and reproduced in a laboratory situation (Viollon and Lavandier 2000). These approaches insist on troubles occurring especially in private spaces in order to give politicians and deciders tools to improve everyday life quality. It is a problem solving approach.

Architects and urban designers are often associated to a more positive approach, insisting on public space as a “soundscape” (EAA, 2006). Research in this field is more directly connected to ambience, in a qualitative approach and in a design perspective (Building with

sounds, 2005). Research concerns the contribution of sound as a new dimension for the sensible perception of the city, the cultural and imaginary aspects, comfort instead of trouble or disease, etc. This research area includes also studies on the impact of visual upon sound (Viollon et al. 2002) and vice versa (Anderson 1983, Carles et al. 1999) and opens up to psychological and linguistic components.

A more peripheral approach in research on sound and the city is the one lead by musicians. Their contribution is also qualitative and brings in a particular sensitivity to soundscape. Institutions like IRCAM (www.ircam.fr) in Paris host composers like Louis Dandrel who become urban sound designers when they work on and with the city (Dandrel 2000). Pierre Mariétan (2005) contributes to research on sensitive approaches to urban studies and ambiences in the Laboratory of Acoustics and Urban Musics (LAMU) of Paris La Villette School of Architecture.

As noted by many researchers, the pioneering research in soundscape was carried out by Schafer the 1960s. In his classic book, *The Turning of the World* (1977), he defines sound as keynotes (the fundamental tonality around which a piece of music modulates), signals or foreground sounds (sounds that are intended to attract attention), and sound marks (sounds that are particularly regarded by a community, in analogy to landmarks). To him ‚acoustic design' meant discovering the principles by which the aesthetic qualities of an acoustic environment may be improved (Brown and Muhar 2004). A distinction has been made between strategies such as the elimination or restriction of ‚sounds of discomfort' (defensive), the preservation of sound that gives character to a place (offensive), and the imaginative placement of sounds to create attractive and stimulating environments (creative) (Hellström 2002).

Further pioneering research was carried out by Southworth (1969) who studied the reactions of different population groups to soundscape, analyzing their pleasantness. One of his findings was that hearers' delight increased when sounds were novel, informative, responsive to personal action, and culturally approved. This suggests that people's subjective experiences of sound are much more complicated than its physical qualities. Sound preferences may be primarily reflect attitudinal and evaluative rather than purely sensory components. Inspired by these findings, Yang and Kang (2005) have carried out an extensive study of people's sound preferences in urban contexts in Sheffield, UK. Their main observations can be summarized as follows:

- In a given soundscape the first noticed sounds do not have to be the loudest;
- In an urban square, people generally prefer natural and culturally related sounds and their specific preferences to a large degree depend on age, cultural background, and log-term environmental experience;
- The source of a sound matters, e.g. if music comes from an open window, a passing car or a live band.

Introducing sound marks may have dramatic effects. Yang and Kang distinguish between passive sound marks, such as fountains and sonic sculptures, and active sound marks, which are sounds generated by interesting activities.

Multimedia artists are working with sound. Stuart Jones (2006), in reflecting on his artistic strategies, emphasizes that different media have different time-space logics. He argues that there are myriads of ways in which they can play with or against each other. Characteristic of sound space is its plasticity. Sound is „continually setting the boundaries of the perceptual space in a fluid way and can move around and occupy any part of that space or several at once" (p. 22). Stuart talks about a sound's *varipresence* arguing that sound can be used for setting the agenda for our reading of reality more than any other medium. He also emphasizes our capability of handling multiple sound strands – we can focus on a single strand or on several related and unrelated ones. He compares sound to the interaction space, which is also fluid, allowing interactants attract, evoke, summon, bring close, release

objects, real or virtual. Stuart in his analysis coins the term ‚audiointeractivity' by which he means users' activities precipitating a change in the sound space.

Stuart describes several of his own art works. Of particular interest are strategies such as locking a sound to a specific spatial reality by carefully placing loudspeakers in a space (such as the spatial reality of a garden, containing the sound within it); or working with dichotomies that encourage interactive participation. One of his examples here is a piece that „sets up dichotomies at the level of experience (intimate/remote, close/edgeless) and understanding (expression/contentlessness) that encourage us to simultaneously become immersed in and deconstruct it. Examples such as these can be used quite directly as sources of inspiration for how to use sound in IPCity.

Another artist, Justin Bennett, member of the Netherlands-based audio/visual performance group BMB con., describes the group's use-based approach to audio-visual performances, which is based on a lot of improvisation (Bennett 1999). With respect to sound he characterizes types of situations that help deal with the accidental and unexpected, such as accumulation (repeating action, building it up, layering it into a texture), impedance (making certain actions difficult by introducing obstacles), instability, interruption, forsaking of control, as well as accidents. He also describes interventions such as manipulating the audience's point of hearing by placing loudspeakers.

4.1.2 Qualities of sound in IP City

When we think of the qualities of sound we can distinguish between a sound's informative content and its symbolic content.

The informative content has three aspects:

- The relation between a sound and its source – when hearing an acoustic event we immediately refer to its source and usually our experience allows us to identify the source;
- Sound as a physical event – each acoustic event is related to time and movement and the latter contains information about the physical properties of the source; for example, when we bang on a glass with our finger this sounds different from moving the glass across the table.
- Spatial parameters – locating a sound forms part of spatial orientation; the sound of a space contains information about its materiality and is part of our presence in the space.

Acoustic events may have different social, cultural and personal meaning. This is what we call the symbolic character of sound. The history of music in different cultures, for example, shows significant stylistic differences and different development patterns. But also the perception of everyday sounds is culturally shaped. Our experience teaches us how to read sound but these readings are also intensely subjective, as we have developed different sensibilities and priorities.

Moreover, sound can be used to tell a story, to identify an element or a character, like the use of leitmotif in music and opera: the melody can be recognised even if variations are made and it can be associated to different "moods" depending on the way it is played. This association capacity with sound references as well as images can be addressed as a different way of expression for debate.

The main research questions for IPCity concerning the qualities of sound are

- How to categorize the informative content of sound – here the task is to develop a sound library that allows classifying sounds according to their source, material origin, and physical determinants;
- How to evaluate and describe the personal and cultural meanings of sound – here the task is to develop a taxonomy using semantic criteria for describing sound.

Sound in an urban context

With respect to an urban context, we can think of different categories of sound relevant for expressing and experiencing:

- *Particular, real sounds* that have a clear meaning, such as the sound of a fountain;
- A *sound scene*, such as the sound of a fountain, with people and playing children around it;
- A *complex soundscape* for a setting - a sound scene without bounds, such as the sound of a fountain, with people and playing children around it, in a park, next to a street and apartment blocks, and a canal with small restaurants on the other side;
- *Synthetic and abstract soundscapes* may enable people to express moods and visions;
- *Music* is often connected with personal moods and emotions and may describe the personal perception of a place or situation;
- *The sound generated by participants* for expressing their relationship to a place or situation in the past, present or future;
- *Sound related to the past, present or future* – temporal development also affects the sounds of a city and their perception; film, for example, uses different sounds for characterizing futuristic elements.

The research questions IPCity needs to address are:

- When and how does a connection with a sound change/extend the meaning of a visual object?
- How can we best support participants in creating their story of a place past, present, imagined and in expressing their expectations and emotions - fears, ambiguities, desires?
- Can we put the sound at the same level as visual or verbal expression, another element for the negotiation? Which proportion does it take compared to image and word?
- How can we tell a story, a site, an event, a project with sound?

Sound as part of interaction design

Sound can be used as part of the user interface providing acoustic feedback. Examples of informational sound are:

- Single, short signal-sound – short and clearly identifiable;
- Multilayer sound – a short, single, and clearly identifiable polyphonic sound.

Working with acoustic feedback includes the following options:

- Positioning of sound so that it allows identify the position of an object;
- Connecting specific sound families with themes, types of interaction, object attributes, architectural rules, specific places in a panorama, and so forth;
- Connecting the movement of an object with the movement of the associated sound – in this way an acoustic signal may indicate the specific change performed through the interaction (of position, attribute, and so forth);
- *Sound modulations* – rule-based adaptations of the sound to the changes of a complex scene; examples are: flows of people or cars, changes between day and night, a change of weather.

Research questions are:

- What kind of information/feedback to transmit acoustically;
- How to create a *sound language* (sound icons) for interactions;
- How to define rules for different kinds of acoustic feedback.

Working with sound in the MR-Tent

Bringing the IPCity technologies outside raises additional questions. Here the challenge is to achieve the right mixture of all the different sound levels. The real sound environment has to be integrated in the produced one.

It will be important to define rules for creating such mixtures of ‚interaction sound' (with the *ColorTable*), panorama sound, urban project sounds, information sounds, flows, sounds from participants inside the tent, sound from the surrounding environment.

There are different options that need to be explored:

- Provide users with rules for manipulating the real soundscape through their interactions;
- Allow users to (acoustically) enter a specific place in a panorama – the position of the *ColorTable* is generally also the hearing position of the user; moving in the panorama may change this hearing position, allowing users to explore the sound scene from different positions;
- Use the temporal dimension of panoramas, associating sound to panoramas by day and by night
- Scouts sending sounds from distant places, which then will be integrated with the exiting soundscape;
- Highlighting and eliminating sounds
- IP City aim is not to work on simulation and this is even stronger for sound than for visual tools: we would rather want to explore sound potential for interaction design through "impressionist touches"
- Like mobility, sound puts space in relation with time: IP City could develop some sort of "sound stroll" through a site, a project (e.g. using scouts) in the perspective of city telling.

General considerations

Working with sound touches upon some general issues that need to be addressed:

- One general research questions is how many sound strands users can handle and, associated with this, how to better understand users' experiencing and manipulating these different sound strands, as well as how to control sound densities.
- When building a sound library for IP City we have to think how to include users as individual‚hearers' in the description of sound files.
- Sound is less exploited than visual perception in everyday life and in urban studies. The first step could be, therefore, to use sound in order to understand, to perceive differently the site, its identity (*genius loci*), rather than to discuss about design.

These considerations are the first attempt to imagine how sound could enrich our approach to presence. We need to test these ideas with different categories of users, sound specialists or not: physicists, engineers, architects, urban and sound designers, musicians, scenic designers preparing exhibition about urban situations, cinema professionals, city users, etc.

4.1.3 Sound and presence

Working with sound is expected to have a profound influence on users' experience of mixed-reality scenes:

- *Spatial orientation* - the sound of a space contains information about its materiality and is part of our presence in the space; sound sets the boundaries of a physical space – it can be locked to this space or spread over it;
- *Content* – as content sound can be used for
  - o defining themes, providing information,
  - o 'qualifying' particular places (e.g. through introducing sound marks),
  - o emphasizing movement and flow, and so forth;
- *Ambience* – sound may convey a strong sense of place and culture, it may be used to evoke and express social, cultural and emotional aspects;
- *Awareness* – sound icons may be used in support of awareness of people and events.

As noted in WP8 and WP9 sounds which assist in navigation and interaction are essential to user experience. Navigational sound cues are often used so that users can continue with the current task rather than having to view a map. For example AudioGPS (Holland et. Al, 2002) uses sounds to tell the user to go forward/back, left/right or how far they are to the target. Ontrack (Jones et. Al, 2007) builds on this by using music to indicate such information. From the perspective of mixed and virtual environments, Larsson et al(2007) explored the effect on presence of matching what you see to what you hear while, Le Groux et. Al (2007) proposed a framework for sounds in mixed reality experiences, Turner (2007) discusses the importance of listening to presence research and Nunez (2007) explore the use of non-diegetic music on presence. While their results and theories vary, they all point to the importance of the use of sound within virtual and mixed realities.

4.2 Special issues of mobile mixed reality interaction

4.2.1 Background

The key idea of mixed reality interaction (MRI), by definition, is interaction "in" the blending of virtual environment (VE) and "real" or physical environment (PE). Mobile devices complicate MRI, because digital information cannot be directly projected onto physical world. We ask if the notion of presence is important in such circumstances. The use of 3D mobile maps for identifying correspondences between buildings in VE and PE was examined. No signs were found of users exhibiting presence in VE. Instead, 1) they constantly switch between the two viewports, 2) they are aware of PE contents and 3) they interact in a way that tries to align the two spaces. Mobile MRI is better understood in terms of a dyadic process constituted by user's agency and cognitive capacities being "split" between VE and PE. The question is how actions in the two environments can cohere in the pursuit of a single task goal (Figure 19).

Figure 18: Real world scene and a view on a mobile device to a 3D city model (top). On the bottom, the phone (Nokia N93) used in this study.

Presence has been defined as the sense of being physically transported to a remote workspace and as a "perceptual illusion of non-mediation" (Lombard and Ditton 1997). When "present", "perceived self-location and realization of action possibilities are connected to a mediated spatial environment; mental capacities ... bound by the mediated environment

instead of reality" (Wirth et al. 2007). Presence has become the prime approach of psychology to the design of virtual environments and basically to all media where the goal is to surpass the limits of human sensory capacities.

One may ask what is the role of this notion in newer forms of technology that have been deliberately designed to leverage the physical presence of the user, or, reversely to blur the boundary of the real and the virtual. Milgram and Kishino (1994) defined mixed reality as "the merging of real and virtual worlds somewhere along the 'virtuality continuum' which connects completely real environments to completely virtual ones." Mixed reality systems either augment the virtual world with physical features or augment the physical with virtual ones. Mixed reality interaction (MRI) is a broader concept that involves tasks where actions and processing of information takes place from in the PE and the VE. Thus, by definition, there is always an aspect of objects being somehow "divided" or "mapped" or "shared" between two planes.

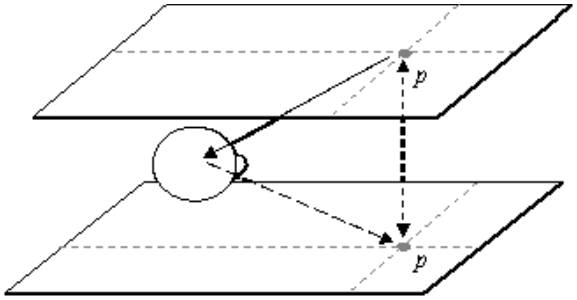


Figure 19: The MR mapping problem: how to understand the referential relationship between two spaces. In mobile MR, the user has to mentally construct the referential relationship between the virtual and the physical, because viewports to the two spaces cannot be projected onto each other.

Mobile devices complicate MRI in the sense that they technically cannot be based on the projection of digital information onto physical world. Moreover, it is physiologically impossible to process a small mobile device display and surrounding scene simultaneously. We call this the "mapping problem". describes this view in a case where the two planes can be conceived as Euclidian spaces, as in the case of mobile maps (Figure 19).

There are two major a priori categories of how users can be "present" in a mixed reality task:

- "Unal presence" - presence in one world at a time:
  a) Physical environment (PE)
  b) Virtual environment (VE).
- "Dual presence" - presence in two environments:
  a) Simultaneously in PE and VE
  b) Sequentially in either PE or VE at a time.

All four options are possible a priori, although they do presume different cognitive mechanisms underlying the feat of achieving presence.

Hypotheses derived from presence research

Regardless of which type of presence there is, the effects H1-H5 mentioned below should be observed if presence is important in this task at all. As a source for these inferences, we refer to Lombard and Ditton's (2007) well-known review.

(H1) Realism in VE is beneficial: Realism of the virtual model should increase sense of presence.

(H2) Consistency of switching behaviour: As a behavioural indicator of presence, users should not exhibit abrupt switches between VE and PE, but either switch

consistently between the two or stay concentrated on one environment for a longer time while disregarding stimuli in the other.

(H3) Mimicking: Users achieving presence should generally prefer manoeuvring in 3D in ways mimicking real world movement.

(H4) Presence is useful: Increased sense of presence should generally improve performance.

(H5) Suspension of disbelief: Presence should be associated with negligence of the physical world.

4.2.2 Case: localizing objects with a mobile map

As a case we look at data from a field experiment Oulasvirta et al (to be published) on how users localize PE buildings with 3D and 2D mobile maps. This is a MR task that explicitly requires mapping of two planes. Technical details of the study are given in the original article. As concerns system and method we want to emphasize that:

- The design of the 3D map instantiates several known principles of good virtual reality design, including photorealism and manoeuvring assistance.
- The default mode of movement and camera in 3D is based on a street-level view. Other views and manoeuvring schemes are optional (e.g. see Figure 20).

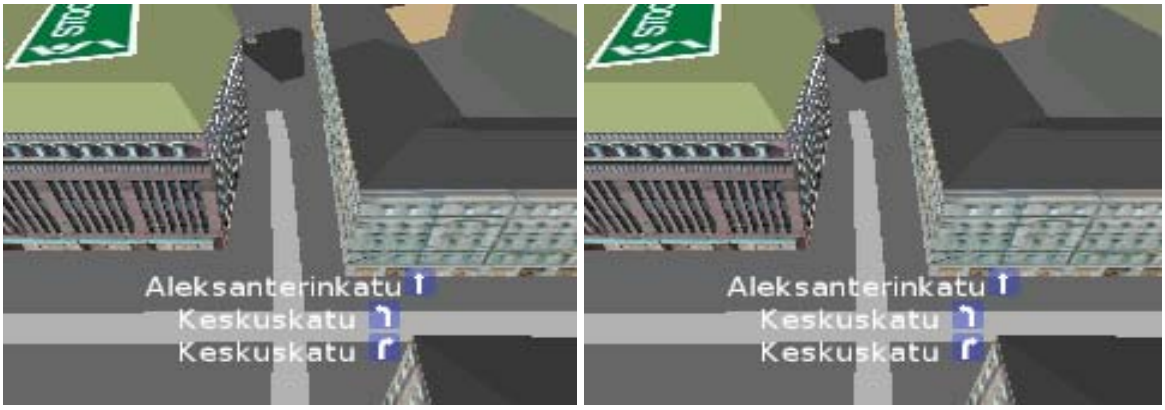


Figure 20: A roof-top view (above) and a track-based manoeuvring scheme (street following, bottom); default view street-level view of Figure 18.

- There is a 2D map as a comparison condition that does not have any “presence-enhancing” features. The map is a simple cartographic street map.
- The task is a pointing task: the user is indicated a target on the VE (map, 2D or 3D), and the user should point toward the direction of the target in the PE. The real target in PE may or 16 subjects performed 24 tasks, spending about 1.5 h on the field with an experimenter.
- Verbal protocols, multi-video data, interaction logs, workload measures, performance measures, and various background information are collected (see Figure 21) for an illustration of the multi-camera setup.

Figure 21: The recording equipment. The user carries one camera on chest (1), and two attached to the mobile device (2 and 3). The moderator follows one step behind, shooting with a wide angle lens (4).

4.2.3 Assessment of evidence

The evidence speaks against the idea that presence is important in mobile MRI. The data is reported in its entirety in the original article, we here concentrate on observations related to the hypotheses.

First, users are perpetually conscious of aspects of PE while interacting with VE, and vice versa. The predominant strategy for solving the task, in both 2D and 3D maps, was by finding a point that maps a location in the VE to one in the PE (hereafter: a reference point). One can infer the target's direction by estimating the angle difference Δ between the target and the reference point, and the target can then be pointed at Δ degrees to left or right from the reference point, assuming that one knows one's own position in relation to the reference point. One can achieve this also without locating oneself on the map, by "sandwiching" the target with two external reference points(This did not always work: In verbal protocols we found frustration of searched-for visual features of PE not found in VE and vice versa.) Now, importantly, this tactic, by definition, entails keeping in mind a description of the target which represents the other environment. Thus, we believe that "suspension of disbelief" cannot be in play here. By contrary, users are constantly evaluating similarities between the worlds.

Table 1: A catalogue of cues used and their frequencies. Based on analysis of think aloud data of 75 tasks.

Cue type	3D	2D
Known landmarks	Very often	Often
Building shapes	Often	-
Façade details	Often	-
Façades (whole)	Often	-
Relative directions	Often	Sometimes
Street names	Often	Very often
Street crossings	Sometimes	Often
Blocks, or part of blocks	Rarely	Sometimes
Parallelism of streets	Rarely	Rarely
Cardinal directions	Very rarely	Sometimes
Store/office names	-	Rarely
Street number	-	Rarely

Second, photorealism of the model does not help but distracts. Table 1 shows some of the cues users used for finding a reference point. An important observation we made is that in 3D use, search operated mostly by scanning buildings that surround the target in the VE, for

example to spot a yellow building in midst of grey ones. We observed that users cannot operate with a photorealistic model efficiently because their attention is constantly guided to ineffective cues that however may be salient in the VE. In this respect, 2D worked much more efficiently and led to faster task completion times. Thus, contrary to findings of presence research, realism is not needed. 2D maps as representations rely on centuries of experience on effective symbols and layouts of a map.

Third, movement in 3D is not "realistic". In principle, if the users so wanted, they could have immersed themselves in the VE to a view that corresponds to their real street-level view and offers rich visual detail. This was the default view. However, to mitigate the "photorealism trap", many 3D users would turn on the Tracks feature see the street names to use those as cues. Some also learned to ascend to the rooftop view and rotated there in search of statues, parks, recognizable buildings and rooftop logos of companies. If this did not work, they "flew" around in the area above the target. Thus, realistic movement did not seem important either.

Fourth, more "immersion" in VE means worse performance. Time spent looking at the PE was higher in 2D than in 3D use (Figure 4.3.5). Conversely, 3D users were more immersed in VE than 2D users. During that time, they travelled the same distance in VE than 2D users. Taken together with the fact that 3D users were slower, we conclude that preferring interaction with the VE actually hampered performance. Good strategies in MR tasks allow users to concentrate on the boundaries and cross-overs of VE and PE.

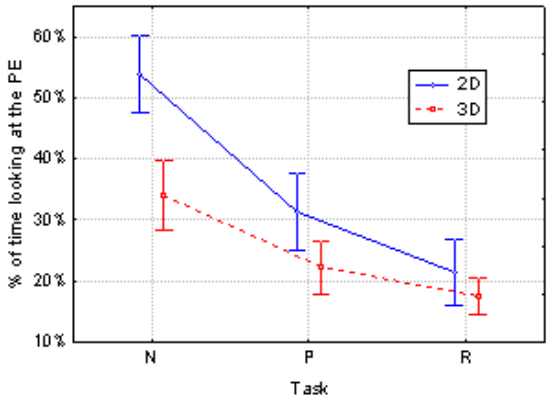


Figure 22: Time spent looking at the PE was higher in 2D than in 3D. Conversely, 3D users were more immersed in VE than 2D users. Taken together with the fact that 3D users were slower, we conclude that preferring interaction with the VE hampered performance. Good strategies allow users to concentrate on the boundaries and cross-overs.

Fifth, navigating in a 3D VE increases working memory load. We divided subjects into two groups, according to a median split for their Corsi score (a test for visuo-spatial working memory span). The high span group was 16% quicker and used Switch perspective 26% more in 3D. They gazed at the environment 11.8% less per task, although the two groups' frequency of gazing at the environment was at the same level. Similar differences were not found in 2D use. These results suggest that 3D performance, but not 2D performance, may be dependent on visuo-spatial working memory span. Due to more fragmented viewing of VE, and less help from bodily strategies, 3D users have to keep in memory more locations of interest to solve the problem.

Sixth, bodily strategies in PE help performance. We were surprised by the general tone of the results concerning bodily conduct: 2D rather than 3D tasks involved more efficient use of body and gaze. 2D users turned their upper bodies more in search of cues like street names and crossings. They deployed gaze significantly more effectively to find cues like parallel streets. They tilted their heads and rotated their devices in their hands more than 3D users. Their walking was significantly more efficient. 2D users did ego-centric alignment more, even when the target was remote and not visible in PE, by relying on the zoom out function to see the current position and the target POI's position in the same view. The crux of these strategies may be that they allow 2D users to avoid mental manipulation and rely more on perception in solving the task. We see a parallel to experienced Tetris players' tactic of

rotating a piece in order to see, rather than mentally simulate, its fit. This means that it is more important to align bodily engagement in two environments, PE and VE, rather than immerse in acting in only one environment, the VE.

4.2.4 Conclusions

Work on scientific concepts proceeds in a cycle of two endeavours: charting the boundaries of existing concepts and proposing new concepts. This case analysis suggests that the notion of presence may not be useful in all areas of mixed reality. Our examples indicate that when operating at the augmented reality end of the spectrum, presence might not be a key issue neither to design for nor to be observed in the field.

The results point that comments like the following on 3D mobile maps must be overly optimistic and detached from the requirements of action arising interacting with mobile maps: “the most positive feature was found to be the possibility to recognize the features in the surrounding environment, which provides a link between the real and virtual worlds. This removes the need to map-read, which is required when attempting to link your position in the real world with a 2D map, hence the VR interface offers an effective way to gauge your initial position and orientation” ()Mountain and Liarokapis 2007) . Our findings lend support to a less Cartesian and more constructivist conception of human perception, where the person is seen as an active, intentional actor in an environment that offers different resources for actions.

We acknowledge the tentativeness of these conclusions. One can state that presence could not even emerge in mobile VE interaction, because of the small display, limited and slow interaction, poor visual quality, and other factors. This may be the case. The desideratum for testing our claim would pair standard measures of presence to those of performance. Our hypothesis is directly operationalizable and testable: higher presence should be associated with poorer performance. Higher attention to boundaries and cross-overs of the two environments should be associated with improved performance. However, our analytical observations on the task and cognitive requirements in MR tasks hint that sense of presence is unlikely, distracting elements are too numerous.

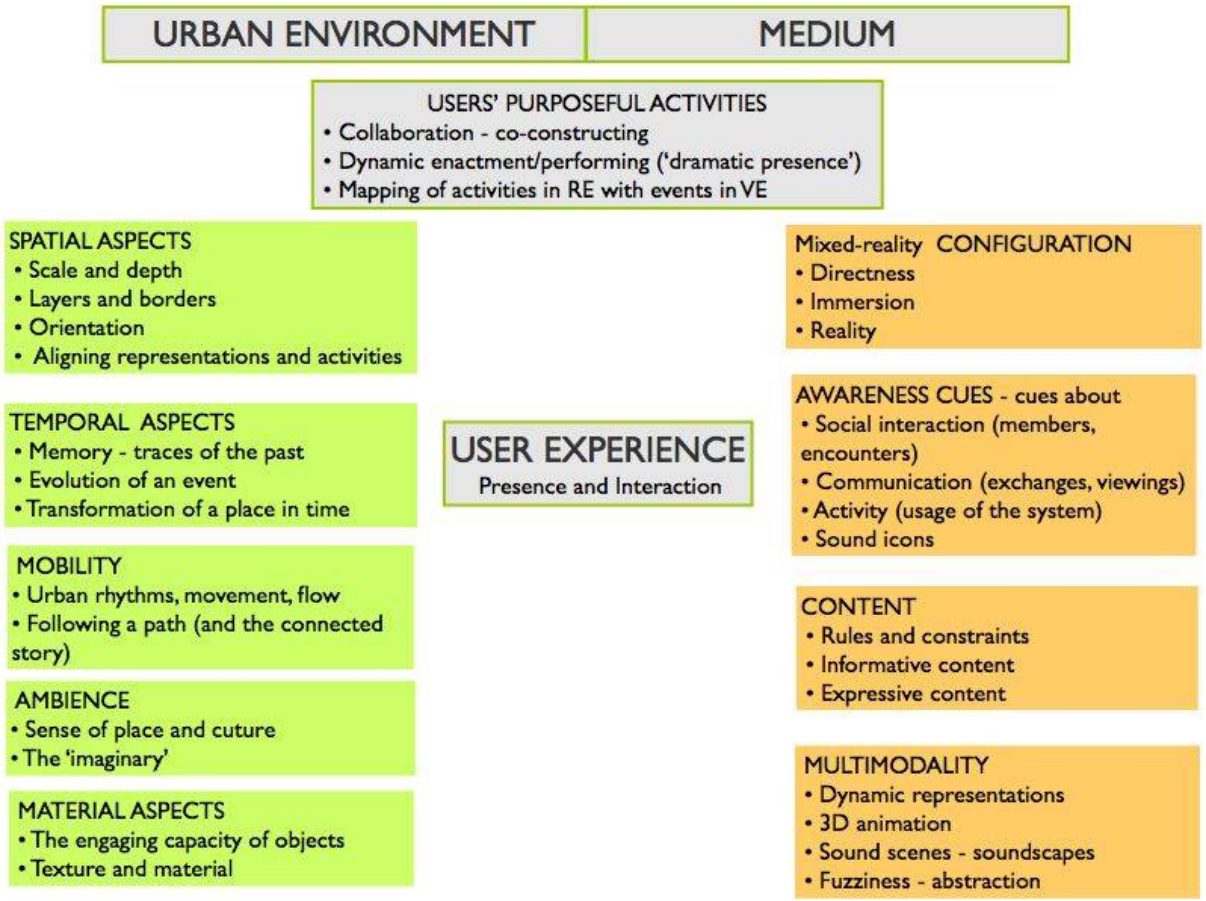
We leave it as a challenge for future research to come up with a more descriptive concept. Importantly, it should capture the synergistic relationship between actions in and perceptions of the two environments

5 Overall conceptual analysis

5.1 A renewed concept map

As a result of our joint analysis of the evaluation results of all four showcases we have reorganized the concept map and also introduced new categories as well as more precise descriptions of aspects to be considered in each category:

- We put ‚users' purposeful activities' on the top of the map, defining the basic activities through which users co-construct their experiences (of presence), with collaboration, dynamic enactment, and mapping as main categories. This category replaces 'social presence', stressing users' active contribution to creating that reach beyond "being together with another" or a sense of being together. This also emphasizes that the main focus of our research is on how users map/align activities in the real environment with events in the virtual environment.
- We have no longer separated urban environment and medium but characterize them in parallel.
- We have introduced and specified 'mobility' and 'multimodality' as main categories, including dynamic representations and 3D animation (see D9.2) in the latter. We also have specified 'content' and 'awareness cues' in ways appropriate to the showcase experiences.



Currently the concept map is highlighting on the left side the aspects of the urban environment that are salient to mixed reality interaction and experiences. These are informed by urban and architecture studies, as well as derived from and exemplified with the showcases. In a similar fashion the right side of the map details several qualities of the "medium" (mixed reality applications). Finally, the central upper box indicates the relevance

of purposeful activities in particular highlighting the social, performative and mixed reality aspect.

5.2 Using the concept map

It is important to clarify how we are using this concept map and how we intend to continue using it. There are at least three possible roles of a concept map:

1. It provides a template for analysing the showcase results. In this sense each box of the map can be used as an aspect to be evaluated. This use is visible in most of the showcases in this deliverable. In particular in the sections “Implications for the concept map” each showcase has selected specific aspects most relevant to the showcase. While this worked well with some of the aspects it is an open issue if the showcases should be evaluated consistently using all aspects.
2. The concept map has also been used as an inspirational input when drafting research questions, planning new features of an application or developing scenarios of use. It has been valuable in pointing to unaddressed areas as referred to by WP9 for example in relation to material aspects of presence.
3. It portrays the current work of IPCity on presence and user experience for the benefit of project partners and also to external audiences. The concept map describes current themes and salient topics in relation with each other and in an organised way. It expresses the distinctive approach and perspectives present in IPCity.

Our aim is to further enrich the concept map, extending the specific ‘instantiations’ of general categories, such as mobility or temporal aspects and so forth, based on examples from the showcases highlighting new and additional aspects. Two such ‘instantiations’ to work with are for example:

Multimodality - support for multisensorial experiences: This theme is addressed in WP6 and has been identified in WP9 in terms of ”something missing”. The emergent issue of sound accounts for the need to design for multisensorial experiences, as does the focus on material aspects of the environment. Along these lines is the paper written by Jacucci and Wagner 2007 on “Performative Roles of Materiality for Collective Creativity” (as part of WP3).

Content - making the hidden present: Mixed reality as a technology that overlays information on a physical scene can also be used for making the invisible visible. Sometimes this can be done by simply highlighting aspects. This is a very fruitful avenue for presence and user experience, as can be seen in some of the examples described section 3. The invisible made visible can be a real aspect of reality made more apparent or a virtual element of a more imaginary world.

5.3 Concepts and design issues towards a vision

One of the distinctive features of IPCity research is its focus on urban environments. This focus has strongly influenced concept development and methodology, orienting the development of applications to urban planning, city tales, events and playful activities. Moreover, the research methodology (se D3.2 in the common evaluation approach) had to be geared to the specific application setting. Another feature of IPCity is its action-oriented view on experience that considers people predominantly as users active in shaping experiences. Finally, IPCity takes a particular perspective on technology and mixed reality, not constraining design to outdated definitions of what can be developed (augmenting 3D VR worlds through HMD and tracking) but opening up to new interpretations.

The focus on urban environments is especially visible in the perspective of the urbanist and architect contributions, which reaches beyond WP6 Urban Renewal, setting themes relevant to all four showcases (see the concept map).

IPCity's action-oriented approach supports critical voices within the presence community, providing additional arguments and motivations but, more importantly, concrete mixed reality applications tested in real settings, which is rare in the traditional presence research.

The particular perspective on technology is visible in the richness of different interaction techniques and applications we have developed. These address the widest range of platforms and interaction paradigms : mobile (e.g. phones), wearable (HMD), pervasive, public displays, multi-touch, tangible, etc.

In the following we propose three preliminary visionary concepts or problems to design for:

- *Stages and resources for performative interaction* - a theme that grows out of the research done in WP6 and WP7
- *Place and presence* - arising from research on place and presence in WP8 and WP9 and is reflected in the focus on urban interventions (WP7)
- *Unified experience versus 'opportunistic switches'* – this emerges from research in WP6 and is addressed in the case described in 4.2.

These themes have been picked as they arise from more than one source inside IPCity research and are therefore initial candidates to be considered to draft a vision of what IPCity as a whole is designing for.

5.3.1 Stages and resources for performative interaction

In our evaluation of mixed reality experiences we have shown how some of the applications provide opportunities for performative interactions. In WP6 Urban Renewal this is characterised by dramatic presence and enactments as opportunities to perform an imaginary design space: "Participants communicate through participating in the construction of the visual scene, and this highly visible, expressive enactment of ideas is in turn an invitation to others to participate, co-experience, contribute to this dynamic enactment" (quoted from 3.1). Users collaborate in dynamically enacting an imaginary space, using all the props and media of the mixed reality application as a resource.

People's enactments with the CityWall (WP7) show how the multi-touch interface and its graspable objects enables participants to act in a more expressive and embodied way in the 'here and now' of the collocated urban space (see taking roles as teacher or as performer, playing with pictures, etc.).

These two examples - enacting an imaginary space (within the real space, on the site of an urban project) or enacting in the 'here and now' - are extremes. The other showcases also present examples of participants switching between the ''here and now" and collectively imagined or virtual places.

The important design aspect is how mixed reality and related technology can be made to pervade the physical, providing more opportunities for action and in particular for expressive and embodied interactions.

5.3.2 Place and presence

Several showcases provide interesting perspectives on place and presence. A key insight is that the experience of a place is directly connected to a space being "a space for something" (Haraway 1991), intricately linking the experience to an activity and a particular cultural interpretation of the place.

In the Time Warp application developed in WP8 users are interacting simultaneously with real and virtual people and places. The Time Warp experience takes place in real space, which is augmented with virtual elements. It is then up to the user's interpretation to create a meaningful unified sense of place and presence from these different elements. This concept of place is close to the one discussed earlier by Relph (1976) and Tuan (1977). The objective

is to have this constructed place to resemble the idea of what the place was like in the past, “time warping” the user into some previous time in that place.

In WP7 the goal is a bit different as the point of interest is in events and not in specific places. In WP7, the mixed reality experience is about extending event participation with the use of technology. With the CityWall installation users are reliving experiences that have happened to them or someone else in an event happening somewhere else in the city. The CityWall can be seen as a window to events and parts of the urban environment users may have not yet personally seen in real life. What is augmented is the “experience of urban environment” rather than a specific “geographically static location in the city”. WP7 uses a more complex concept of place, as the technology has become part of the urban environment itself and has implications for people’s social interactions (observed in the WP7 user studies reported earlier in this document). At the same time this local urban experience is extended and enriched with an experience of something happening somewhere else: in the end we are augmenting the local urban experience with remote experiences.

In both cases the key factor in users constructing the experience of place is that it is an interpretation happening in the user’s mind that has it’s roots in the social and cultural context the user is part of. In this way presence can be seen as a social representation of a place like discussed by Augoustinos and Walker (1996) and originally Serge Moscovici (1988). The theory of social representations sees psychological experience as being mediated and determined by the individual’s belongingness to a collectivity of others who share similar views, experiences, and a common environment and language. In this way the sense of presence and the place you experience to be in is not just a sum of visual cues, but a combination of visual perception and your past, culturally mediated experiences.

The design issue following from these observations is to support a sense of place and culture (‘ambience’ in urban terms) to emerge in users’ interactions with a mixed reality application, by using sound as well as expressive visual content, work with fuzziness and abstraction, make use of material resources in the environment, emphasizing hidden (invisible) and imaginary aspects.

5.3.3 Unified experience versus ‘opportunistic switches’

Traditionally telepresence has been interested in investigating the feeling of being “there” (or being with someone) not acknowledging the role of technology mediation. One of our key findings is that this “there” is more complex than a 3D spatial reconstruction conveys and it is not separable from its experiencer (see section 2, 3.3, 3.4 and Spagnolli and Gamberini 2005). Moreover, in mixed reality a possible “virtual there” is mixed with the “here and now”. We have used the notion of ‘unified experience’, arguing that how unified an experience is depends on users’ conscious effort of combing and relating the “virtual there” with the “here and now” and we have highlighted some design features that support this connecting.

As a consequence, we need to carefully examine in each case what mixed or augmented means in referring to reality. Mixed reality systems either augment the virtual world with physical features or augment the physical with virtual ones. Mixed reality interaction occurs when the task involves actions and processing of information from both, the PE and VE, and can for example be identified with the problem of mapping.

However, as suggested by the definition of MR as a spectrum (Hirose et al. 2002) between augmented reality and augmented virtuality, tasks (and actions) can be considered to be solved primarily in VE or PE. As an example finding a location in a city is primarily a PE task although it also involves tasks and actions in VE (as in 4.2). We observed how participants in the mobile map orientation task needed considerable effort to immerse themselves in the VE because they had to come to an understanding of the VE as being a representation of the PE around them. This case is different from VE being a primary world where the PE serves as an augmentation. In this case it is possibly easier for participants to immerse themselves, as the VE is a substitution of reality because it is the primary world.

In other cases discussed in the literature the tasks and actions are primarily in the VE, as for example in the study of how an augmented virtuality system induced vertigo and stress by mixing a physical ledge with a virtual representation on HMD of an opening to the floor below Meehan et al. 2002 (see for another example Human PacMan (Cheok et al 2003)).

We conclude from these observations that, when operating at the AR end of the spectrum, presence might not be a key issue neither to design for nor to be observed. When on the other hand designing for mixed reality interactions, attention has to be given to how to support users' mapping actions and events from both, PE and VE.

6 Ethical considerations

The application and systems developed in IPCity potentially address several ethical issues:

- *Issues of transparency*. through user centred interface development, users should be provided with a valid and simple model of what the system does and should be made aware when their activity has an effect on the system status or the data being processed.; a special problem in WP6 is the potential for manipulating users;
- *Issues of privacy, confidentiality and trust*. Ubiquitous and pervasive systems raise issues of privacy especially what pertains to context aware features. While IPCity does not focus on security of systems or legal aspects, the research will explore the range of personal information obtainable through mixed reality technologies and in participatory field trials IPCity will increase our understanding of how systems can become harmful (e.g. surveillance in the city).
- *Issues regarding intellectual property*. Particular intellectual property issues arise with systems that share or publish non commercial (end user created) content, for example when citizens contribute with stories, multimedia and other personal material. The investigation of emerging licensing approaches for non commercial content (e.g. http://creativecommons.org/) will be considered. One partner in IPCity (TKK) has developed a peer to peer sharing system that implements these licensing approaches for non-commercial digital content.
- *User empowerment, literacy and participation*. A general orientation of the project is to empower users in their role as citizens, spectators, or visitors/tourists. This includes a promotion of an active and participative role that contrasts with traditional commercial models that view users as passive consumers of media (commercial content and advertisement). In this approach, for example, participation of citizens is sought in urban renewal projects increasing literacy by presenting information in ways that help citizens understand choices.
- *Design for all and equitable access*. Moreover, user centred development will include design opportunities to target needs of particular user groups (users with disabilities, senior citizens, and cultural groups). This is particularly taken into account by social and anthropological approaches as ethnography.

First field trials have drawn our attention to in particular three of these issues.

6.1 Privacy

With the CityWall installation in WP7 user contributed media content of large-scale events are shown in a large public screen. This raises of course privacy concerns: what if the content contributed by the users is somehow offending or otherwise inappropriate? With CityWall this issue was solved by circulating the content through a third party public web service called *Flickr* which has its own license agreement and content moderation policy. Working this way we have not received any complaints from the public during the time the CityWall has been installed in the Helsinki city centre. Unfortunately not all content could be moderated this way: the CityWall had a text inputting feature that enabled users to write comments on the wall. This feature had to be removed almost instantly as we realized that it was mainly used for joking and writing inappropriate things to the wall.

Another aspect of privacy relates to the issue of identity: people can get offended by the fact that their pictures are shown in a public place in a central location of a city. As the content for CityWall is downloaded from *Flickr* where the pictures are publicly available for everyone to see, the CityWall content has been already made public previously, but of course the context with CityWall is different than with the Internet. That is why we had a section in our user interviews about privacy issues asking the subjects how they felt when photos about them were published in the CityWall. Surprisingly, the users did not seem to mind, one user for example commenting:

> "It doesn't matter. It isn't so public that it would matter that you have a photo of yourself there. But if it were a bigger screen, then it could be a little more uncomfortable"

In our case the users did not seem to mind having their picture published, but this probably is not the case with everyone and with every public installation, so this area of privacy should be taken in more consideration. At least a more robust way (than just contacting the administrators) should be offered for the users to delete the content they want.

6.2 Urban renewal - manipulation of stakeholders

The notion of ‚negotiation' supposes a degree of subjectivity of stakeholders and the research for a consensus. It is as such ethical because it aims to define the common values which constitute collective action(Paquot and Younés 2000) It entails at the same time different convictions and conflicting views and there is nonetheless the will to convince the others on a certain subject.

Graphic representations constitute the basis to describe, to discuss and to communicate on urban projects and very much influence the outcome of such procedures (Neto 2006) They contribute to the overture of the negotiation procedure and to the distribution of the roles of different stakeholders: they structure the content of discussions and the power structure between the participants. The use of technical vocabulary and documents as discussion tools influences for example the participation of citizens and reduces the possibility of a real exchange (Söderströmand Zepf 1998) Graphic representations are as such of a strategic nature and are influenced by a certain subjectivity, mostly that of the architect/urban planner or that of the client (Estevez 2001).

The elaboration of a graphic representation includes three steps: the architect/urban planner defines his objectives, what he wants to achieve. He elaborates on his reasoning and the information he wants to use and decides on the appropriate graphic language to this end. The resulting representations are far from being objective: the architect chooses what he wants to show and what he does not show and how he shows it (Martouzet 2002) Graphic representations have in this case a rhetorical dimension: they are conceived to convince, to please, to seduce and they adopt themselves to their interlocutor which brings into question their neutrality and their scientific character. It seems that we cannot guarantee an impersonal use of graphic representations simply because there is always a degree of subjectivity in the production of such tools due to the strategies and the subjectivity of each actor including the client and the architect implied. The importance is to reduce this degree of subjectivity and particularly for those questions concerning the public realm: architects, urban planners, bureaucrats and politicians who work on the production of urban space have the responsibility to help create liveable places and a liveable world for the greater public good and this is what legitimates their action. This responsibility obliges the concerned to adopt discussion tools which are as objective as possible.

The use of information technologies, computer aided design, augmented/virtual reality, etc. enforces the influence of graphic representations in negotiation procedures. The use of synthetic images/perspectives has the advantage of being more comprehensible for the non-initiated. At the same time, these tools present some problems:

- *The creation of the model.* Neto (2006) explains that experts "responsible for creating the models have to balance three aspects that influence the accuracy and objectivity of the model: level of abstraction, accuracy and realism to make it a feasible reality. If this is so how can computer visualization be the object of a standard validation process? In fact, it seems that both the images that come from the computer model and the creation of the actual model itself are subjective" (Neto 2006).
- *The interpretation of the model*. Interpretation of representations depends on the cultural, social and professional of the recipient: traditional tools have the disadvantage of not being easily comprehensible. New technologies allow for synthetic images and simulations which are much more accessible: these images are most of the time very seducing and do not allow for a real appreciation of the project

for the non-initiated. This amplifies the importance of the content of these representations and makes indispensable a pedagogic assistance to facilitate the comprehension and to prevent misunderstandings (Terrin 2006).

- *The verification of the information /falsifiable or not.* The misrepresentations and biased representations are more difficult to point out and this represents a real ethical issue (Brey 1999) Information technologies constitute a “boîte noire” and the stakeholders depend on experts who have the knowledge to manipulate them: they do not necessarily have the means to verify the accuracy of the simulation and to effectively evaluate design proposals and this is very problematic.
- *Technology as an incontestable tool.* Technology is perceived as serious, precise and exact by those who are uninitiated: it is as such revered and not perceived as a tool that can be put to any use in relation with the objectives of the client. This fascination of technology and technological media can mislead the discussion and thus curtail the real issues.

The use of acoustic stimuli to enrich the visual stimuli complicates the question of subjectivity and ethics concerning graphic representations: studies on the influence of the interaction between visual and acoustic stimuli on perception of the environment show that “the interaction of a setting’s visual and acoustic characteristics significantly influences evaluation of that setting” (Anderson. 1983) and that “the congruence or coherence between sound and image influences preferences … a change in sound-image compatibility conditions is enough to produce quiet different aesthetic and affective reactions. Visual information and acoustic information as such can reinforce or interfere with each other.” (Carles, Barrio et al. 1999) The use of sound to enhance graphic representations has to be treated thus with care to not to compromise the project content and the negotiation procedure.

6.3 User empowerment, literacy and participation

Within WP6 there is a discussion on how to reduce the complexity of the tools (ColorTable, UrbanSketcher) while at the same time preserving the richness of possibilities. In our field trials we observed how long it took users - all of them people with a professional background and computer literate – to understand the basic interaction possibilities. One consequence is to organize field trials of longer duration (at least one full day) so as to enable users to get acquainted with the technologies, collaborate on the project, and have ample time for discussion and reflection. Another implication is to implement different uses in different tools, s something we already started (see demonstrator 3 in WP6).

In WP6 working with user-created content is more challenging than in WP7 or WP9. This is to do with the fact that producing content expressing the perspective of, for example residents, requires intense interaction with those people before the field trial, encouraging and supporting them in creating content (of sufficiently high technical quality) that can be meaningfully used in users’ enactments of their visions.

In WP7 simplicity has been one of the main goals when designing technology to be used in large-scale events like the CityWall that is an installation that should be available to use for every participant of the event regardless of their gender, age or language they speak. With the CityWall installation all you have to do is to put your hands on the touch wall and start interacting. This is the great benefit of tangible user interfaces: you can use them as you would use any other real material object and if the affordances they offer are visible and easy to grasp, the use principle of the object can be internalized. Also the timeline feature has a real world counterpart as it resembles a calendar format that is familiar to most of people. From our video data we have observed that the CityWall has been used by all kinds of people: for example lots of tourists coming from different cultures were observed using the CityWall without any problems. With mobile applications like MapLens keeping the design simplistic is trickier as the platform technology (mobile phones) itself is complicated to use (for elderly people for example). This is why in addition to the solutions that require more technical knowledge we also need applications that are easy to approach for everyone.

7 Dissemination

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A publication in a special issues of PsychNology has been planned.

Furthermore, a workshop on ‚Urban Mixed Reality' as part of CHI 2008 is in preparation (see McCall, R., Wagner, I., Kuuti, K. and Jaccuci, G. Urban Mixed Realities: Technologies, Theories and Frontiers, CHI 2008, Extended Abstracts).

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