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A review of locative media, mobile and embodied spatial interaction ☆

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Mobile phones have become a mundane and well-established communication device in the everyday lives of many people. Their promise is to connect us to anybody, from anywhere at anytime. Mobile communication has contributed to a shift of people's role towards 'networked individuals' in urban environments (Wellman, 2001, 2002); our person-to-person relationships have become more complex affording a seamless transitioning between being physically present at a particular place and being digitally connected at all times. Mobile media support people not only to connect to distant others, but also to coordinate and initiate social interactions in their physical proximity, e.g. spontaneously organising collective actions (Rheingold, 2002).

The advent of GPS enabled phones has given rise to what today is referred to as 'locative media'. The first use of the term is traced back to Kalnins and Tuters in 2003 (de Waal, 2012; Galloway and Matthew, 2006), who selected 'locative media' as a title for an international workshop of artists and researchers (International Workshop 'Locative Media', 2003), aiming to explore how wireless and location-based networking affects people's notions of space and social organisation within space. Later, the term became a synonym for media that blurred the barrier between the physical and the virtual world, in particular mobile media that augment people's experiences in real places through relevant geo-tagged information from the Internet (Espinoza et al., 2001; Kjeldskov and Paay, 2005; Lancaster University, 1999; Proboscis, 2003).

Locative media applications have opened up new opportunities for mediated interactions with and within physical spaces (Bilandzic and Foth, 2009). A workshop at CHI 2007 focused on 'mobile spatial interaction' (MSI) and classified relevant applications in four categories (Fröhlich et al., 2007): applications that (1) facilitate navigation and wayfinding; (2) mobile augmented reality applications; and applications to (3) create; or (4) access information attached to physical places or objects. Since 2007, smart phones with touch-screen displays, QWERTY-keyboards, multimedia recording capabilities, as well as mobile high-speed Internet connectivity through 3G and WiFi networks enable users to continuously capture, create, upload and share geo-referenced content. Design principles that have shaped the Web 2.0 as a 'Social Web' (O'Reilly, 2005), in particular user participation, folksonomy and geo-tagging, have been translated for mobile interactions (Jaokar and Fish, 2006). Mobile users collectively tag, rate and recommend restaurants, cafés and other public places, crafting and nourishing a digital information layer that augments the urban physical infrastructure in real-time. The ubiquitous connectivity through mobile devices has transformed our urban environments into 'hybrid spaces,' where social interaction and communication patterns traverse through physical, digital, and a mix of both spaces (De Souza e Silva, 2006). In particular, applications that subscribe to the latter two MSI categories have triggered new socio-spatial practices and interaction patterns in urban environments, also referred to as 'net localities' (cf. Gordon and de Souza e Silva, 2011).

In contrary to Putnam's (1995) claim of declining social capital in urban environments through ICT, such community driven social services empower people to harness the collective intelligence (Anderson, 2006; Scharl and Tochtermann, 2007; Schuler, 2009; Shirky, 2008; Surowiecki, 2004) of their global

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and local community in-situ as they are traversing everyday life and activities. The probably most prominent example of this phenomenon is location-based social networking (LBSN) through mobile applications such as Dodgeball, Loopt, Foursquare or Facebook Places. They enable users to 'check-in,' i.e. digitally confirm their physical presence at a particular place. Aggregated with social network information, users can see where their friends have checked-in as well as background information of current and previous check-ins of people in their immediate proximity. Knowing where our friends hang out might reveal places that we might enjoy as well, and looking through ratings and comments from many previous navigators tells us how the majority of people perceive a specific place. People naturally navigate space by looking at what others do. Such social navigation affordances have been successfully transferred to virtual spaces (Dieberger, 1997; Dourish and Chalmers, 1994; Höök et al., 2003), and eventually to MSI applications (Bilandzic et al., 2008; Höök, 2003) enabling people to socially navigate real world environments in a way that exceeds traditional, physical barriers of space. This trend can be observed on a more general level. In early 2000, before the emergence of the Web 2.0, Erickson and Kellogg (2000) argued that visibility, awareness, and accountability, as important building blocks of our everyday social interaction in the physical space, should be transferred to support interaction in virtual spaces. They suggest that augmenting virtual spaces with such simple characteristics of the physical world would create 'social translucent systems' which would "eventually support the same sort of social innovation and diversity that can be observed in physically based cultures" (2000, p. 80). Looking back at the evolution and success of Web 2.0, we can confirm that they were right. In fact, the social translucence that we today find in Web 2.0 goes beyond what is afforded by the physical world—it bridges spatial, temporal and social barriers. The convergence of Web 2.0 as a 'social translucent system' with locative media creates a digital layer on top of the physical world affording new practices for social interaction that would not be possible otherwise; these affordances have caused a social translucence of physical space, hence transformed it into a *translucent hybrid space*.

With ideas and developments in "context-aware computing," first introduced by (Schilit et al., 1994), space becomes even more translucent. Sensor equipped devices not only detect and respond to location, but also other contextually relevant variables, such as the user's current activity, emotional state, focus of attention, identity and presence of nearby people or objects, time, temperature and so forth (Dey et al., 1999). Information gathered through ubiquitous context-sensing often overcomes the limited abilities of human perception. Such as the telescope and microscope enabled us to see things normally invisible to the naked eye, Schmidt et al. (2011) envision that sensor-equipped computing devices will ultimately reveal new insights about us and our environments—"by the middle of this century, the boundaries between direct and remote perception will become blurred" (p. 87). While it is technically possible to measure a huge variety of contextual parameters (Schmidt, 2002), and there are toolkits (Dey, 2000; Dey and Abowd, 2000a) to help with the application development of such, Dourish (2004) reminds us that context is a rather relative construct, which is not stable and cannot be defined in general (e.g. Dey and Abowd, 2000b). Context is "continually renegotiated and defined in the course of action" (Dourish, 2004, p. 29), hence the scope and set of features that describe the context of a situation is a dynamic product of the social settings, actions of and interactions between people. Therefore it is impossible for a system to fully capture a situational context and relevant context parameters in advance.

While many mobile social software applications have been explicitly designed to facilitate specific types of social encounters in particular user context scenarios, e.g. with application areas in enterprises (Eagle, 2004), dating (Wired, 1998), group finding (Kjeldskov and Paay, 2005), conferences (Eagle and Pentland, 2005) or carpooling (Hartwig, 2006), recent LBSN as outlined above do not follow such explicit goals. They augment the physicality of a place for the matter of making its invisible social properties visible. As they change our perceived physical boundaries and notions of space, they also affect our social interactions and practices within these boundaries.

Pervasive connectivity of location based people networks and accessibility to the collective intelligence that is embedded in a place brings not only the trend of 'glocalisation' (Robertson, 1995; Wellman, 2001) to a new level, but also issues around privacy and publicness, triggering tactical practices (Certeau and Rendall, 1984) that were not anticipated by the designers of such media. In her study of users of Dodgeball, one of the first commercial LBSNs, Humphreys (2010, p. 774) found that the application is not only used to facilitate, but also to avoid sociality in urban public spaces. Furthermore, while users have met new people through Dodgeball, these people tended to be demographically similar to themselves hence facilitating 'social molecularisation' (p. 776). Similarly, Crawford (2008, p. 91) argues that mobile social software "takes the chance out of chance encounters" by filtering and pre-selecting demographically compatible people for face-to-face encounters. As a consequence users tend to flock into mobile cocoons of similar people, missing the qualities and benefits of the social diversity and heterogeneity in urban environments (Wood and Landry, 2007).

Looking at the development and yet early findings about people's use and practices of locative media that have become mundane, the question is how do we go about the design and shaping of future locative media? How do we realise opportunities afforded by new technology, yet consider issues and risks that come with its use?

In order to support spatial interaction and experiences in a meaningful way (Lentini and Decortis, 2010), two things need to be considered. First, *methods* to investigate and

understand the social and cultural context of people's spatial practices, and second, *design principles* that guide the form and function for new media and technologies according to their potential to support such practices and rich experiences in everyday life.

Over the last 20 years, mobile and ubiquitous computing has been shaped by many technology-oriented innovations. However, as Bell and Dourish state, "perhaps dealing with the messiness of everyday life should be a central element of ubicomp's research agenda" (Bell and Dourish, 2007, p. 134). In fact, as computer technology spreads from the desktop to people's everyday environments, the traditional focus in Human–Computer Interaction on interfaces and interaction between humans and computers has perpetually shifted to accommodate a broader perspective that seeks to understand the dynamics between people and the spatiality where such interactions are situated in (e.g. Galloway and Matthew, 2006). Hassenzahl's (2011) description of the difference between 'user experience' and 'experience design' illustrates this shift of foci. While the study of user experience implies a focus on the relationship between the user and a particular artefact, experience design focuses on the needs, emotions and meanings of people's everyday experiences. Focusing on such situated experiential aspects of the user rather than materialistic aspects of a specific artefact, experience design does not presuppose the use of technology or creation of a particular artefact. In fact, the design outcome often fuses with the spatial infrastructure, hence affords embodied interaction (Dourish, 2001) through direct use and manipulation of everyday infrastructure or objects (cf. Millard and Soylu, 2009). While the mobile phone tends to shift its user's attention from the immediate spatial environment to the mobile display (which people sometimes intentionally apply as a cocooning method when traversing urban environments (Mainwaring et al., 2005)), embodied artefacts are part of the physical infrastructure of space; they are visible and accessible to everyone (Falk et al., 1999), thus have the potential to enrich the *collective* situated experience of people in a place (e.g. Veerasawmy and Ludvigsen, 2010). In terms of mediating situated experiences and interaction between people and (hybrid) places, and among people within a (hybrid) place, perhaps an 'embodied spatial interaction' approach is more suitable than mediation through a dedicated device such as in MSI. In the context of mediating 'shared encounters' (Willis, 2010), some studies have shown the applicability and benefits of different embodied interaction approaches in urban settings (e.g. through multi-user, multi-touch displays (Jacucci et al., 2010, p. 26) and digital carpets (Schieck et al., 2010, p. 26)) or have identified gaps where embodied interaction is suggested as a promising approach (Konomi et al., 2010).

The other question is how to approach investigations of the messy everydayness, and spatial experience methodologically? Coyne notes, "the move to the everyday promotes methods of research that engage with narrative and socially situated ethnographic study, rather than the transportation of phenomena to the laboratory, or isolation into the calculative world of variables and quantities" (Coyne, 2010, p. 74). Foth calls for, "research approaches that can differentiate (and break apart) a universally applicable model of 'The City' by being sensitive to individual circumstances, local characteristics and socio-cultural contexts." (Foth, 2009, p. xxviii–xxix.)

Methodologically, ethnography provides powerful tools to help understand the facets of a socio-cultural setting in a detailed and fine-grained manner. However, having its roots in social sciences, traditional ethnographic research does not necessarily imply or propose specific implications for the design of an artefact (Hughes et al., 1995) and is often regarded as a "prolonged activity" (Hughes et al., 1995, p. 59) causing time pressure if particularly dedicated to inform system design. A trade-off, which has been established to bridge the dichotomy between understanding social aspects of a setting and technology design goals, are methods that follow a "quick and dirty" principle of ethnographic research, such as cultural probes or quick user interviews. However, such ethnographic techniques that are explicitly applied to inform design-aspects of a specific artefact might 'marginalise' theory (Dourish, 2006), i.e. miss important social contexts and human factors of the targeted environment that are crucial to understand what role design and technology can or should have at the targeted site in the first place. The role and significance of ethnography in the context of ubiquitous computing and human–computer interaction has caused some earlier confusion (Dourish, 2007). Ethnography might not outline obvious implications for design, but serves as a powerful tool for understanding, describing and capturing social and cultural phenomena and contextual settings, hence informing the overall role which technology might or should play at the site of interest.

Designing technologies that are embedded in peoples everyday lives, and locative media appears to evolve more and more into such a technology, requires a methodology that recognises the significance of ethnography in its traditional sense, yet bridges the gap between ethnographic research and deriving implications for design. This is what Taylor refers to as design-oriented ethnography (Taylor, 2009).

The ultimate goal is to inform the role of technology in a way that it evolves from people's natural practices, tasks and activities and, in particular, from the context and meaning that they attach to those everyday activities. Therefore, evaluation of a technology artefact cannot be practised in laboratory environments only, but through iterative cycles of analysis, design and re-design while it is used within people's everyday activities and context (Ackerman, 2000). In accordance, Willis (2010, p. 13) calls for an approach where "computer scientists team with professionals such as ethnographers and partners in the community to take a long-term view of how changes can be made to the way in which shared experiences are facilitated in these social scenes".

In fact, such cooperation between researchers and participants or other 'partners in the community' over a

longer period of time is a significant principle of Action Research (Blum, 1955; Susman and Evered, 1978). Action Research is a research approach that has its roots in the social sciences. Its aims to find practical solutions to issues in a social setting by taking action; the researcher provokes social change and observes the outcomes. Baskerville and Wood-Harper (1996) refer to Action Research as an "interventionist approach to the acquisition of scientific knowledge". Hereby, the collaboration between researchers and participants is a crucial factor to achieve this goal, as the participants' problem-oriented point of view, and the researcher's strong methodological knowledge and solution-orientation (Hearn and Foth, 2005) cross-fertilise each other.

If approaches, such as Action Research, are canonically designed to create and evaluate solutions in and for social settings, a logical question that arises is how can such approaches be combined with engineering-oriented goals towards designing, developing and evaluating new technology, or in this case, locative media artefacts that will shape people's actions, interactions and shared encounters in the future? Even though traditional Action Research does not aim to solve problems through the development of technological artefacts per se, its methodological approach can be applied as a tool to understand the underlying problems in a socio-cultural setting, inform the design and requirements of technological solutions, implement (act) and evaluate (reflect) its impact in real-world settings.

Situated in a similar dichotomy between design-oriented thinking and investigation of relevant socio-cultural aspects in organisational settings, methodology literature in information systems research has started a discussion about the convergence between Action Research and Design Science Research (Baskerville et al., 2007; Cole et al., 2005; Figueiredo and Cunha, 2006; Iivari and Venable, 2009; Jarvinen, 2007). This is a first step towards treating technology designed for use in socio-technical settings not as isolated IT solutions, but rather as "ensembles emerging from design, use and ongoing refinement in context" (Sein et al., 2011). As artefacts are not only technologically, but also socially constructed, they have to evolve, grow and be shaped by and within the organisational context (Iivari, 2003), rather than introduced overnight. It will bring the design of locative media closer to what has been earlier discussed as 'social construction' (Bijker et al., 1987) or an 'ensemble view of technology' (Orlikowski and Iacono, 2001, p. 26).

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