

New uses for mobile pervasive games - Lessons learned for CSCW systems to support collaboration in vast work sites

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Abstract. New pervasive games draw upon the location of players and objects as well as the availability of several mobile players to create an appealing experience in a large game site. The games include support for interaction other players as well as with location. The advances in games research is of benefit for specific mobile work where a vast site is both topic and resource to get the job done. We discuss how these new means for annotating the location as well as sharing information with colleagues could possibly improve individual work, collaboration as well as learning.

Introduction

The purpose of this position paper is to identify some areas where CSCW systems for work in vast work sites could benefit of emergent research on mobile pervasive games. A broad type of mobile work depends on people moving around a vast work site and conducting tasks that use the location both as a resource and a topic by itself. Such work includes infrastructure management of vast structures like roads, factories, airports and electric power lines. But it also includes work at vast storage sites such as harbours and transportation e.g. public bus systems. The mobility of the people engaged in these activities is a necessity to get the work done, but can also constrain the possibilities to establish smooth collaboration. It is hard to contact each other when people are not at hand when collaboration

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becomes an issue. The difficulties in collaboration have consequences first for the possibility to conduct the task at hand efficiently and secondly on the possibilities to learn from other colleagues. Third, the tendency is that such work be done individually and therefore it becomes monotonous. We suggest that recent research in pervasive gaming demonstrates principles and lessons that can be applied more generally in CSCW systems for mobile work in vast work settings. There are similarities between many pervasive games and mobile work in vast settings since both have locations as resource and as topic, and more general issues to draw on with regard to how a large unfamiliar space becomes a *place* that one has experience of; that one understands in a social and practical way, and can interact in.

Collaboration in a vast work site

Many forms of mobile work include collaboration and a focus on the geography both as a topic and a resource in the work. The size of a work site influence the way work is done. A vast work site has the consequence that, workers have to move around to handle tasks, finding colleagues to enable collaboration is difficult, organisational procedures are difficult to relate to specific local objects, movement in vehicles negatively affect possibilities to communicate with locally available colleagues, and mobile workers become more solitary than co-located workers.

These characteristics are present in the work of particular work tasks e.g. infrastructure management at airports and road inspection, as well as public bus transportation. An important part of airport management in Northern Europe consists of snow clearance during winter (Juhlin & Weilenmann, 2001). The snow sweeping operation involves a group of vehicles. Radio communication is used for collaboration across a vast work area, in the sweeping group as well as with other vehicles in the vicinity and the tower. The coordination of snow clearing can be understood as an ongoing interactionally negotiated practice. The tower and the snow clearers have different views, depending on their tasks and their locations. Coordination is then achieved through negotiations between different localities that take into account the changing situation in each locality. There is not one single unit with control over everyone; the control is distributed over various people, and the decisions are consequently also distributed, although this goes against regulations.

A road inspector spends most of his working day alone inside the cabin of the truck, to identify and deal with objects and defects that could disturb traffic on main roads (Esbjörnsson and Juhlin, 2002). The inspector patrols the road-network according to a predetermined schedule, determined by traffic flow and road size. A major part of the inspector's time is spent seated in the cabin of the truck, where most of the information technology is attached. The vast character of

the site defines the character of the work. First, the identification of defects demands prolonged engagement and therefore they need to get back to the same object several times, although finding the same object twice is difficult in a vast area. Second, the mobile character of the work constrains their activities. The mobility of other road users decreases their freedom of action. Stopping the vehicle is often very difficult and time consuming. Therefore, they try to remember the defect and its location when they pass by, although it is not easy to remember all the details and such memorization tends to individualize the performance of work task. It becomes difficult to share the inspection of a road section, or information on its condition.

Bus drivers' main task is to manoeuvre their bus through the chaotic reality on the roads in a predictable way i.e. following the timetables (Juhlin & Normark, 2001). This work creates an intricate web of co-ordinated public transport, but co-ordination is becoming increasingly difficult as traffic and passenger demands increase. In Sweden, a recent institutional invention called 'integrated transportation' increases the demand on coordination even further. Several bus routes are synchronised so that passengers, at designated locations, change between buses without a waiting period. The knowledge a bus-driver can get, by comparing her watch with information from the detailed timetable, is not enough to establish coordination. New centralised information systems have been tested with poor results, and the bus drivers do not engage in any specific efforts to establish integration unless they have visual cues on the whereabouts of their colleagues. Again, the vast work site obstructs efforts to collaborate.

Collaboration in mobile game settings

In all the areas above, there is a constant discussion as to how to improve work with the use of new mobile information technology. Discussion only about common technologies such as mobile phones and location tracking does not address the more complex issues of coordination, learning and articulation of work, and also the contextualised social interaction that ubicomp technology can afford. Consequently a number of researchers have turned to the techniques and systems that address similar problems are being developed in ubicomp games that draw upon both locations and mobile social encounters as resources in game play and social interaction. For our own part, we have explored these issues in, amongst other systems:

Backseat gaming (Brunnberg and Juhlin, 2003), a mobile augmented reality game that makes use of changing scenery and sense of motion during travelling. The real world passing by the vehicle acts as the world where the game takes place and the game content has clear connections to the roadside objects;

Treasure (Barkhuus et al. 2005), a mobile multiplayer game for PDAs in which players use areas of low and high wi-fi signal strength as resources as they hunt ‘coins’ and avoid or chase other players;

Road Rager (Brunnberg, 2004), a game designed to enable passengers in different moving vehicles to play against each other during a fleeting meeting in traffic, balancing the player’s engagement between system and road when the time for identification and interaction with the opponent is brief; and

Castles, a game undergoing pilot trials at U. Glasgow, that uses mobile ad hoc networks to let players share current game state, data on past play and game code modules as they move around a city, finding resources and building up ‘armies’.

These games do not just support the use of locations as resource in mobile game play, but also establish collaboration on finding and marking locations, and building up experience and understanding of those locations fit into a larger picture of social and technological interaction. These techniques could be useful for work in vast sites, which struggle with practical issues such as finding and marking locations, but also in establishing satisfying and effective ways of collaborating appropriate to the specifics of the people, places and work involved.

Some of the games above support *context dependent gesture recognition*. It includes two dimensions of context dependence. First, gesture recognition allows the player to set up and sustain interaction at the same time as they do the task at hand, which is of critical importance in the context of vast work sites. The mobile workers struggle with similar problems when they want to combine doing work with handling their own movements, whether they are walking or driving. Second, *Road Rager* and *Backseat Gaming* provide an indexical gesture language i.e. gestures’ meaning can be understood only by understanding the relation to the local or geographical context. This could be of use also in work situations where work is focused on changing the state of the surroundings i.e. transporting objects from one place to another or setting up communication systems.

Several of the key technological resources used for remote communication vary significantly in their availability and performance, in particular positioning and communications (Borriello et al., 2005). Mobile workers may at times utilize technical limitations, for example using times when they are out of mobile phone coverage to concentrate on individual work. They use areas that they know to have good phone coverage to talk to colleagues and superiors. Rather than ignore or hide such variability, a number of mobile game designers have explored ways to deliberately reveal such variations in interfaces, and even to highlight them in the interaction around them in ‘seamful’ ways, such as *Treasure*. Seamful ‘serious games’ could make workers more aware of the locations where such technical limitations do and do not occur, and helping them develop patterns of movement and communication appropriate to the locations they work in.

Where there is no communication via such networks, mobile devices can still support high-bandwidth communication and information sharing. This has been shown in games built around mobile ad hoc networks, such as U. Glasgow's *Castles* and in the Interactive Institute's *Road Rager*. Such direct connections have been used to spread game state, code updates and user activity logs for use in recommender tools, and could be used to distribute work-related information far more quickly and cheaply than via GPRS or 3G networks. We suggest therefore that workers on the move can opportunistically take advantage of the low cost and high speed of direct peer-to-peer connections between mobile devices. The social interaction around the data sharing that takes place here has been found, in games, to be as important as the data sharing.

In the work activities discussed above, the specific location is important for getting the job done. Learning how to do the job could be improved if it takes place at the location where the tasks are done. This has been utilized in recent systems where logs of user activity and associated video are used to 'replay' important events and situations, as a resource for post-game analysis and discussion of tactics (Barkhuus et al. 2005), for an orchestrator to update players with the recent significant play that they could not attend to (Greenhalgh 2000) or for players to share and discuss in developing tactics and sharing 'war stories'. In general, these systems correspond to recent theoretical work that emphasises how the history of activity and work is a resource and a constraint on work, i.e. part of the 'context' of ubicomp and collaborative systems just as much as the more immediately observable features that many system designs tend to focus on (Chalmers 2005).

Conclusion

We suggest that the new ways of enabling mobile interaction with locations as well as with remote or co-present peers open up new possibilities for work in vast work sites. Many researchers and developers are involved in exploring technological possibilities, but in this paper and in our work more generally we ground system design in user studies as well as technology development. Our aim is to maintain a balance between the grounded experience of real settings and the open-ended potential for technical functionality.

Our experience has led us to focus on four key topics. Firstly, the support of gestural and indexical reference to objects and co-workers, so that people can refer and interact in ways that fit the ongoing context of work with less of the complex specification or input of parameters that can distract from that work. Secondly, we are developing ways to help people accommodate or even take advantage of the variation of communications and positioning, designing in more 'seamful ways.' Thirdly, we are developing support for direct interaction via mobile ad hoc networks, to allow rich sharing and interaction around information

even when far from wi-fi hotspots and other infrastructure often taken for granted in lab-based research pilots. Finally, we are exploring the recording and reuse of data on situated activity, to supplement existing work resources and help extend learning and articulation of the job out into the work site itself.

Overall, we suggest that there are valuable lessons to be gained from research into games in which players create their forms of play subject to the rules of the game, the technology they use and the wider social and environmental situation. We see strong and useful parallels with the situation of workers who create their work within organisational rules but also within their wider technical, social and environmental setting. The challenge for future research is to allow such design potential to be realised in ways that build on current work practices, and yet let people change those practices for the better as they use our technology to go about their work in their way in their work community.

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