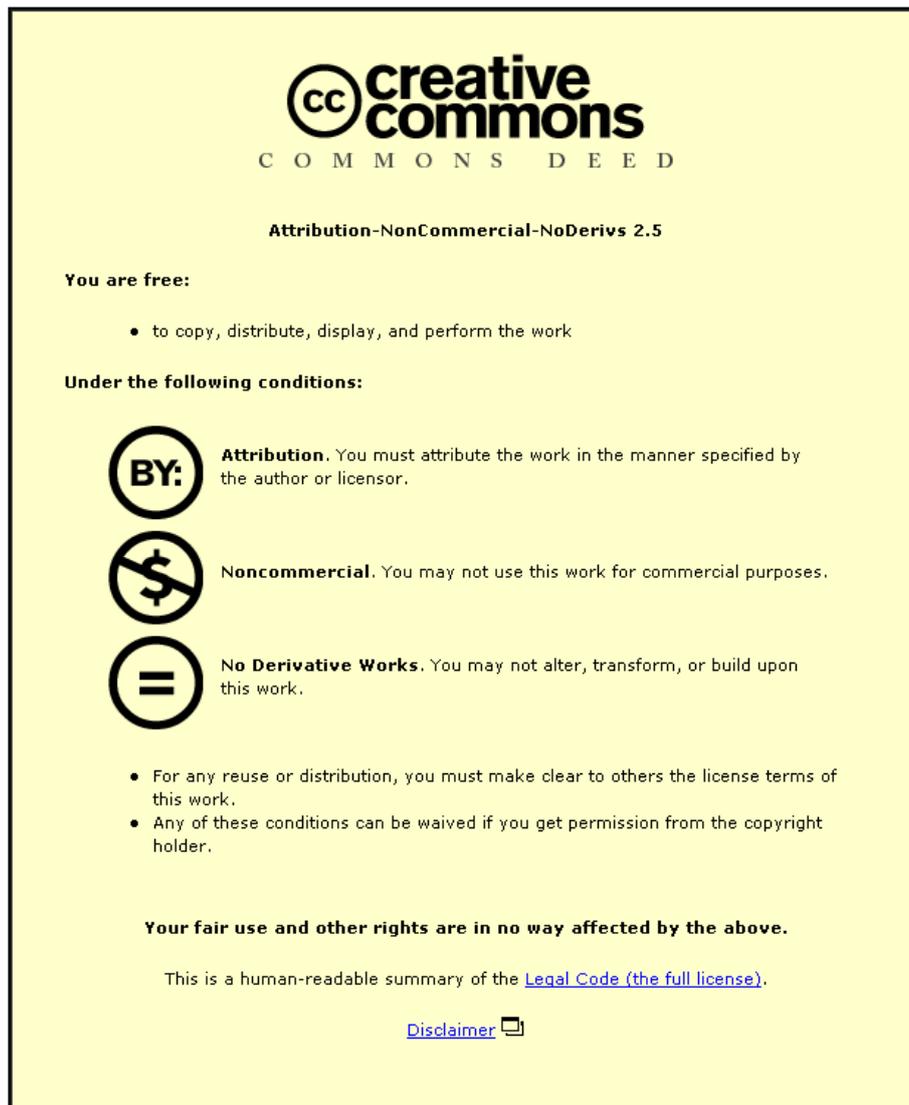




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# The Role of Spatial Contextual Factors in Mobile Personalization at Large Sports Events

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**Abstract.** This paper presents three field studies undertaken at large sports events in the UK and China, with aim of improving the user experience at these types of events through the design of personally-relevant mobile services. These field studies investigated: which aspects of spatial context were relevant within the confines of a large sporting event, how their relevance differed according to sports event and language/culture, and how they could be used to prescribe the behaviour of a personalizable/adaptive mobile device. Spatial aspects of context were found to be highly significant within the large sports arena. They can be used to maximize the relevance of information and communication services delivered to a spectator over a mobile device. A range of design implications are discussed.

**Keywords:** Spatial Contextual Factors, Mobile Personalization, Large Sports Events

## 1 Introduction

### 1.1 Background

Spectators at large scale sporting events (e.g., football matches, athletics events) provide a unique opportunity for developers of mobile, spatially-aware applications. For example, it is forecast that around 500,000 foreign and one million domestic tourists will visit the city of Beijing during the Olympics in 2008 [1]. At such multinational events, there may be diverse sporting action taking place, and spectators with a range of interests, cultural backgrounds and languages.

While technology can provide consumers with ubiquitous access to sports[2], one of the most important things for these spectators will be the quality of the user experience that they encounter when they attend events. At large sporting events, this user experience has been shown to be highly variable [3]. Reported problems include

a lack of social interaction with fellow spectators, and insufficient relevant information on the events or the sporting action taking place [3, 4, 5].

## **1.2 The role of mobile spatial interaction**

A recent workshop on mobile spatial interaction [6] has underlined the user-centred opportunities and challenges for mobile devices and applications that are spatially-aware. In particular, this workshop highlighted (1) how mobile devices can help discovery and interaction with new environments; (2) the potential to better support users' tasks and goals; (3) the importance of context in determining appropriate content and device interaction; and (4) the potential adoption of mobile services which capitalize on and promote relevant spatial interactions.

With regard to large sporting events, mobile devices have the potential to enhance the user experience by fulfilling three distinct roles: (1) support the creation and maintenance of communities at these events (engagement with the audience); (2) provide personally relevant information relating to the action taking place (engagement with the action); (3) perform a functional role to support the other activities that a user may undertake in a sporting arena (e.g. navigation, location services etc).

At a general level, it is possible to specify what the user requirements are for a mobile service targeted at spectators at large sports events, and propose design solutions that satisfy those needs. However, due to the diversity of potential users, wide ranging user goals and a variable context of use, services are unlikely to be successful unless they are *personalized*. Personalization is the ability to provide content and services tailored to individuals on the basis of knowledge about their preferences and behaviour [7]. Services must be sensitive to the contextual factors that impact on the user experience within the spatial confines of the stadium. Personalization should therefore take into account the user needs at a general motivational level (such as interest in particular sports events) as well as those which change more dynamically (e.g. a desire for more information on particular athletes within a stadium).

## **1.3 Aims and Objectives**

The overall aim of this study was to enhance the design of mobile devices/services in relation to large sporting events. The specific objectives were to:

- Identify the key contextual factors that affect the user experience at large sporting events.
- Investigate the influence of the type of sporting event and the user language/culture on the relative importance of these contextual factors.
- Identify the implications for personalized or adaptive services for end users that promote the user experience and are sensitive to contextual influences within the stadium.

## 2 Discussion of Terms

### 2.1 User Experience

This study was undertaken with the aim of enhancing the ‘user experience’ within a sports stadium. As user experience is a key determinant of the success of a (consumer) product, it needs to be incorporated within the product development process [8].

The user experience refers to the subjective experience that an individual encounters within a stadium; it is defined by the spatial bounds of the stadium, and arises as a result of the interactions that occur between the individual and other entities within the stadium. These interactions can be between the user and the sporting action, the user and other individuals (including the crowd), the user and other information sources, and the user and their mobile device. There has been considerable interest in defining user experience; within this study, a multi-dimensional view of its determinants of user experience was used, encompassing the elements shown in Table 1.

**Table 1.** Theoretical components of user experience

<b>Component</b>	<b>Meaning</b>
User factor	Emotion[8], expectations, needs, motivation [9,10]
Product factor	Usability, functionality [11,12]
Large sports event (situation-specific)	Physical and social contexts[13], interactions [8]
Social factor	Social user and creativity in use [14]
Cultural factor	Values, beliefs [15]

### 2.2 Mobile Personalization

A simple definition of mobile personalization is that it is the ability to provide content and services tailored to individuals on the basis of knowledge about their preferences and behavior [7]. Personalization has been discussed extensively in relation to mobile services [16] and the usefulness of mobile personalization has been shown in a number of scenarios, e.g. tourist guides [17, 18] and reminder systems [19]. Bonnet [20] concludes that the ultimate aim of personalization is user satisfaction. Although studies over at least a decade have addressed personalization of services, there have been relatively few studies that have specifically addressed the impact on user experience, and/or considered the context of a large sporting event.

### **2.3 Context**

Context has been discussed widely within the HCI literature, and this article does not provide a lengthy review. A broad definition of context – as offered by Dix et al. [21] is used, where context is assumed to be all things that are relevant to the interaction between a user and a mobile device. In general terms these include aspects of the user, what they are doing or intend to do, and the physical and social environment (including objects, people and resources) that an individual is operating within. For the purposes of this study, if the contextual factor can potentially influence the user experience, then the contextual factor is considered relevant.

The importance of context is highlighted by Dey et al. [22] who describe how 'a goal of context acquisition is to determine what a user is trying to accomplish. Because the user's objective is difficult to determine directly, context cues can be used to help infer this information and to inform an application on how to best support the user.' Context acquisition therefore supports personalization, as described above. By way of example, Cheverst et al. [23] described a portable tourist guide system, in which the relevant personal context can consist of factors such as the visitor's interests and previous visits to a location

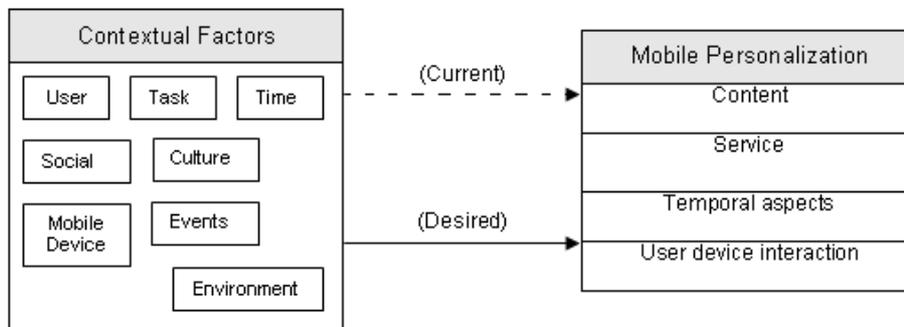
Similarly, Bradley and Dunlop [24] highlight the need to understand contextual interactions in order to maximize usability of systems. Dey et al. [25] - based on Pascoe [26] - describe four context aware capabilities that applications can support: (1) contextual sensing; (2) contextual adaptation; (3) contextual resource discovery; and (4) contextual augmentation. A key point is that relevant context may be highly situation-specific, consistent with the views of Dourish [27] that all interaction is influenced by the setting within which it occurs – implying the need to undertake situated and individual - rather than simulated and generalized studies on context and its influence.

### **2.4 The Relevance of Spatial Context within this study**

Although it has long been recognized that there is more to context than location [24], the spatial aspects of context have a particular influence on the user experience within a sports stadium. The sports event is itself usually defined within a specific physical space, with the user experience being created within that space. In addition, at any one time, the action within a stadium typically occurs at a particular physical location. This may be predefined and discrete (e.g. particular athletics events occurring at pre-scheduled and fixed locations within a stadium). It could be pre-scheduled and spatially varying (e.g. track or swimming races), or unscheduled and spatially unpredictable (e.g. the action within a football match). Of particular interest to the spectator is where the action is taking place, where they are situated, and whether their visual experience can be enhanced or augmented from a physical or virtual world perspective.

Relevant spatial context does not only refer to the sporting action, its geographical relationship with the spectator, and the location of other resources (e.g. information, facilities etc). The user experience is also influenced by the social context within the stadium, as described above. This social engagement with the wider community at a sports event depends on the locations of spectators, friends and like-minded spectators. This wider social engagement is particularly relevant for cultures such as the Chinese, where a sense of social belonging is important.

By analyzing and attempting to understand the relationship between the user experience and spatial (and other) contextual factors, it is possible to prescribe how a mobile device should adapt itself according to the relevant contextual (spatial and other) factors, as shown in Figure 1 below.



**Fig. 1.** Relationship of use of context and mobile personalization

### 3 User Studies

#### 3.1 Method

A field-based research approach was chosen based on the need to understand *situated action* [27], the degree to which user needs within the stadium were, or were not being met and the spatial contextual influences on the user experience encountered by individuals. Rather than being passive subjects, participants were considered to be *informants* and *co-designers* [28] during the event. A combination of self-report, experimenter observation, and co-enquiry was used, as described below.

During the event, each participant had a simple proforma to record unmet user needs during the sports event. 'Unmet user needs' was interpreted widely to mean a gap between the desired and realized user experience, and therefore included any of the aspects shown in Table 1. These unmet user needs were then synthesized and discussed with participants during the semi-structured interviews, described below.

Based on analysis of literature [21, 22, 23, 24, 25, 26, 27], an *a priori* assumption was made regarding the contextual factors that were relevant in influencing the user experience. These are shown in Table 2. For methodological consistency and completeness, these factors formed the basis of a prompt sheet for semi-structured interviews with the users. These interviews, based on [29], were carried out individually with participants after they had watched the event for approximately an hour. They discussed the requirements recorded by the participants, and investigated how the spatial and other contextual factors existing within the stadium would influence how a mobile application could meet their needs. These interviews specifically investigated the impact of varying context (in relation to those factors shown in Table 2) on the personalization of services to meet user needs. This covered *explicit* and *implicit* roles for spatial attributes, which is discussed in below. By way of example, participants expressed varying interest in sporting action occurring at different locations within the stadium. Interviews therefore discussed how dynamic personalization of mobile devices could take into account relative locations of spectators and the sporting action, and how this would depend on the type of sporting action that was taking place.

**Table 2.** Contextual factors summarized from the literature [21, 22, 23, 24, 25, 26, 27]

1. User Factors	2. Task	3. Environment	4. Social
Gender/age	Task type	Weather	'With whom'
Interest/preference re. sports	Task goals	Location	Co-location of others
Knowledge/experience of sports	Task importance	Noise Level	Activities of other users
Mood	Task status	Lighting	Social Atmosphere
Direction of attention	Linked task	Traffic	Group Dynamics
Motivation	Task duration	Crowd density and behaviour	
5. Time	6. Culture	7. Mobile Device	8. Events
Date	Nationality	Screen size	Events type
Time	Language	Battery	Events characteristics
		Ease of use	

Direct observation was also used to gather data on user behaviour and visible evidence of whether user needs were being met during the sports. This direct observation identified user attention to the sporting action, their interactions with other individuals (either one a one-to-one basis or as part of the crowd), and interaction with other information sources within the stadium. Although participants were aware that this observation was taking place, it was discreet by being outside of the normal line of site of the spectator. As well as enabling limited triangulation of data, direct observation was also able to capture overt user behaviours that were highly temporal in nature. An example was identifying periods of boredom during events, and then, during the structured interviews, being able to probe the participant about the factors that caused this. As far as possible, the direct observation was compatible with the ethos of ethnography [30], where the researcher is immersed in

the user's naturally occurring environment in order to collect data without imposing meaning from an external perspective.

### 3.2 Three Field Studies

The first field study took place at the Accenture Loughborough International Athletics 2007 sports event in the UK. It was an annual large scale international athletics sports events, in its 49th year. It brought together athletic teams from Loughborough University, the Great Britain under-20 and Student squads, and international athletes representing England, Wales and Scotland. It was a one day event running from 11:00 am till 6:00 pm. The stadium is modern and is used for national and international athletics events.

The second field study was conducted at the fifteenth international amateur athletics competition in Changsha, China. The event was chosen to be similar to the UK athletics event (study 1), but situated in China in order to observe the differential influence of the language and culture of the host country. It was an annual large scale event attracting athletic teams from Asian countries including Thailand, Japan, Korean, and thirty four provinces within China. It was a one day event running from 8:00 in the morning till 6:00 in the afternoon. The event took place at the HeLong stadium: an older, but recently refurbished sports stadium, with a 5000 capacity.

The third field study was carried out at a football event in China. This was chosen so that although the language/cultural aspects were the same as for study 2, the event (and the nature of the action taking place) was different to the previous study. The event was an international football tournament at Shangdong, China. It featured an all-star team from Shandong and two teams from the Spanish professional league, FC Sevilla, and Real Zaragoza. There were two competitions taking place during the events, one in the afternoon, and the other in the evening. The event was held in the 45,000-seat capacity Jinan Stadium in Shandong province. It was a stadium used regularly for professional football competitions.



**Fig. 2.** The three events being studied

Eight participants took part in each study, making a total of 24 participants split equally by gender. All participants were mobile device users, and familiar with the idea of personalization. Ages and occupations were as follows:

- Study 1: Age 18-35, mean = 22; occupations included: student, financial analyst, engineer, computer programmer, social worker and teacher.

- Study 2: Age 16-33, mean = 25; occupations included: student, news reporter, business officer, mechanical engineer, and accountant.
- Study 3: Age 19-32, mean = 24; occupations included: student, business man, technical assistant, teacher, secretary and researcher.

### 3.3 Procedure

Participants provided informed consent at the beginning of each study, and were given brief explanations of the concepts of personalization and the context of use. They attended the sports events with groups of friends as per normal. During the event, each participant used the proforma to record where user needs were unmet or only partially met, and where the audience experience could be improved.

Each individual was observed for approximately an hour; after this time, the requirements identified by them were grouped into information requirements, functional requirements and social requirements. These were discussed with the participant using the semi-structured interview with contextual prompts. This process was completed for each participant that took part, to complete the data collection for that event.

The affinity diagram technique [31] was used for the qualitative data analysis. It was used to create groups of attributes under each contextual factor. For example, social factors included the friends present, and their location. In summary, each of the eight contextual factors was sub-coded to produce a total set of 78 unique contextual factors. Most of these factors had had either explicit or implicit spatial components.

## 4 Results and Discussion

### 4.1 Contextual influences common to all studies

There were 11 common contextual factors identified by participants as influencing their user experience across the three user studies. The contextual attributes identified by 100% of participants were as follows

(1) *Preferences and Interest in Sports*. This included interest in particular sports, specific athletes and current or historical information such as record holders. Preferences and interests can be used to characterize a user [32]; however interests and preferences are also *influenced by* contextual factors. For example, action happening near to the user can arouse new and unanticipated interest from a spectator. During events, the assimilation of information that directly addresses stable or transient spectator interests was prioritized by individuals over other information.

(2) *Progress of Events*. This was regarded as a critical temporal influence [33] on the user experience and the need for information. The temporal distinctions within this study related to periods of watching events, socializing, and resting/relaxing. The

individuals' willingness to receive event-related information was related to whether they were actually watching the event, and whether they were either willing to, or wanted to divert their attention away from the event. A guide that was sensitive to the progress of events could more closely integrate real and virtual user experiences. Temporal design implications are discussed more fully below.

The contextual attributes identified by at least 75% of participants were as follows:

(3) *Location in the Stadium*. In contrast to typical mobile applications such as tourist guides [17, 18], the users' location within this study was relatively static. It included both the orientation and distance of users to the events. Users described how location played a key role in the quality of their user experience. Spectators could often only watch the competition from a particular viewing angle. Users expected to be able to view the live events from a suitable viewing angle according to their location – they wanted the benefits of real and 'armchair' spectatorship, with information tailored according to the spatial relationship between them and the sporting action.

(4) *Event Types*. Sports events were classified according to their temporal and spatial characteristics. Football was classified as a single, long-running event occurring over a distributed space. By contrast, athletics events consisted of multiple shorter events, many of which occurred at discrete geographical locations. There were specific information needs during the athletics events, which were not present during the football competition. Participants expressed frustration at not being able to follow the action from multiple events occurring simultaneously. In addition, the scheduling of multiple events during the athletics programme produced the 'temporal tensions' described by [33] which were not so apparent with continuous events such as football.

(5) *Language*. This factor was used to describe the terminology which was employed during the sports event as well as the native language of the spectator. This factor influenced the need for translation of information. In addition, the complexity of the terminology used within a sports event led to a need for simple, non-technical descriptions of the key aspects of an event, including an introduction to the rules of competition.

(6) *With Whom*. This factor refers to who you are with [34]. It influenced users' information requirements as well as social interaction. This study's participants described the need for identifying topics of mutual interest, in order to help initiate conversation with other fellow spectators.

(7) *Mobile Screen*. This physical factor referred to the potential screen size of a mobile device. Screen size influenced the desired organization of content as well as information presentation to the end user.

Four other factors were identified by at least 50% of participants:

(8) The *nationality* of the spectators, and the link with that of the athletes/teams.

(9) The *public media channels* present in the stadium.

(10) The *knowledge/experience* of the user in relation to the particular sports event.

(11) The *social atmosphere* present in the stadium.

The most interesting findings are discussed below.

#### 4.2 Differences due to culture/nationality and language

One aim of the study was to specifically investigate the impact of participant culture/nationality and language on the user experience within the confines of a large sporting event. The study included two matched events held in the UK and China, with the same event (athletics), held within similar stadiums, and with similar participants in terms of key demographics. The native language of the participants in both studies was Mandarin Chinese. Language was identified by participants as a more important contextual factor at the event held in the UK, due to the mismatch between the native language of the participants and the host language. During the study in China, language was not perceived as so important: it was therefore identified as a barrier to understanding (especially during complex events) but not as an enabler. The study demonstrated the need to support the native language of individual spectators at events such as athletics, with this being less important for football matches.

The role of culture, which meant which country (and home town or province) a user came from, also varied. During the UK study, users watched and socialized during the events as one group of Chinese spectators, without preferences for particular athletes based on their nationality. However, for the study in China, users exhibited distinct preferences for Chinese athletes, and specifically for athletes from their home town or province. In this case, the participants formed themselves into three distinct, spatially separated groups based on home provinces, with discussion and interaction largely contained within those groups. This role of culture can be explained in relation to the users' sense of belonging and group interaction [35, 36] and the important role these play within Chinese culture.

#### 4.3 Differences due to the type of sports event

The study also investigated the impact of sports event on the role of spatial and other contextual factors in enhancing the user experience. The users' *location* in the stadium was regarded as less important at the football event than at the athletics event. Unlike other location aware applications [17, 18], the spatial relationship of interest is the movement of the sporting action in relation to a fixed vantage point within the stadium. Since athletics meetings have several simultaneous events occurring at different locations in the stadium, spectators can often only actively participate in those events close to where they are sitting. In contrast, during football matches, although the focus of action moves, the movement of all players on the field mirrors the movement of the ball, and action is rarely contained within one location for long. Spectators at the football event were able to engage in the event irrespective of their physical location.

Similarly, *event progress* was a more significant contextual factor during the athletics event due to the intermittent scheduling of these events. In contrast, football was perceived as a continuous event. Windows of opportunity [37] arose during the athletics event, with quick, simple and timely information needed to satisfy user

needs. In contrast, during the football event, the temporal factor was less influential, with spectators willing to interact with a mobile device during most stages of the event, with the exception of goal scoring opportunities.

Two final major differences due to the type of sports event were the factors of ‘with whom’ and screen size. ‘With whom’ was regarded as less important during the football event as greater social interaction occurred naturally during the football event. This may have been because of the single focus of attention of the spectators, irrespective of where they were physically located. In contrast, the spatially distributed action within the athletics event resulted in less focus of spectators on common action. Regarding physical device factors, unsurprisingly, users preferred larger screens over smaller screens (but this simple judgment did not take into account the more complex trade-offs involved). However, the larger screen was seen as more important at the athletics event due to the spatially distributed action, and the potential for simultaneous display of information relating to different spatial locations within the stadium.

#### 4.4 The Role of Location

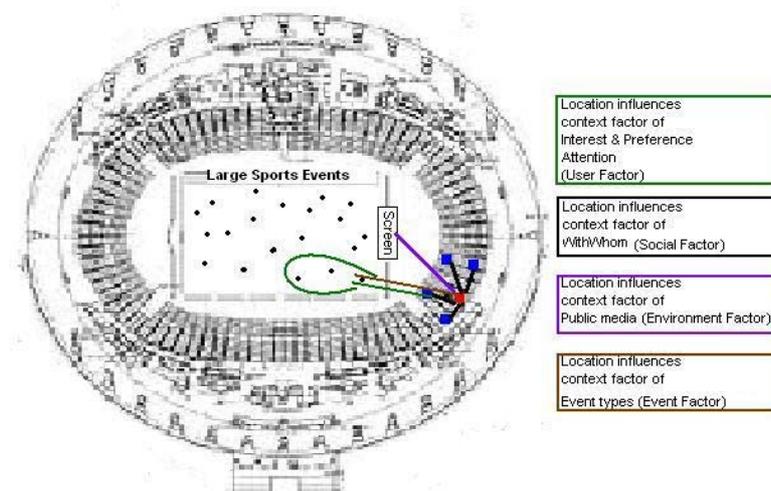


Fig. 3. The role of location in the context factors at large sports events

A clear finding from the study was that location, or more accurately the spatial relationships between entities in the stadium played a much greater role than explicitly identified by participant (see Figure 3). Users considered location to be ‘where they are’ in the stadium. However location attributes had a major impact on several other contextual factors which influenced the user experience. Location played a role in the interests and preferences of the spectator, and their focus of attention. Interest was *generated* by the proximity of events, or even seemingly trivial factors such as how athletes nearby were dressed. Similarly, action which was further away was of less interest to the spectator.

The contextual factor of ‘*with whom*’ is defined by the relative distances between fellow spectators. Users expected close (person to person) social interactions with people at a range of up to five meters. The ‘boundary’ around a physical community at a sports event seemed to be influenced by the density of the crowd. The level of interaction with the public media was also influenced by the users’ location in the stadium and the visibility or audibility of other information sources. The user experience was negatively impacted by being unable to follow publicly broadcast event information, either due to spatial factors or language barriers. Similarly, for larger international sports events, the language and cultural issues can be influenced by the spectators’ location in the stadium. The clustering of nationalities within spatial boundaries within a stadium presents the possibility for language support based on location attributes of a spatially defined demographic group.

Location also impacted differentially according to the *event type*. The relative location of spectator and sporting action impacted on the extent to which a spectator could follow an event. Provision of location-sensitive information is important in multiple, spatially distributed sports events (e.g. athletics) in order to integrate individual action within an overall event. For single events (e.g. football matches), location influences the quality of the visual experience (e.g. provision of different viewing angles).

## **5 Design Implications for Mobile Personalization**

### **5.1 Designs for Information Content**

A problem with the current user experience at large sports events is that spectators can either be lacking information that is relevant, or can be overloaded with information aimed at a general audience. A key design opportunity for mobile devices at large sports events is to use mobile personalization based on contextual factors to maximise information *relevance*. Relevance is described as: personal; contextual; depending on what has been communicated before; varying with the cognitive and affective state of the addressee; and a function of effort and effect [38].

To design information content, key influencing factors can be used as attributes to filter and supplement the mass of event information available. This can take into account static influences (e.g. spectator and athlete nationalities), relatively stable influences (e.g. long standing interests and past viewing history) and highly transient factors such as what is happening near to the individual spectator. Examples of the latter may be seemingly ‘trivial’ events, such as false starts or other incidents which are of interest mainly because of their proximity to the spectator (i.e. independent of non-spatial factors). Particular opportunities occur for enhancing the user experience when static, stable and transient factors coincide.

The users' location in the stadium and the type of event occurring can serve as attributes for mobile devices to help define relevance. Information can be provided to the spectator which is not normally available based on the spatial relationships between them and the sporting action. This may be views from different viewing angles, or information on events which are of interest but not easily visible by the spectator. Participants expressed frustration at not being able to follow the action from multiple events occurring simultaneously.

Information content can also be provided dependent on who the user is sitting with or near. If a user sits with unfamiliar fellow spectators, mobile devices can determine the common interests of co-located spectators, and provide information to help form temporary social networks. This could be as simple as providing information that can be used as initial topics of conversation. The collection and sharing of personal information introduces potential privacy issues, as has been widely discussed [39]. Some systems balance personalization and privacy concerns by only tracking preferences information. Most users are comfortable giving this information as long as it remains disconnected from their physical selves; however this does reduce the potential for preferences to be used to form temporary, spatially defined social networks. Alternatively, a solution is to allow users to easily manage the information they are willing to share with others [40].

## 5.2 Temporal Considerations

A mobile device needs to take into account the 'temporal tensions' described by Tamminen [33], and provide information according to relevant time windows. As highlighted by May [37], windows of opportunity open and then close again, and information delivery must take these windows into account. These windows influence benefit, and the expenditure of effort. In line with [38], an individual may choose to process something whose effects may be lost if not processed immediately, and ignore something which can be processed later.

Temporal influences (and hence the need for timely delivery) are highly dependent on the *type of sports event*. Windows for information delivery occur after individual events or heats within athletics meetings, and it is likely that such information has a relatively steep decay curve. In contrast, information windows occur *within* longer, more continuous events such as football matches, and information delivery needs to be integrated within the ongoing action. Some information has a short-term value, for example the finishing times within an athletics race. A simple test of temporal influences on information value is to ask whether the usefulness of, or potential interest in, information will change if it is delivered one minute later, five minutes later, 30 minutes later etc.

### **5.3 Design for Information Interaction**

Mobile personalization can include changes in the interaction mode and the user interface, as a result of key contextual factors, many of which have a spatial element. This reflects the contextual adaptation described by Dey et al. [25] based on Pascoe [26]. Depending on the users attention (which will in turn be influenced by the spatial relationships within the stadium), interaction can be overt or unobtrusive. If a user is actively engaged in an event, information can be *made available* (e.g. by SMS), rather than pushed to the user.

Information presentation also needs to take into account the type of event, the extent to which it is geographically distributed, and the physical characteristics of any device. Where events have multiple, distributed sources of action, coding or multiple 'windows' are needed to group information and minimize cognitive load. Videos and stills, including other spatially-derived views of the action will enhance the user experience where screens are large enough to accommodate them. Picture-in-picture images will enable a degree of parallel processing of events or incidents that are spatially distributed.

### **5.4 Design for Social Interaction**

Social interactions are key to a fulfilling user experience at a large sports event. Design for social interaction implies the need to encourage people to communicate and share experiences with other people within the spatial confines of a stadium [33], and mobile personalization needs to support this aspect. Mobile personalization can create opportunities for interaction with fellow spectators who sit together, by providing conversation topics of common interest, and supporting real, geographically-bounded temporary communities. However, a key requirement is to understand how the use of a mobile device for this purpose is 'negotiated' [41], since most individuals at large sports event will be strangers.

Nationality (including the home town or province) is an important attribute which can be harnessed for designing social interaction among Chinese users in particular. The studies showed how Chinese users displayed interest in information relating to where they came from, reflecting their desire for groups interaction and social belonging [35, 36]. Personalization of spatial mobile interactions can help assign individuals who are from the same place and share common interest to a virtual group to promote a sense of group belonging. It can help to emphasis group image (another important cultural characteristic of Chinese users) by presenting personalized group information and creating personalized features, such as group chants and anthems.

## **6 Conclusions**

This article describes the role of spatial context (amongst other key factors) in enabling the design of personally relevant mobile services for spectators at large

sports events. In particular, the study investigated how the user experience at such events may be enhanced by a mobile device that is sensitive to key contextual factors.

The significant aspects of spatial context were much more than ‘where I am sitting’ which was the typical term used by participants to describe this concept. Spatial attributes interacted with a range of other key influences such as users’ interests and preferences, their focus of attention, their sense of social belonging, the usefulness of public media in stadium, and the impact of the type of event they were watching. In relation to the type of event, the user experience generated by sporting activity in the stadium was impacted directly by the spatial relationships between the spectator, the stadium and the sporting action.

The design implications were based on the role that manual or automatic mobile personalization can play in enhancing the user experience. At a basic level, personalization can maximize the relevance of information to the end user by taking into account the situational needs of the spectator, and by adding value over and above other information and communication channels within a stadium.

There are several limitations to the study. Although participants and events were chosen carefully for comparison and external validity, these results are only based on a sample of 24 Chinese spectators. From each of the three studies, a duplicity of results emerged after five to six users out of a total of eight. However, it would be useful to extend the study to other demographic groups, and a greater variety of sporting events.

A final point to underline is that spectators go to large sports events to watch the action, not look at their mobile devices. A design challenge is therefore to ensure that devices enhance, rather than detract from, the user experience at such events.

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