Many-Screen Viewing: Evaluating an Olympics Companion Application

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ABSTRACT

The trend of users integrating second screen behaviours in their viewing habits, and practitioners' interest in designing systems to support them has evolved a strong research agenda. In this paper we extend these ideas to explore many-screen interaction, investigating how users, gathered around the television with multiple second screen devices, share, control and coordinate their interactions. We report on a formative evaluation into behaviours with a many-screen prototype app for watching sport programming. The Olympics Second Screen application allows users to watch, share and control highlight programmes in a collocated group. We discuss our findings through recommendations to designers and HCI practitioners. Our results suggest the importance of supporting parallel viewing between collocated viewers, and sharing and queuing of programming between devices. Additionally, results highlight the significance of the television in a viewing ecology, and user awareness of control and interaction.

Author Keywords
Second Screen; Multiscreen; iTV; User Experience

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
There is a growing trend for employing multiple screens for television viewing, augmenting the traditional TV screen with tablets and phones. This movement has been identified by a range of authors from academia [9] and industry [28], who have variously attempted to rationalise these new multiscreen viewing behaviours, revealing how they empower the user to "control, transfer, enrich, and share" [8] television viewing.

Much of this work has focused on the ad-hoc use of second screens by viewers [14,18] as they engage in media 'stacking' and 'meshing' [25]. Other work has focused on the explicit design of second screen companion applications that bring additional interactive functionality to television programmes, for example content to deepen a viewer's knowledge of characters [21], supplementary web media about the themes, topics or the actors in a programme [1], enabling viewers to share opinions and judgements through social media [2], and to access Electronic Programme Guides (EPGs) [10].

Other studies have investigated sports programming and the interplay between user-generated content, professional broadcasting and the experience of being at an event [12, 5]. Significantly, CoStream@home [12] shared user-generated video of an event and spectators' reactions between viewers at home and spectators in the stadium. Home users interacted with a second screen display merging this content with professional video. The authors present a technical implementation and a research agenda that includes embedding these interactions into the social setting of viewing.

This research has been mirrored by developments in the broadcast industry where a growing number of second screen applications are being commercially deployed (e.g., In the UK 'The Million Pound Drop' [15] and 'Antiques Roadshow' [3] in the UK both offer apps that allow viewers to play along). In spite of this wealth of technical implementation and user experience research, little has been reported about how we might understand and design for situations in which groups of viewers gather around a television and interact with multiple second screens. These we refer to as many-screen applications. How might such groups coordinate their viewing and interactions when using multiple second screen devices? How will this impact on their social interaction, and what kinds of shared companion apps might be appropriate? We therefore present a formative user study to reveal the design issues that arise when complex ecologies of devices are used for many-screen television viewing. We describe the design of a prototype 'Olympics' application that allowed collocated viewers to follow multiple simultaneous channels of sports events and associated statistics, switching them between different devices and backwards and forwards in time. We present the results of a study in which users were observed interacting with first one, then two, and then three companion devices. We conclude with a series of recommendations for the design of many-screen viewing applications.

STUDY DESIGN
Our study was designed to collect formative user observations and opinion on the impact of a many-screen application on

collective viewing of sports programming. Through both industry engagement and the development process, 3 specific research objectives came into focus that have guided our discussion and conclusions. Firstly, *(1)* how might programming and supplementary media be shared between a group of collocated viewers on a collection of devices, *(2)* how do collocated viewers consume a schedule of television programming and associated many-screen content across an ecology of devices that changes size, and *(3)* how does the many-screen approach alter the viewing experience, beyond dual screen and more traditional viewing practices?

To answer these questions, we first constructed a prototype sports companion app as described below. We then studied this app being used by groups of three viewers at a time, who were given increased access to display devices. We recorded user interactions on video and interviewed them as a group afterwards to discuss their experiences. We conducted these formative investigations in a laboratory setting, which permitted the close observation of user activities and allowed for the study to be constrained to the precise behaviours of our interests, specifically the introduction of additional screens during the study period and the availability of content.

Industry Engagement

The study was developed during a period of immersion within a corporate setting in order to foreground industry relevance. The BBC's R&D lab was approached due to their extensive experience within the multiscreen context. Over recent years they had deployed several multiscreen applications, maintained a research interest in their development, and were keen to prototype and investigate the potential of second screen technology, especially for use in sports broadcasting. Academic literature also supports sport as a salient genre for the development and user acceptability of second screen programming[16]. The development process was informed through a series of formal discussions with both sports producers and software developers. The purpose of these discussions was (a) to highlight and respond to the issues surrounding second screen systems and (b) to establish relationships that would allow for an on-going, iterative design process.

Prior to our engagement with the BBC they had received critical acclaim for their broadcasting of the 2012 Olympic Games and were keen to build on these achievements. At peak times during the Olympiad they broadcasted 26 simultaneous video feeds. We took this as an opportunity to engage with the possibilities around a multisport tournament, where the action unfolds concurrently across a number of different events. We therefore built an application that would allow for the watching of highlights of the Olympic games across a number of devices, while also supporting additional statistics synchronised with the video programming.

Application design

The prototype Olympics Second screen system is comprised of three separate applications that communicate with each other: a television that can display a single video stream; a remote control app for switching the television channel; and a second screen app that runs on a tablet and that can simultaneously display other video streams and/or associated statistics. In the study, the television application was deployed through a desktop PC (also running the server) connected to a large flat screen, while the remote was deployed to a smartphone and the second screen app to a 9-inch tablet.

To allow for rapid prototyping, each of these components was built using HTML5 web standards, communicating through a server that delivered the video and supplementary content, keeping the components in sync with each other.
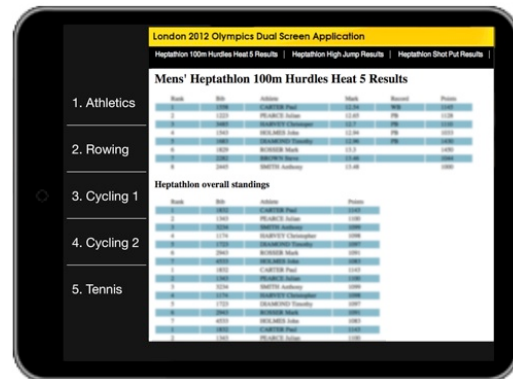

Figure 1: Olympics Tablet Application

Our study applications provided the following functionality:

'Broadcast' a schedule of television programming: The application recreated the effect of a broadcast so that programmes of highlights were only available to users to select and watch at specific times. Each channel therefore had a 'live playhead'. Unlike a regular playhead, which increases with user progress through a video. The live playhead charts time passing, again allowing for a replication of a live broadcast. If the user selected to watch a particular channel, the video would start playing from the live playhead.

Control the television from a second screen and remote application: Both the remote and second screen applications could control the television. Both devices allowed the user to pause, rewind and fast-forward the video. Fast-forwarding was only an available option however when the user had rewound the programme, as would be expected from a PVR on a live television broadcast. The second screen application offered a richer selection of control options for selecting a programme than the remote, which only allowed users to watch programmes from the live playhead. On the tablet application, users could select between watching a programme from the start, resuming where they were last watching (on either the second screen or the television) or from the live playhead.

Augment video programmes with statistics and other relevant information: Each of the available programmes of highlights had an associated feed of statistical updates about the events in the video. These updates were available to users on the

second screen app and were only available after the event had been watched on the television or the tablet.

Video could be played on the second screen application and the television: In addition to the second screen application being used to view statistics and control the television, users were able to watch the video content directly on the device.

Multiple second screen applications could be connected to the television: The system was designed so that any number of second screen application instances could be connected to the television. In the user trial discussed here, users had access to between 1 and 3 second screen applications at a time.
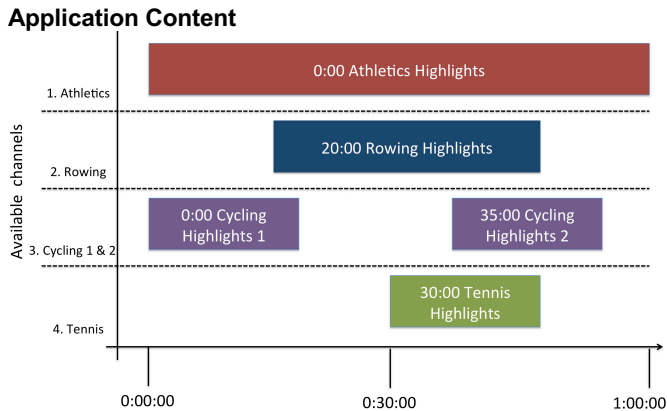
Application Content

Figure 2: Application Trial Programme Schedule

For our study, we constructed 5 channels of content, Athletics, Rowing, Cycling 1 and 2, and Tennis. Each of these feeds consisted of edited video highlights from the London 2012 Olympics along with an associated statistics feed, which contained a series of updates on events results and additional stories about the video feed. For the purposes of our study, this content was scheduled to generate a 'golden hour', where the most exciting moments would coincide across different channels, requiring our viewers to make decision about which to watch and how best to employ their various second screen devices. Our study was conducted approximately one year after the games, and while we were therefore unable to encapsulate the excitement of witnessing the games live, our study schedule allowed for the replication of a highlights broadcast. Many of the study participants relished the opportunity to revisit the events and to see moments that they had missed during the Olympiad. The programming was also scheduled to play out during the trial so not all of the channels were available at the same time, as shown in Figure 2. Finally, the application would not allow viewers to fast-forward beyond the current 'live' playhead as this schedule unfolded.

STUDY PROCEDURE
At the start of the trial, the workings of the application were explained to the participants and they had the opportunity to ask questions about its functionality. While the researcher prepared the application the participants were asked to discuss, with the help of the programme schedule, how they would make use of the time they had to watch, stating

preferences and organising content between devices. Participants were then asked to watch Olympic Highlights for approximately 50 minutes, attempting to watch as much content as they could in the time. At the start of the trial period participants had access to a single tablet, the television and remote control. An extra tablet was given to the participants to use 20 minutes into the trial and then another tablet at 35 minutes. We also provided a pair of headphones with each tablet, although it wasn't indicated when or whether participants should use them. We video taped our participants using one camera located below the television set pointing back at them and another behind them looking over their shoulders, to maximise coverage of their activities, providing us with views of their interactions with each other and also with the various tablets.

At the end of the study period participants were asked to complete a short semi-structured interview, explaining their experiences with the application. Questions centred on user opinion of the application, how they managed the content across the devices and what they believed to be the effect of adding additional tablets during the trial.

The assembled data was analysed thematically. Coding key moments of interaction, collaboration and user error from the trial video recordings. Additionally, user opinion and reflections were codified from the interview data. These nodes were subsequently ordered into high-level categories. In the following section we report on the key themes that emerged from this analysis.

RESULTS
30 participants, 16 male and 14 female, completed the study. We recruited participants in groups of three, who knew one another well and watched TV together. Three groups were comprised of work colleagues (groups 1, 2 and 9), a further three groups of students (6, 8 and 10) and 4 groups of friends (3, 4, 5 and 7). All participants were aged between 16 and 65 and experienced with smart devices. We asked users to talk about their experiences of second screening. In all groups at least 2 participants responded that they used their devices while watching, to augment viewing, by playing along or looking up further information. However, only 2 participants had used dedicated second screen applications.

We begin by summarising their general opinions about the application before focusing in greater detail on how users organised their local ecology of devices, how they shared devices and how they used them to control the content.

General opinions
General responses to the application were broadly favourable from the large majority (27) of participants who could see it being embedded in their television viewing practices when watching the Olympics or indeed, when viewing in general. Several responded that they could imagine using the application in a family situation where they were balancing viewing tensions between them. For example S102 (study

group 10 participant 2) describes how she could imagine using the tablet to watch the gymnastics allowing S101 the television for watching athletics. S31 and S21 highlighted how the application's stats feature could be part of a more social experience.

S21 *"The TV is inherently social. Everyone sits down together the bits of the application that go with that are being able to look up stats and negotiating what goes on the main screen."*

Three of the participants offered negative opinions. Two were reticent to engage with the multiple features of the application, describing a desire to just watch television without interference from the tablet:

S91: *"television would be the main focus [...] If I was with other people. Say in your living room watching something. My principle concern would not to look like I was distancing myself from them by bringing that out [point to tablet.] Unless we had said 'ooh about such and such, lets look it up'".*

A further participant criticised the inability of the application to capture the wealth of information about events above those offered by services on the open Web.

Broadly speaking, other participants were more positive. Nine stated that they found the statistics feature to be a welcome addition to the Olympics experience, offering more depth than the TV programme alone could provide, reinforcing findings from earlier studies, such as of Basapur *et al.*'s companion device [1]. Positive opinions were also shared on the application's ability to offer the individual user more freedom in viewing within the group, such as being able to control the television from each device and watch what they wanted on the tablet. In the following sections, we look beyond this initial feedback to describe participant behaviour and opinions central to the research objectives on many-screen television watching.

Ecology size, sociality and the arrangement of devices
As the trial progressed and the number of tablets available to participants increased, the configurations employed and the sociality of users changed. 8 groups of participants responded positively to the increase in the number of tablets, stating a preference for the individual experience, the freedom of making their own selection, and a sense that they weren't keeping others away from a limited resource.

S12: *"At the start with the iPad I shared out info which people asked for or I found interesting, when more came in I hogged the one tablet"*
S13: *"In real life you would always want your own iPad you wouldn't want to be sharing it"*

As well as highlighting a preference for having more tablets available, this quote is also indicative of behavioural differences between users sharing a tablet and having one each. When the participants only had access to one tablet, we observed a number of sharing practices where the group decided who would use the tablet, and they would be called upon by others to relay additional information about what they were watching as a group on the television (we discuss this in greater depth in the section titled Focus and sharing). As the number of tablets increased this sociality was observed to decrease; in instances where all three participants were using a tablet to either watch video or reading statistics, they appeared to be more isolated from each other.

One user felt that the social situation in which they were watching would influence how available tablets would be utilised. This suggested that limited access to tablets could spark sibling disputes, as they fought over getting to use the tablet, and social situations where the sharing of information between friends would be used to spark discussion and debate.

S53: *"If you had the one tablet and you were siblings that you would probably fight over it [...] but if you were mates"*

Additionally, when faced with a single tablet, participants were forced to more carefully consider how the devices were distributed between them and which devices the content was played on. Group members stated preferences for particular sports or events and the group tried to accommodate these while organising who was going to use the tablet and what was playing on the television.

S31: *"if we start by somebody watching cycling on the tablet and two of us watch athletics on there."[...]*
S33: *"can I have the tablet?"*

The role of the television
For many users the TVs role in the ecology was as the 'big screen', the preferred focal point for viewing, if it could be negotiated between users. When important events such as the men's 100m final were coming up, users would switch from watching on the tablet to the TV if they could.

S13 (watching on the tablet): *"The men's 100m is coming up"*
S11 (Holding the remote): *"let me know if you want it on the big screen"*

This interchange was typical of discussions around the men's 100m final, often seen as the most prestigious event of summer Olympic games. It is worthy of note that all our study groups watched this event on the television during the evaluation.

Headphones and sound
where both devices where generating sound, participants had issues with sound overload when trying to watch video simultaneously on the television and on the tablet. 7 of the 10 study groups experienced this issue. Different strategies were however adopted to rectify the problem. Group 2, for example, attempted to balance sound across each device so that the tablets were loud enough to hear, but did not disrupt the television. However this approach was quickly dismissed and headphones were used. Alternately, groups 9 and 10 turned the volume down on the tablets and used them just as visual video displays, relying on the on-screen graphics for contextual information. In all other instances however groups

opted to use the headphones that were provided to watch the video feeds on the tablets.

S41: "It's a bit much if you've got more than one thing going on at once. But the other time using headphones made it feel a bit more asocial than otherwise."

Users wrestled with the sociality of wearing headphones while watching together in a group and our results show a distinct dichotomy. Some felt that the wearing of headphones, so as not to disturb the viewing of others, was the socially responsible action. Five other participants however felt that by isolating themselves from the rest of the group wearing headphones was an antisocial act; one that took them away from communal viewing on the television. 4 users were observed trying to rectify these social issues by wearing the headphones so a can covered one ear only and the other was able to hear the TV and conversations of the other viewers.

Focus and Sharing
We now consider some of the ways in which our participants shared their tablets.

Requesting and showing
We observed two ways in which statistical content available on the tablet was shared between users. The first of these was by request; when a user, who wasn't using a tablet at the time, would ask another user to answer a question for them about what they had seen on TV or to add credence to the discussion the group were having about the events or results.

S103: "so did she win it or not."
S102: "get some stats up"
S101: [looks at the stats feed on their tablet] "she came second [...] they got the same time [...] oh you get get the photo finish."

The second mode of sharing was when a user would see something of interest on the tablet and pass it on to the others. This was also used as a method of scheduling, determining what content to play next on the television or other tablets. Although our application didn't have EPG features, we observed several examples where users would engage in a dialogue about what one another were watching on the tablets, and the availability of channels, when making decisions about what to watch next and how to balance the available content between the devices.

S42: "oh I think this might be it. Yes this is it [men's 100 metres]"
S41: "you want to get it on [the television]"

We recorded a number of ways in which this content was shared between those participants with a tablet and those without; most obvious of those was verbal communication. Other practices were however employed, which maybe of more interest to designers, as participants made use of these personal devices in a much more public way. Frequently, participants would lean in to see what was on another tablet or the tablet would be held out and turned round so that other

participants could see what was on it. We observed this particularly with graphical content on the tablet. Where a photo finish, an image of an athlete or video clip couldn't be fully conferred to the others through explanation.

S23: It looks like a mug shot or something. [S21 leans over to see tablet]
S22: Is that the tennis things
S23: No [shows tablet to S22]

Using the tablet to queue up content for the big screen
Group 10 exhibited a distinctive and especially structured approach towards using tablets in relation to the television, by using the tablet as a preview screen for queuing up what they wanted to see next on the television. While one channel was playing on the TV, the group would have another running on the tablet, which they would keep an eye on from the location of the coffee table. When an upcoming event of interest was spied on the tablet. it would be paused. When the event on the TV was finished, the channel playing on the tablet would be resumed on the television at the same point as it had been paused on the tablet. The channel that had been playing on the TV was then resumed on the tablet and the process would repeat, hopping between the two channels. When an additional tablet was made available to the group, this was used as a further preview screen.

Watching alone
Although sharing was common, it was not always the case as tablets allowed for an individual to be able to watch their choice of video content while the rest of the group watched another channel on the television. This functionality was used by at least 1 participant in 9 of the study groups, at some point in their collective viewing.

Content control
Both the remote control and each tablet offered a mechanism for controlling the television channel and the playhead in the video stream. During interview S72 referred to this as "a bombardment of controlling the same thing in many different ways". During our study this led to users from 5 groups being unable to identify who was making changes to the state of the content on the television. For example, if a user was interacting with the tablet and another made a change to the television station they would become concerned that they had inadvertently changed the TV station by mistake.

S82: Oh what's happened there was that me
S81: Was that you. Did you do that [S83 nods]
S82: Ok just making sure that wasn't me

While mistaken actions and confusion between control mechanisms was characteristic of several groups' experiences, some used this for mischievous ends. S83 for example subjected his colleagues to multiple renditions of 'god save the queen', strategically rewinding so that the medal ceremony looped repeatedly. This was compounded as other members of the group realised that removing the remote control from the

offending participant didn't stop their behaviour, as they could use the tablet in the same way. S23 and S22 referred to this as S21 "Still having the power" despite them having removed the remote from his reach. During the interview S13 talks about how he could see the applications and the multiple points of control as being the "source of fights" with friends while watching, suggesting also that the amount of simultaneous choice leads to everyone having to make compromises about what and when they watch certain events.

Liveness

The application allowed participants to pause, rewind, fast-forward and play TV channels independently on different devices. This led to users from half (5) of our groups having issues with comprehension both when they were watching live and when they were watching 'replayed' (somewhere behind the live playhead) events. Part of the problem was the lack of visible representation of where they were in each video, as the application didn't offer visibility of the video playhead, relative to the live playhead, or of overall progress through the programme. This also led to confusion as to whether the fast forward functionality was available. We observed 7 groups try to fast-forward beyond the live playhead in an attempt to skip past programming that they were not interested in, unaware that they were already watching live.

This confusion around liveness and a lack of its visibility were especially apparent when a viewer switched the television to a channel that another was already watching on the tablet, where either of these devices was not watching at the live playhead. This could cause the especially painful problem of 'spoilers', in which one device would prematurely reveal the result of an event that was being watched on another device. For example while watching the athletics on their tablet, participant S82 rewound to get back to the start of an event. Sometime later, their colleague S81 changed the TV channel to the athletics as well, but in 'live mode'. As a result, S82 got to see the result of the event too early. Group 7 experienced similar problems where the television channel was changed while S71 was watching the same channel, leading to the exclamation "they are happening at the same time but different times".

DISCUSSION

We organise our discussions around five key implications for the designers of many-screen television applications, grounded in our findings on the nature of watching television across a number of devices. We draw upon literature from iTV, mobile television and broader HCI fields to substantiate our proposals. We also suggest several avenues our findings suggest for future research in this field.

1. Support parallel viewing: At first glance, the desire to concurrently view a programme on a personal device *and* a television, whilst collocated with other viewers, seems an unlikely use case. However, the majority of the participants in our evaluation responded positively to this functionality and could envisage usage scenarios where this style of interaction

was a welcome addition to their television viewing experience. This finding is supported by D'heer *et al.* [13], who allowed users to consume their personal viewing choices alone, while still being a part of the living room family dynamic.

As was seen in our evaluation, the watching of video on the television, simultaneously with other devices, raises issues with the delivery of audio. Previous work in the mobile television field has reported a user dislike for wearing headphones while watching the TV [7,20]. Whilst it wasn't many of our users' first choice, headphones quickly became the chosen option. However, users did try and utilise the headphones in ways that allowed them to remain a part of the wider sociality of the experience, with some users abandoning headphones altogether and watching the video feeds on the tablet without any sound. Users who adopted this behaviour found it to be an acceptable way to watch sport programming, relying instead upon on-screen graphics.

Not only did supporting parallel viewing afford viewers opportunities for agency in what they were watching, potentially balancing domestic tensions, but it also provided a unique method of television scheduling. We discuss the consequence of this in the next implication.

2. Support Scheduling, Queuing and Sharing: Unlike other studies into EPGs, which provide mechanisms by which users could see what events and programming were about to start [10], the Olympics application did not offer this feature. Instead, users engaged with content on the tablet, through both the video and statistical feeds, utilising the range of control mechanisms on the tablet and remote applications to ensure that the most exiting content was shared on the television for all to watch and enjoy.

Complex viewing behaviours, most notably that of queuing, were enabled by the applications 'resume' feature, allowing the user to resume playback from the tablet on the TV, and from the TV on the tablet. This feature was particularly important in allowing users the freedom to schedule their viewing across the feeds, ensuring they saw as many key events as possible. However, users suggested the option to play content on the TV or the tablet from the start of an event, offering a potentially more elegant solution. In light of this, we would recommend in building-in a resume playback function between devices, or a mechanism by which viewers could skip to key moments of the action. This feature offers the desirable opportunity to allow users to perform ad-hoc scheduling of content as the situation unfolds. Subsequently we see opportunities that build on this functionality, especially in relation to complex sequencing of sports events observed in our participant groups such as groups 10, who queued up the next event on the tablet before switching the television to it at the next opportune moment. In this context interactive mechanisms would allow users to collaboratively generate playlists of events and content they wish to see.

Our ecology of tablets was "fluidly" coupled. This, in theory, allowed users to make use of as many as they desired. Our evaluation suggests a relationship between the availability of tablets and sociality. Where viewers were sharing the tablet between them there was an enhanced sense of sociality, more sharing and discussions. Therefore, restricting the number of tablets that can be used in a given situation may allow designers the opportunity to play with the social dynamics of the viewing groups. Terrenghi, *et al.* [27] summarise that an understanding of the scale of a display ecosystem can be helpful in establishing the design space. Our finding mirrors this idea, suggesting that being able to tailor the ecology to specific numbers of devices may be helpful in informing the design of effective socially grounded systems.

3.Maintain User Awareness and Respect the Big Screen: Users struggled to understand which of them was controlling the TV when presented with a range of devices, all of which were capable of making these changes. In preceding HCI literature on awareness, Bier & Freeman [6] suggest the concept of per-user feedback, highlighting the user making changes on the communal display groupware device. Projecting which user or device initiated an action on the television is a potential solution to this problem. However this raises further design issues and opportunities. We witnessed 'bad behaviour' by several participants, exerting too much control on the television and our participants observed that this might arise in 'real life' situations, such as squabbling children. Future work could look at design solutions that mitigate this kind of conduct and better democratise viewing between the group members.

The television has long since been considered as a cornerstone of domestic life and plays a key role in the social environment that surrounds it. Not only does its physical presence in a room play a part in the home but also the content that is broadcast through it [26]. Silverstone's descriptions of the TV in the domestic environment describe it as a slowly evolving landscape. While a minority of our participants responded negatively to the intrusion of the tablet application into their television watching practice, this was not a view shared by all. For many though, more ready to accept the opportunities of many-screen viewing, the television was still principle within the hierarchy of viewing devices that users interacted with. The big screen was always the preferred place to watch the most significant events and exciting moments.

4.Acknowledge Liveness and the Impact of Spoilers: We observed users struggling to establish a sense of whether they were watching live or whether they were watching from an earlier location in the video programme. As discussed in the previous discussion point, these issues might be ameliorated by improved feedback to the user, informing them whether they are watching live and any impact this has on fast-forward functionality. Issues of liveness led to instances where viewers were potentially seeing spoilers on the television of events they had yet to see on the tablet. The impact of spoilers has been considered, given the distribution of PVR systems

and social media services [22,23]. Our findings suggest that spoilers can come from other places, for example where multiple users are simultaneously watching the same programme, at different points in the narrative, on different devices. Designers of many-screen apps could use a number of strategies to reduce the possibilities of users seeing spoilers, either by blocking future content on the television until all users have caught up, or by providing adequate warning to viewers of potential spoilers.

5.Recognise the Complexity of Gesture and Attention: O'Hara *et al.* [24] reflect on the complex uses of personal mobile devices and their utilisation with video, in the home. They found that often the experience of watching is not limited to the individual user, but is shared in complex ways. We witnessed participants behaving similarly, both with video content and the statistical feeds in the application. They would shift focus and move in closer to see the relatively small screen, or it would be held aloft by users to show others what they were seeing, diverting attention away from the television.

This has implications for technologies that try to track the viewer's gaze. Prior work in the television literature has focused on attention as an important factor in measuring the impact of programming and advertising. Often these investigations have used gaze tracking as their principle methodology (see [17] for an overview). More recently, gaze detection has been employed in multi-feed sports broadcasting on a single screen [11] and second screen systems [19]. Looking towards the deployment of many-screen television systems, this line of inquiry is evidently a useful direction and one that we are confident will continue. However, we also saw that sharing of content and focus on devices was embedded within the complex social setting of viewing. In applications that make use of complex vision systems to obtain interaction from the user, such as those proposed by Dezfuli *et al.* [12], the system will be required to untangle the mix of social queues and gestures, involving the smart devices and those which are intended to address the ecology and instigate action [4]. The design opportunities for fostering these systems will come from a deeper understanding of the way content is shared between users and attention and gesture are directed at different devices within a local ecology.

CONCLUSION
We have detailed and discussed the findings of a formative user study into the implications of many-display devices on second screen television viewing. In preparation for our study we developed the Olympics second screen app. The application allowed viewers to revisit highlights of the 2012 Games across a range of devices. Our findings lead to five implications for designers and practitioners involved in the development of these systems, which came to the fore through our work. We observed a number of ways in which sharing of content was enabled through the use of multiple devices. This led to a recommendation to support viewers in queuing up content on a tablet before then 'pushing' it to the big screen of the television for communal watching. Parallel viewing was

observed to be a further way in which users enriched the experience of watching together. Enabling viewers to watch alone and have agency over the second screen device, even in the collocated environment, was positively received, in certain social settings. These practices however resulted in challenges to users' understanding of liveness. They struggled to maintain comprehension as to the point they were watching in the broadcast across several devices, between multiple participants. These behaviours therefore highlight the importance of on screen viewer feedback in reducing user confusion and avoiding the possibility of spoilers.

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