Towards Cross-device Harmony
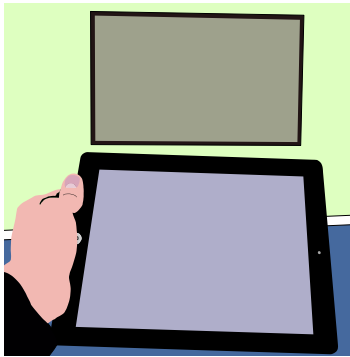

Figure 1: A dual-screen use case – in such scenarios, the users switch their attention between the motion rich TV and the second screen companion content (in this example on the tablet). Though both displays can be considered the primary focus, research shows that generally the more motion rich TV content becomes the 'primary' display. Here the user is holding up the tablet so that the displays meet. However, the device is typically rested on a user's lap (discussed in Figure 2) on the next page.

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Abstract
In modern home entertainment, our personal devices regularly supplement some 'primary' screen. Such layouts of screens in the living room afford enhanced autonomous browsing, collocated interactions, and give broadcasters the opportunity to enhance TV through multi-device experiences. TV/personal device scenarios are becoming one of the first ubiquitous cross-device situations, and therefore stand as a potential exemplar of the use case. Our research looks at the potential attention bottlenecks in such scenarios, and works towards improving such experiences through informed design of attention.

Author Keywords
Dual-screen; companion content; television; attention; user experience; media; displays; media

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

Introduction
The infrastructure for exciting, multi-sensory, cross-device experiences lies in our hands, and adorns our walls – by bringing along our handheld devices, we open up a new world of personalised second screen
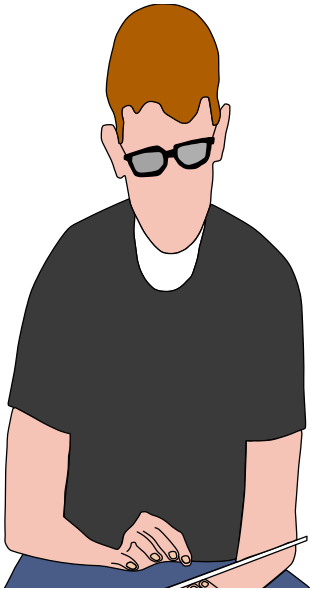
content. The inherent portability, connectability, and sheer computing power of such devices make them prime candidates to supplement larger displays (e.g. Smart TVs) with complementary multimodal stimuli and additional interaction possibilities. Much research has documented how we may appropriate existing technologies to engage in complementary multi-device consumption of media. Therefore, many broadcasters and application developers have began leveraging such research to design between-device media as the next step from beyond traditional linear broadcast.

There are, however, some confounds when it comes to such scenarios – as we divide our attention between devices we create a disjunct between displays. In this workshop paper we reflect on the TV for HCI communities' reflections on attention across devices with an aim to further consider how this applies to cross-device interactions generally.

Context & Brief Background

We increasingly watch TV accompanied by a second screen – we Google tangential information in programmes, social network, or simply browse the web. In 2012, Google suggested that 77% of us second-screened regularly [2] (a statistic later revised up to 87% by Accenture [3]). Predominantly, this growing practice is done on smartphones, tablets, and laptops.

Clearly, then, this use case (Figures 1 and 2) is ubiquitous and (unsurprisingly) broadcasters now wish to lever this enthusiasm for dual-screens to enhance UX. To support dual-screen experiences content providers have began developing companion applications –

material developed for second-screen handheld devices that run alongside a TV programme, providing relevant facts, quizzes, and social media content. With the increasing proliferation of internet-driven media and object based broadcasting (see [6]), this area of multi-device media is quickly accelerating and therefore people are considering its fundamental design.

There are many recent commercial examples of programmes which utilise a second device with supporting material (e.g. [4]). In addition to this, much literature in the HCI for TV community explores this scenario from an academic standpoint, to support content creators. Further, for such cases, some work (e.g. Brown et al. [1]) has investigated how attention switches for dual-screen companion content.

Currently dual-screen experiences require users to manage their own attention across displays – they are often overloaded with information to the point where they cannot engage with content as its designers envisioned. Moreover, the visual disjunct between the foci (see Figure 2) can mean users fixating on one display. This, coupled with the inherent cost of display switching [8], negatively impacts on UX.

Due to the lack of thorough investigation on this topic, the dual-screen experience is fundamentally *undesigned*. Therefore, our research looks at how we may better design cross-device media to encompass attention, and design towards experiences in which the displays are complementary, and harmonious. To this end we have been building on the literature by conducting preliminary interviews, designing interventions, and conducting systematic studies with users. We, by working with our industry part-

Figure 2: In companion content scenarios users tend to switch attention, as opposed to divide. Typically, users rest the device on their lap, in their peripheral – creating a visual congruence between the foci. This means they must constantly check the device for new content when focusing on the TV, and monitor the auditory stream of the TV for points that pique their interest.
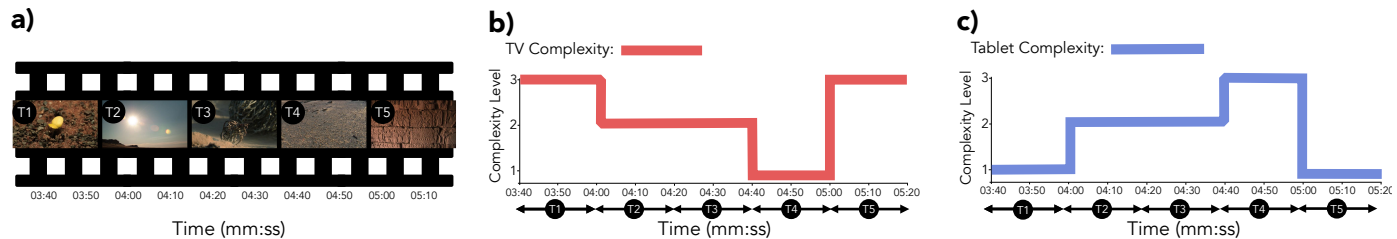
a)

b)

c)

Figure 3: Content *curation* process: a) video is broken down into 20 second time slices; b) complexity of TV content is determined; c) complexity of tablet content is determined by inverting the TV complexity value. Figure from [5]

ners (the BBC), are refining our idea of what creates a positive multi-device media experience through proper cross-device attention management.

Work so Far

To establish the current experience of the dual-screen use case we conducted interviews with participants about their usage habits. In general we found early on that there are some clear attention bottlenecks. For example, when users view content on their phones (be it social media or related web content) they, generally, to some degree need to make some sacrifice – to try to 'block out' one device, in favour of another. Though we can monitor content in our peripheral, in either the audio of visual domain, it requires extraneous effort.

To explore this more systematically we conducted a lab study in which participants watched TV accompanied by companion content – related textual and graphical information (e.g. Figure 4). The independent variables were the companion device's textual and graphical complexity. In general, we saw increased visual attention and increased effort required

as the complexity was increased, more so for textual information. We then associated this with our qualitative data from the participants to learn better what TV content requires more effort as the second screen complexity is increased.

Using our qualitative data we established a set of observable and codeable behaviours in the presence of varying complexity, and from this developed systems in which the complexity on a tablet computer adapted (we term this *curated*) based on the complexity of the TV (see Figure 3). We then compared this to a baseline and an adaptable (by the user) case and found that such methods complement more 'lean back' companion experiences. In addition, we found a degree of variability in the participants who enjoyed the adaptable UI. Some, who were more engaged with the second screen material actively increased the complexity of the content. Whereas others, who wanted to engage with the companion content less, turned down the complexity so that they could gain a better gist of the materials. These studies culminated in the work presented in [5].

Figure 4: Example of a simple piece of trivia typical of companion content. The users are free to swipe through such trivia or view as a slide show. This was used in the mediating attention experiment, and in the work of Brown et al. [1].

Figure 5: Example on an on-TV notification. Such calls to action are often found in current interactive TV, for example encouraging users to follow a hashtag, or press the (BBC) red button for more information.

In our work, we have also considered how we may move a participants gaze between displays. For example, in [7] we looked at a variety of methods to notify users we looked at how we may mediate attention between the foci. For example, we found that if we wish to command attention shifts quickly and effectively we should use peripheral stimuli (on the tablet) of either audio or visual medium. And that if we wish to permit some degree of autonomy to the users calls to action on the TV work effectively (Figure 5). Further, we found that in contexts with updating information that users strongly preferred their attention to be mediated to some extent, to avoid over/under-attendance of a device.

In summary, we have so far looked at key areas of concern in the dual-device media scenario, and have investigated solutions to alleviate. In the future, we hope to reflect on how we may glean insight from the increasingly ubiquitous use case that is multi-device TV, towards considering how we may better design complementary UI for general (non-media) cross-device scenarios.

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