Peripheral Interaction with Desktop Tangibles [2][3]

The Form of Peripheral Interaction – A Framework for Experience Design

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Abstract
By analysing a set of applications drawn from diverse domains yet all facilitating interaction on the periphery of the user's attention, this paper derives a framework of four qualities that can be used to characterize the desired experience of peripheral interaction in general.

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ACM Classification Keywords
H.5.2 Information interfaces and presentation (e.g., HCI)

Introduction
In its early stages, the potential of Calm Computing, which "engages both the center and the periphery of our attention" and "moves back and forth between the two" [11], was realized in the form of ambient information displays. Exploiting the opportunity to not just sense but to act on the periphery of our attention, my PhD dissertation explored what I called *peripheral interaction*: "any kind of interaction with objects – physical or digital – that do not occupy the typical centre of the user's attention" [2](p.20).

Since my focus was on tangible interaction for desk-based office work (see sidebar, this page), I also offered an expanded characterisation of the qualities of peripheral interaction in this context:

> *"Peripheral interaction is about episodic engagement with tangibles, in which users perform fast, frequent interactions with physical objects on the periphery of their workspace, to create, inspect and update digital information which otherwise resides on the periphery of their attention."* [2](p.20)

In additional descriptions, I emphasized the "digital, cognitive, and social use" of peripheral interaction with tangibles [2](p.22), especially for activities that are "auxiliary" to the focal work activity [2](p.21). I later clarified these statements as relating to *peripheral tangible interaction* [3], a proper and distinct subset of the more general category of peripheral interaction.

Bakker [1] has done much to populate this broader category, especially with regard to the attentional and cross-modal nature of the periphery. In this paper, I revisit my earlier definitions in light of this and my own subsequent work, expanding them into an experience-oriented design framework. This framework, in contrast with the taxonomic dimensions by Hausen [6], offers four qualities that can characterize the experience of a system designed for peripheral interaction.

Example Use: FireFlies

As an example application of the framework, consider the FireFlies system (Bakker [1]) for primary school classrooms.

Feeling of interaction

Light-objects displayed in front of each child support *economy of orientation* for the teacher through peripheral awareness of the light colour distribution.

The teacher-tool allows the teacher to set the colour of a child's light-object by first selecting the colour and then the child's name. Combining these two steps would improve the *economy of action*, as was suggested [1](p.137).

Clipping the teacher-tool to the teacher's clothing (e.g., belt) reduced the feeling of encumberment compared with a wrist-worn device (e.g., the prior NoteLet prototype) [1](p.122), increasing tool availability and the resulting *economy of transition*.

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The FORM framework

My definitions of peripheral tangible interaction (PTI) can be unpacked into four parts:

1. **Feeling**. PTI can engender a feeling of economy through "fast, frequent interactions", but how else might such feelings arise?

2. **Organization**. PTI can facilitate "auxiliary work activities" embedded in the focal activity, but how else might activities be organized?

3. **Rhythm**. PTI can follow a pattern of "episodic engagement", but how might different episodes of interaction be connected over time?

4. **Meaning**. PTI can consist of "digital, cognitive, and social use" of tangibles, but how might other media be used in such meaningful ways?

The Feeling of Peripheral Interaction

Peripheral interaction can lead to feelings of economy compared with achieving the same goals though sequential actions that need complete attentional focus. Three major sources of interaction economy include:

ECONOMY OF ORIENTATION

Peripheral interaction systems can help users to orient their attention towards potential interaction goals. In my desktop PTI system [2][3], tokens provide passive physical reminders of tasks to do, documents to work on, and people to follow. In my subsequent work on mobile micro-learning, flashcard applications provide active orientation towards items to be reviewed at opportune moments (based on location for MicroMandarin [5] and forgetting for MemReflex [4]). The common benefit is the reduced need to remember.

ECONOMY OF ACTION

Peripheral interactions can be crafted to achieve multiple goals at once. In my desktop PTI system [2][3], nudging a token in a particular direction simultaneously selects both a digital object and the attribute assigned to that direction. In my work on presentation tools, SidePoint [11] analyses slide text and offers related "knowledge snippets" in a side panel, allowing peripheral monitoring of potentially useful information while authoring slides. The advantage in both cases is the reduced number of actions required.

ECONOMY OF TRANSITION

Peripheral interaction can help to parallelize multiple activities. In my desktop PTI system [2][3], these are focal and "auxiliary" aspects of the same work activity, performed in adjacent physical spaces at the desktop. In my work on exertion gaming [7][8], virtual spaces connecting physically distant exercise sites support fast switching of attention between exertion, game, and social goals. Such reconfiguration of the environment can reduce the cost of activity transitions.

The Organization of Peripheral Interaction

Peripheral interaction can itself be configured in multiple ways with respect to the overlap between the focal and peripheral activities. All help to reduce the risk of the peripheral activity from becoming neglected or forgotten. Prominent organizational forms include:

EMBEDDED ACTIVITY

My desktop PTI system [2][3] embeds auxiliary work activities in the context and flow of focal work activities performed on a desktop workstation. This organization has the benefit that auxiliary tasks created through the focal activity can be acted upon immediately.

Organization of interaction

As an open-ended technology for primary school teaching, FireFlies can be seen as potentially facilitating multiple organizations of activity.

It can support the *embedded activity* of communicating with children about their current work [1](p.129), as well as the *background activity* of staying aware of children independent of their work [1](p.131). Another possible use could be to develop background games based around children's vigilance to the teacher changing their light colour, creating a *coupled activity*.

Rhythm of interaction

The rhythm of interaction with FireFlies might vary over different scales of interaction.

At a high level, interaction might be seen to follow *regular intervals* throughout the day. At the intermediate level of lessons, interactions might follow *contracting intervals* as the teacher checks the general progress made in the lesson.

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BACKGROUND ACTIVITY

In my flashcard applications for mobile micro-learning [4][5], the goal is to encourage learners to "identify and exploit the many moments during the day where other distractions are temporarily halted and attention can be diverted" to learning [5] or other activities, e.g., updating social network status [9]. In all cases, the persistent potential for background interaction could encourage more frequent and habitual interactions.

COUPLED ACTIVITY

Exertion gaming [7][8] involves the creation of game mechanics and interaction devices in ways that couple physical exertion and social interaction, even when players are geographically separated (e.g., [8]). This organization allows peripheral engagement with one or more sub-activities (e.g., exertion, social interaction) while focusing on another (e.g., winning the game), all in the context of a fundamentally new, hybrid activity. The benefit is that several independently focal activities can be combined into a single schedulable session.

The Rhythm of Peripheral Interaction

While the granularity of episodes of peripheral interaction has already been suggested as a design dimension [6], peripheral interactions addressing the same goal (e.g., to complete a particular task [2][3] or learn a particular word [4][5]) can themselves follow different rhythms that shape the overall experience:

REGULAR INTERVALS

Peripheral interactions for social purposes (e.g., following the availability of a colleague through their contact token [2][3] or playing exertion games with distant friends [7][8]) typically follow a regular pattern with the goal of maintaining social relationships.

CONTRACTING INTERVALS

Peripheral interaction with work items often increases in frequency as deadlines approach, resulting in contracting intervals between item interactions. An example from my desktop PTI system [2][3] is using a task token to track time spent on a task and estimate the time remaining. An example from my PitchPerfect tool for presentation rehearsal [10] is the anticipated increase in rehearsal frequency as the talk approaches.

EXPANDING INTERVALS

Intervals between peripheral interactions can also expand over time as the purpose of those interactions is fulfilled. An example from my desktop PTI system [2][3] is using a document token to interact frequently with a document as it is being created, but then with reduced frequency as the document stabilises over time. Another example from my spaced-repetition flashcard applications [4][5] is that each test of an item strengthens memory for that item, meaning that the intervals between successive tests can be increased.

The Meaning of Peripheral Interaction

Peripheral interaction can be meaningful in ways that are instrumental, cognitive, and social, cutting across different input and output media and modalities:

DIGITAL CONTROL

A main purpose of peripheral interaction is to access or update digital state, e.g., work information through subtle physical actions on augmented tokens [2][3], game state through exertion with the physical body [7][8], or the state of learning systems through regular mobile and desktop interaction [4][5][10].

At a low level, interaction between the teacher and any particular child may well follow *expanding intervals* as the child first indicates that they are stuck and the teacher then helps them to overcome sticking points until they make a breakthrough.

Meaning of interaction

Although it uses digital technology, FireFlies does not offer *digital control* over any persistent digital state. Future designs with fixed colour meanings could benefit from tracking and analytics over time. This would trade-off against the free use and open interpretation of colours, however, which can currently be used to create ad-hoc *memory cues*, e.g., about which children have yet to be visited in person. The primary use of FireFlies is for *social communication*, and the redundant representation of the distribution of light colours through a soundscape highlights the potential for peripheral interaction to cross the boundaries of any one medium or sensory modality.

MEMORY CUE

Peripheral interaction can support the creation and use of memory cues. Digital cues, e.g., from adaptive flashcards, can prompt both visually [5] and aurally [4]. Physical cues, e.g., PTI tokens [2][3], can prompt passively through their arrangement and annotation.

SOCIAL COMMUNICATION

Peripheral interaction can also support various forms of lightweight social communication. This can be mediated physically, e.g., through the exchange of tokens representing certain rights and responsibilities [2][3], as well as digitally, e.g., through virtual spaces [7][8].

Using the framework

As with many design frameworks, the FORM framework can be used in multiple ways. Firstly, it can *establish aspirations* for designers thinking about the desired experience of interactions prior to more concrete design work. Secondly, it can *systematize analysis* of a design and its peripheral interaction qualities, encouraging broad consideration of fundamental concerns. Thirdly, it can help *standardize language* for designers talking and writing about their systems, their design choices, and the inherent trade-offs among them.

Conclusion

Through analysis of both my early definitions of peripheral interaction with tangibles and the peripheral interaction qualities of my non-tangible systems, I have presented a highly provisional framework for the design of peripheral interaction in general. When designing a system for such peripheral interaction, this framework can help designers to map out the qualities of the desired experience and ultimately shape the final form of the system and its broader interaction design.

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