Evaluating Peripheral Interactions

Wendy Ju
Center for Design Research,
Stanford University
424 Panama Mall, Building 560
Stanford CA 94306 USA
wendyju@stanford.edu

Abstract
One of the key challenges in the design of peripheral interactions is discerning whether the intended interaction will work as intended: Does it accomplish its functional goals? Does it do so appropriately? Does it have more or less attentional cost than desired? Because the interactions in question are non-focal, it can be difficult to ask users about their design directly, or to employ standard UI or UX evaluation techniques. This paper expands on the unique factors involved in evaluating peripheral interactions and outlines some novel techniques that my colleagues and I have developed to accomplish this task.

Author Keywords
Peripheral interactions; implicit interactions; video prototyping; field studies; evaluation techniques

Introduction
As computational and electronic components grow smaller and less expensive, and as the reach of networked technologies grows ever more ubiquitous, we find ourselves interacting with computers and interactive devise in ever more contexts and scenarios. While these technologies can help to provide information, assistance and support in a wide variety of applications, they also introduce novel challenges for design. The assumptions, principles and techniques developed for people working desktop computers at work, or playing their living room game consoles at home need to be modified to account for the fact that nowadays people are often interacting with computers and interactive devices in non-focal ways; often the interaction is to-the-side of a person's central focus of attention, and it would be unsustainable to have every device demand attentional focus to function.

One of the keys to design is the iterative design cycle. This cycle has been modeled by numerous design theorists in different ways (e.g. Express-Test-Cycle, [1] Analysis-Synthesis [2] divergence-convergence [3] Designers of novel interactions need evaluation tools and techniques to assess and characterize the how people respond to different designed interactions. Designers of peripheral interactions have all the challenges associated with evaluating interaction designs: that people have to evaluate a pattern of behavior rather than a static dimension, that the interaction often needs to take place in a particular context, that there is a chicken-and-egg problem with the interaction to be designed and the technology needed to support that interaction. In addition, they have to contend with the fact that users often, by

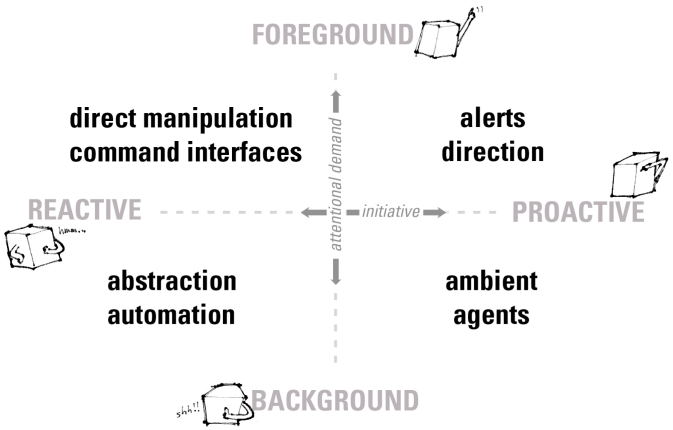

Figure 1. The Implicit Interaction Framework characterizes interactions by their attentional demand and their initiative.

design, do not notice the interaction that is to be evaluated, and often interact with peripheral interfaces tacitly, almost subliminally, so that they themselves are not sure exactly what should occur, only whether things feel more right or more wrong.

Point-of-View

I personally have been engaged for many years on the design of implicit interactions, which use physical movement and other implicit means of signaling in the pattern of dynamic and responsive behavior between two or more entities. For my research, I have proposed a framework that divides the interaction space by attentional demand (from foreground to background) and by initiative (from proactive to responsive), and I have shown through design examples and controlled studies how successful implicit interactions move through the space of the framework over the course of an interactive exchange. [4].

The Implicit Interaction Framework builds on Bill Buxton's concept of attentional ground [5]: "What we mean by Foreground are activities which are in the fore of human consciousness—intentional activities. Speaking on the telephone, or typing into a computer are just two examples." Buxton's definition of foreground overlaps only with the left half of the implicit interaction framework; he only considers the realm of user-initiated interactions—typing into a keyboard, or switching on a light. Hence, this definition conflates attention with intention, making it inadequate for describing device-initiated interactions—a cell phone ringing, or an automatic door opening. These interactions clearly take place in the foreground but are not at all intentional on the part of the user. As we move into the realm of computational devices, where often it is the device that is leading the interaction, the importance of initiative in determining the right path through the attentional space becomes more obvious and critical.

From the perspective of my work, peripheral interactions are those that take place in large part in the attentional periphery—as opposed in the attentional focus. However, by my framework, and that of Buxton's, peripheral interactions must at some point cross into the attentional foreground, even if just for a few seconds, even if the interactions are non-verbal or non-graphical. My own research argues that the locus-of-agency for these transitions, when interactions move from the attentional background to the attentional foreground and vice-versa, is an important factor. In my framing, peripheral interactions are *communications* with a sender and receiver, and the dynamic of who sends what message when is critical to the nature of the unfolding interaction.

Special Characteristics of Peripheral Interactions

From the perspective of evaluation, peripheral interactions are distinct from focal interactions in some key ways:

1) By definition, in a peripheral interaction the recipient's attention is shared with at least one other task.

Peripheral interactions take place in a context where multiple things are happening; any evaluation might need to invoke or take place in that context, and with the other tasks at play.

2) Even if the recipient has attention to spare, the peripheral interaction may be beneath attention.

Key aspects of peripheral interactions might evade notice; musicians in a quartet might be focused on starting at the same time and not notice the way that the deep preparatory inhalation or the speed of the lead violinist's bow cues that timing.

3) The sender's role in the peripheral interaction is sometimes subtle or even unconscious.

Beyond not requiring attention, it may even be that the person employing a peripheral interaction gets tripped up or confused if they try to focus on the peripheral interactions they employ, much as people have difficulty tying knots if you ask them questions about how they do it.

4) The rules of how a peripheral interaction should unfold are usually tacit.

We all know how to, say, use our body to shrug "I'm sorry" when we come into a classroom late and try to work our way into an empty seat in the middle of the auditorium—but it would be difficult to articulate what to do or how to recognize this behavior to another person or system.

5) Peripheral interactions are often highly contextual and even culturally specific.

Although there are generalizable patterns in the way that peripheral interactions transition through the attentional and initiative space, the specific gestures or cues often rely upon the interactants ability to decipher deictic references to the objects, affordances and activities involved.

Some Evaluation Approaches

Here are evaluation approaches that my research colleagues and I have used as ways to understand how people employ peripheral interactions, or to evaluate what factors matter in making for good or bad peripheral interactions. We often use a mix of these approaches simultaneously as the situation demands.

Field Studies

Because we are often looking for people's naturalistic response to an interaction, in terms of timing and attention, we often employ field studies of peripheral interactions in quasi-public spaces. This helps fix the context of the interaction, and helps to establish ecological validity for the interaction.

Wizard of Oz

To understand the factors that matter for a design, it is often better to fake the interaction than to build a system that really works. This approach always raises objections from engineers, who feel that it is important for realism's sake to use a real system. However, in terms of exploring interaction, a faked system is more flexible, and allows the designers to explore a wider design space than any existing system, which necessarily has trade offs and compromises built into its design. From the interaction perspective, the only thing that matters is that the interaction feels real

enough to the user that they can behave or respond naturally.

Video Prototypes

Video prototypes allow designers and researchers to capture important situational or scenario-based aspects of interaction, which can be particularly important to peripheral interactions. By staging the context the interactions are designed for, we can better determine if the designed interaction is situationally appropriate. In addition, a video prototype can show a first- or third-person view of the interaction; for instance, we can film the video as if the viewer were interacting with a device, or if they were watching someone else do it. One important aspect of creating video prototypes for evaluation is that the videos be natural enough not to be "selling" the interaction to the viewer. In fact, it is best if the viewer can see several videos of alternative interactions to compare and contrast rather than just having one to evaluate.

Crowdsourcing

It can also be useful to use the fact that everyday people have basic intuitions about how to manage the timing of interactions and the right degree of attention to demand. By designing systems that make it easy for people to puppet or wizard of oz novel systems, we can learn important design principles or patterns.

Mini Case Study

It can be useful to understand how these different types of evaluation can be used throughout the design and evaluation of a peripherally interactive system, and so we would like to highlight a study we made of gesturing automatic doors. [6]

To understand the effect that gesturing doors might have on people's perceptions of and behaviors around gesturing automatic doors, we needed people to be encountering the doors as they would "in the wild" as they were on their way from one place to another. In this study, 1) we first experimented with people's responses using Wizard of Oz gesturing of the doors using a hidden human operator and a lever to push open the door, 2) we had others puppet the doors and talk through their theories of what the doors should do with us, 3) we ran field studies with several different gesturing conditions and then chased down people to have them answer a questionnaire after the fact, and 4) we ran online within-subjects studies using crowdsourced respondants to evaluate video prototypes of a person interacting with a gesturing door.

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