TOWARD INTIMACY IN USER EXPERIENCE:
ENDURING INTERACTION IN THE USE OF COMPUTATIONAL OBJECTS

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ABSTRACT

Affective aspects of user experience, like friendliness and pleasantness, are said to be too subjective to be assessed by user-evaluation approaches. This paper connects the issue of affectivity to bodily experience, providing a theoretical reflection on the topic of engagingness in terms of sensory perception, motor action, and cognitive operation. It introduces the idea of "enduring interaction," grounded in phenomenology in philosophy, to refer to the phenomenon of continuingly engaging interaction within constantly changing computational environments, as opposed to the discrete, conversational type of computer-human interaction. Enduring interaction emphasizes the temporal pattern of user engagement with an interactive system. The author argues this new design perspective would lead to intimacy, which explains a user's affection for a design. With design exemplars from mechanical and digital artifacts, the paper shows how the framework assists in analyzing user experience of varying intimacy and opens up possibilities for creating more affective computational artifacts.

Keywords: affective user experience, interaction design, sensorimotor experience, phenomenology, temporal

INTRODUCTION

User experience has become one of the major concerns of interaction design. Practical dimensions of user experience, including usefulness, efficiency, effectiveness, and usability, have been well addressed in the tradition of human-computer interaction and have become scientifically "measurable" by empirical user-evaluation approaches. In contrast, affective aspects like friendliness, familiarity, and pleasantness, are commonly seen as "subjective." They are difficult, and also controversial, to assess. Although some researchers conducted empirical user studies evaluating related subjective qualities (Dehn & Mulken, 2000; Rozendaal & Schifferstein, 2010; Serenko, Bontis, & Detlor, 2007), purely empirical analyses might not be sound to art and design practitioners, who are mostly from the humanities disciplines. The situation is like evaluating the quality of a work in an art gallery, or a movie in an art cinema, by requiring visiting audiences to give scores on the work. The results do serve as references on the reception of a design strategy, but might not prove the logic behind a design. As Lars Hallnäs puts it, between empirical findings lies "a fundamental gap" (Hallnäs, 2011). She thinks that foundational design notions are required to augment empirical research results. The author of this paper also believes that theoretically grounded design perspectives are key to providing new interpretation and orientation for defining and achieving those subjective qualities of user experience. This paper offers an interdisciplinary design perspective on the topic of engaging experience, explaining why people feel familiar and intimate to a design object. The idea underpins the affectivity of user experience.

Why do we focus on engaging experience? What kinds of artifacts require our particular attention on this aspect? Everyday design objects by convention afford people to use, to act upon, rather than to engage. For example, a bed affords a person to lie down and sleep. Meanwhile, some use cases can be more complex. A task chair affords one to sit comfortably, allowing him or her to concentrate on the desktop work. A sofa may afford people to sit even at a reclined position, occasionally letting one engage in the television at the front. The television in contrast is intended to afford one's engagement in the media content. Unlike traditional single-purpose design things, today's computer-based devices afford our engagement in diverse kinds of activities. People sometimes use a laptop computer to shop online. A user looks at images of different items and then selects one to add to the shopping cart by a mouse click on the button "add to cart." The website then responds with an updated list of selected items in the cart, followed by further options like "proceed to checkout" or "continue to shop." Every discrete choice (a mouse click) results in a discrete response by the system. The input and response sections take turns, showing a conversational style of interaction. It is a feedback loop engaging the user in a turn-based exchange of intention and information.

On the other hand, a laptop computer also affords users to play video games, such as first-person shooting games. A user looks at images of all the computer-controlled characters, or NPCs (non-player characters), and quickly identifies an evil one. Without thinking about which buttons to click, the user agilely moves the gun sight by sliding the mouse, or by running finger across the touchpad. The bodily action embodies the user's intention: The gun sight has moved in the direction he or she intended. Meanwhile, the targeted NPC flees, and the user just continues to chase. The input and response sections go on in parallel. The user is continuously and simultaneously engaged in motor action (to slide the mouse) and sensory perception (to look at the animated NPC). This use case scenario demonstrates a type of engaging experience, in which interaction mobilizes an enduring motor-sensory feedback loop. We call this phenomenon "enduring interaction."

In contrast to the discrete, turn-based conversational style of interaction (commonly featured by the point-and-click mechanism in many graphical user interfaces), enduring interaction emphasizes the continuous, parallel, and non-verbal form (e.g., bodily motion) of interaction between users and systems in terms of motor action and animation. Enduring interaction engages users both bodily and conceptually. Users continuously perform motor action and simultaneously perceive animated feedback from systems. Meanwhile, they make meaning through the sensorimotor experience. In the aforementioned case of first-person shooting games, for instance, the user understands the power relation with the targeted NPC based on its action and reaction, and instantly determines the next tactic. Another common example is a user running fingers over a laptop computer's touchpad and seeing the virtual panel scrolling in a window as a result. That user might be provoked to imagine the scrolling process as reminiscent of panning a camera over the background. In short, these users are concurrently engaged in motor action, sensory perception, as well as cognitive operation like imagination. Through this kind of repeated engagement, as the paper shall show later, users are able to develop habitual abilities in an environment in order for more sophisticated cognitive power, resulting in familiar and intimate feelings. That is why users love the related interactive products.

(Chow & Harrell, 2009) has described the processes of imaginative meaning-making involving significant motor-sensory interaction. This paper elaborates on the form of motor-sensory interaction enabling the meaningful engaging experience. It first grounds the notion of enduring interaction in a synthesis of existing theories, and suggests centralizing the temporal aspect of computational artifacts as the key to creating bodily and conceptually engaging experience. It then delineates two temporal forms of engagingness, which focus on how artifacts change over time in response to use, including both the active and inactive. Design examples finally illustrate the embodiment of enduring interaction in an array of interface engagement varying in intimacy.

ENDURING INTERACTION

This section focuses on how enduring motor-sensory interaction enables a feeling of intimacy, which finally leads to affection for an environment. According to the phenomenological views of Maurice Merleau-Ponty on bodily motion and Gilles Deleuze's cinematic philosophy on the perception of time, we are informed that users can develop habitual abilities by exercising bodily motion and sensing changes in a world. This habituation gives users a sense of familiarity in an environment. In interaction design, this goal can be achieved by mobilizing two sides of the motor-sensory connection: (1) motion-based user input and (2) a constantly changing environment.

MOTION-BASED INPUT

To phenomenologist, our bodies are able to develop motor habits through experience, turning unfamiliar behaviors into habitual abilities and then opening up possibilities for doing something increasingly sophisticated in the world (Russon, 2003, pp. 29-30). Through repeated practice, our bodies "absorb" the motor knowledge and take care of our everyday motion (Dreyfus, Wrathall, & ebrary Inc., 2006). This motility is seen by Merleau-Ponty as "basic intentionality" (Merleau-Ponty, 1962, p. 137). It reveals our consciousness as "not a matter of 'I think that' but of 'I can'" move "our body toward something" (Merleau-Ponty, 1962, pp. 137-139). In other words, bodily motion exercised in space and time embodies intentionality. This dictum underpins the notion of enduring interaction.

As movement takes place in space and time, our body also "inhabits space and time" (Merleau-Ponty, 1962, p. 139). As Merleau-Ponty puts it, "I belong to space and time, my body combines with them and includes them" (Merleau-Ponty, 1962, p. 140). Meanwhile, he tends to dismiss the river metaphor of time, saying that time is "not like a river, not a flowing substance" and "it is not the past that pushes the present, nor the present that pushes the future, into being" (Merleau-Ponty, 1962, p. 411). Merleau-Ponty's doubt regarding the more-or-less ongoing linear ordering of past, present, and future echoes Gilles Deleuze's cinematic philosophy.

CONSTANTLY CHANGING ENVIRONMENTS

Deleuze uses cinematographic perception, particularly manifested by the moving camera and montage, to argue that time is not alternating sections of sensory perception, but constantly changing wholes involving concurrent segments of varying saliency and attention. He calls the "becoming" whole, which is "to change constantly, or to give rise of something new, in short, to endure" (Deleuze, 1986, p. 9). I add that cinema makes this "becoming" perceptible to humans, that is, scales it appropriately to the human body and human perception. This idea of perception resonates with Merleau-Ponty's views that "sight and movement are specific ways of entering relationship with objects" (Merleau-Ponty, 1962, p. 137). Hence our bodies, in phenomenological terms, "absorb" the newly habituated skill to sense time in a "becoming" world. With this sense of time, our bodies develop more sophisticated motor habits so as to free up our focused attention to explore further possibilities in mental phenomena like enjoyment or imagination.

Therefore, exercising bodily motion in a constantly changing environment is a means for us to develop ability and absorb knowledge, that is, to demonstrate intentionality. This notion of embodiment complements the theoretical framework of enduring interaction.

TEMPORAL FORM OF USE

Through exercising bodily motion in a constantly changing environment, users experience habitual engagement in an interactive object with a new sense of time, resulting in development of sophisticated power in a world, which is, an embodiment of intentionality. Empowered users feel at home, a sense of familiarity, while this home is also full of unknown possibilities. One can elaborate feeling or imagination from the experience at hand. The situation is analogical to playing musical instruments. When a player develops the dexterity with the piano, he or she does not attend much to the keyboard but instead focuses more on picturing the visual rhythm. This room for imagination and expression makes one enjoy spending time with an artifact. More examples about time spent with interactive objects will be discussed in the next section. Now this section first validates the value of temporality in user experience and delineates the fundamental form of use in time.

The two qualities of enduring interaction, motion-based user input and constantly changing system output, jointly describe the temporal aspect of this bodily experience. Emphasizing these two qualities in the design of interactive products means a centralization of temporality in user experience. This design perspective particularly applies to computational objects, addressing a latest well-recognized phenomenon in design.

As John Maeda puts it, “dynamic surfaces” of computational objects drive users’ perception and designers’ attention away from the spatial dimension to the temporal (Maeda, 2000, p. 25). Ramia Mazé and Johan Redström further comment that “the ‘surface’ for expression” should include the temporal dimension m, 2005). By “surface” they mean the perceptible form (usually through interfaces) of computer programs during execution. Hallnäs regards the execution of programs, or in computer science terms “processing,” as the materiality of computation – “a new temporal material,” because it appears only in run-time, or in Hallnäs words, only when the computational things are “in use” (Hallnäs, 2011). Using a computational object means perceiving and experiencing the temporal material of computation. For user experience to be engaging, design of computational objects should focus on the “pattern” of the temporal material, that is, when and how users perceive and act upon the output of processing, how and when the processing continues in response to use. This goal can be achieved by incorporating motion-based input and constantly changing environments, the two qualities of enduring interaction. They specify the temporal form of use.

Based on the two qualities of enduring interaction, temporal form of use can have two states, corresponding to how an artifact’s surface, or interface, changes over time in response to two states of use: Firstly, the common conception of use – acting upon the artifact; secondly, a more holistic view of use – doing nothing but sensing the artifact.

STATE 1: ACTIVE USE

In the first case, the interactive artifact’s surface changes continuously in response to the user’s bodily action.

An analogy: Use of the VTR jog dial

Consider the jog dial of a video tape recorder (VTR). When the user spins the dial, the finger motion, including speed and direction, conveys the intention of going forward or backward at variable speed. (Figure 1) Meanwhile, the machine winds the videotape forward or backward accordingly and instantaneously displays the corresponding part of content. The output constantly changes with the motion-based input.

Figure 1. A user spins a jog dial to play video forward

STATE 2: INACTIVE USE

This state describes the exceptional case that the artifact’s surface changes continuously in response to inactive use. That means the user is still using and engaging in the artifact, but taking no action.

An analogy: Use of a French press pot

An illustrative example is using a French press pot for brewing tea or coffee. After pouring water into the pot with coffee powder, the user covers the lid and then just waits. Taking no action does not mean nonuse. Instead, the user is sensing the gradual change of color and the aroma. Once the user feels that those signals meet the intended concentration, he or she starts to press the filter. (Figure 2) The output keeps changing while there is no user action.

Figure 2. A French press in inactive use and then active use

TEMPORAL PATTERNS OF ENGAGEMENT

Enduring interaction particularly applies to the use of computational objects. The two qualities, motion-based input and constantly changing output jointly describe how and when a user acts and a system presents. They inform different patterns of users' engagement in a system, including:

- Alternating engagement
- Overlapping engagement
- Sustaining engagement

The names describe different temporal patterns interwoven by users' motor action and sensory perception. Alternating engagement means user input sections and perception of system output sections are alternating, which is the turn-based conversational style of interaction. Overlapping engagement refers to the time when the two sections overlap and synchronize. This pattern corresponds to the first temporal form of use described earlier. If perception sections sustain even after an action section, the engagement is sustaining. It refers to the second temporal form of use.

This array of engagement patterns provides a model for designing surfaces (i.e., interfaces) of computational objects aiming at more engaging user experience. Identifying the temporal pattern of an engaging experience with an artifact informs designers of promising ways for facilitating (or empowering) users to develop familiarity, to more immediately exercise intentionality, and to elaborate possibilities for imagination and expression in everyday life. As a result, users feel satisfied. To illustrate, we analyze interaction mechanisms of some existing interactive artifacts, including both mechanical and digital ones.

ALTERNATING ENGAGEMENT

Alternating engagement mainly refers to the conversational style of interaction with artifacts or machines. The mechanism, like formal verbal dialogue, involves discrete sections of user input and system feedback taking turns alternately. The ordered connection of these sections is the "immobilized" and "fixed" nature of the environment. This kind of environment usually requires the user to follow the alternation and might not open to new possibilities.

The use of mechanical typewriters is a typical example. The typewriter responds to each key tap by the typist with a corresponding character strike in sequential order. When a typist performs any one stroke without waiting for the feedback of the preceding tap's completion a jam occurs. In other words, the input and feedback sections cannot overlap. This mechanical constraint leads to strictly alternate sections, resulting in the defining characteristic of alternating engagement. Moreover, alternating engagement usually involves no motion-based input, not to mention constantly changing environments. In typing a text, the typist only needs to attend to the timing of each tap. Other parameters of bodily action like the direction from which the finger hit a key or the speed of reaching a key could exert no significant influence on the outlook of the printed text.

The phenomenon of alternating engagement seems to be a result of the mechanics of an apparatus, yet this type of engagement should not be thought of only limited to mechanical artifacts. In fact, examples can be found in digital environments as well, including the command-line environment of MS-DOS (Figure 3) and the point-and-click mechanism in most graphical user interfaces (Figure 4). In these cases, a system always takes a user input, whether it is a tap of the "return" key or a mouse click on a button, and then responds accordingly. The system does not immediately process the next input until it completes the current output. If no input arrives after output, it waits indefinitely. Clearly the alternating pattern is a matter of design conventions, not physics as in the typewriter example. The user could only focus on the alternating stimuli-and-responses pattern and is forced to act out intentions only sequentially.

Figure 3. A command listing a directory content in the MS-DOS environment

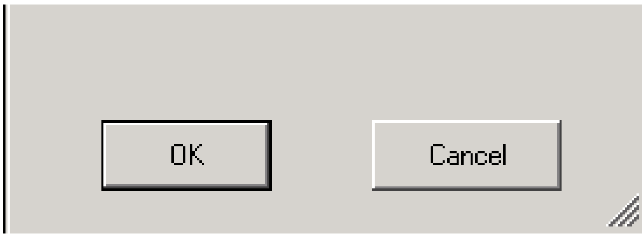

Figure 4. A typical dialog box in graphical user interfaces

OVERLAPPING ENGAGEMENT

Overlapping engagement differs from alternating in that user input sections seem to overlap with system output sections. An artifact accepts users' motion-based input, the motion data of which affects output instantaneously. This process results in an illusion of continuous response. A user is simultaneously engaged in performing motor action and perceiving sensory feedback. When getting used to the engagement, one is able to develop more sophisticated abilities such as parallel cognitive processing. The habituation makes one at home.

Some machine interfaces provide good examples. As mentioned, professional VTRs with jog dials allow users to control video playback by rotating the knob. The motion components of the dial affect how the medium is presented. A clockwise spin results in fast-forward, whereas a counter-clockwise spin rewinds the tape. The faster it spins, the faster the tape plays. The case is similar to the mechanics of the zoetrope, a nineteenth-century optical device (Figure 5). The viewer has to keep rotating the apparatus and simultaneously sees the animated effect through the slits. The direction of rotating determines the direction of the animation, and the spinning speed is the playback speed. These machines accept motion-based input and present instantaneous output, allowing users to manipulate outcomes quite variably. The power of manipulation gives users a sense of familiarity.

Figure 5. A modern remake of zoetrope

Many so-called immersive computer interfaces entail similar interaction continuously and simultaneously engaging users in action and perception. This kind of visual interface, whether 2- or 3-dimentsional, is one in which users can navigate by moving the mouse, swiping on the touch screen, or moving fingers on the touchpad. The most classical examples include the interfaces of many first-person shooting games, like *Doom*, in which the player moves the mouse left or right to look around, forward to walk, backward to retreat, and the interface shows animated content accordingly. Multimedia websites enabled by technologies such as Quicktime VR or Flash often present interactive panoramic views or menus allowing visitors to pan the views or menus left or right with the mouse (e.g., *Out My Window*, an interactive documentary by Katerina Cizek, see Figure 6). Users of these interfaces, through practice, become automatic in "moving" and have attention being freed up to elaborate conceptual meaning as intended by the designers. For example, the *Out My Window* website enables a visitor to readily "navigate" around the globe by just rolling the pointer over a world map, a composite of apartments, or a strip of people's portraits. The instantaneous and continuous visual feedback in terms of color tone and scale gives the user a feeling of "moving" between topics. One can concentrate on the stories in those apartments that envelop the city life in different part of the world.

Figure 6. A screenshot of the Out My Window website

Similar form of navigable interface can be seen in many hand-held devices, tablet computers, or laptops. Users run fingers on the touch screen or touchpad to scroll through screens or some larger-than-screen canvas. Moreover, when a user of the Mac OS X system rolls the pointer (by moving finger on the touchpad) over the Dock (a special container of user-selected application icons for easy access), the icons instantaneously vary in size to reflect the proximity to the pointer. (Figure 7) The direction, speed and even frequency of the motion-based input cause immediate and continuous visual feedback on the screen. The user is engaged in motor action and sensory perception simultaneously. This overlapping engagement again gives the user a sense of "approaching" the targeted application in a familiar environment. One can develop the habit and so become less vulnerable to clicking on wrong icons.

Figure 7. The magnification effect of the Dock in Mac OS X

SUSTAINING ENGAGEMENT

Lastly, sustaining engagement describes those situations in which systems still show transformation for a period of time when users stop taking action. This kind of engagement is sustaining in that the changing environment continues to engage the user in the perception of time during inactive use. Meanwhile, the user is still using the artifact, because one can resume action any time to trigger particular variation that would carry on. This "becoming" whole is persistent and divergent. This holistic experience of use satisfies the user's desire to anticipate and to exercise.

In the zoetrope case mentioned above, the viewer needs to spin the apparatus in order to see the animated effect. Unlike the VTR, which immediately halts if the user stops spinning the jog dial, the viewer of the zoetrope even though defers the motor action, the animation would continue to engage the viewer for a while due to inertia. Although at a moment the viewer is not taking any action but just gazing, the apparatus is still in use and the engagement is sustaining. The viewer's attention is caught by the animation, rather than by the motor habit to spin the drum.

Another good analogy is the tea-serving mechanical doll of Edo-period Japan called *karakuri* (Figure 8). After winding it up, the automaton paces slowly with a cup of tea to approach its user. When it bows, the gesture cues the user to pick up the teacup. If the user does so, it waits for the return of the cup; otherwise, it turns away, and comes back after a while. Winding it up notwithstanding (which is a type of alternating engagement), the doll is geared to follow its internal rules continuously. The doll might react to its audience's timely motor action or wander around. In short, it behaves differently in different occasions and engages its audience in continuing and differing happenings.

Figure 8. A modern remake of karakuri

In computational media, examples of sustaining engagement are emerging. One example is the greeting front page *SnowDays* at Popularfront.com. The page displays an outdoor view of snow falling (Figure 9). The downward drifting flakes vary in shape because they are actually other web visitors' individual submissions. A visitor may create a customized snowflake using a simple interactive cutting tool and attaching a message. Once the visitor submits the flake, it is added to the system database and then falls in the scene, constituting part of the "becoming" whole. Using a touchpad, a visitor can run a finger across it to "catch" a falling flake and check out the details and the attached message. Yet one has to take timely action, otherwise the target may fall out of the window frame. The mechanism here is a simple example of motion-based input. This is because direction and speed of finger motion still embody one's intention toward a snowflake. Furthermore, while a flake is held by a visitor, new flakes from others are still continuously added to the database and may enter the scene at any time. At times, a visitor may choose to do nothing but watch as the scene keeps snowing while the background color changes with the time of day. The whole environment is undergoing enduring change no matter whether the user oversees all flakes or performs close-up actions. Repeated use of the interface environment makes the user able to naturally pick up and appreciate a flake, while consciously thinking about the story behind the attached message. Since anyone might have a moment of being alone and missing the other, the user experience is evocative and the poignant feeling is intimately affective to the user.

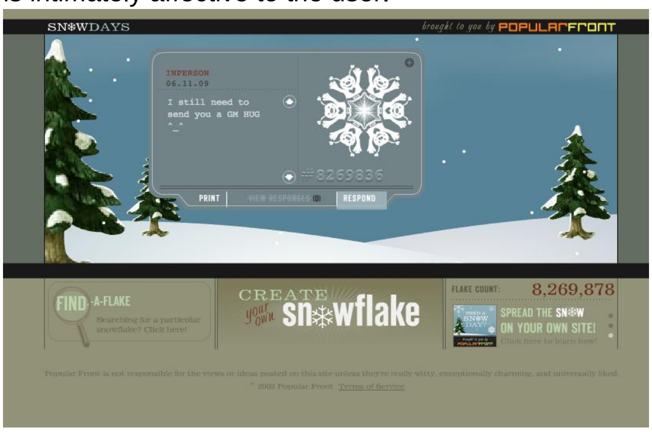

Figure 9: A screenshot of SnowDays at Popularfront.com

Another good example is the water-level interface of the Japanese mobile phone N702iS. The interface displays computer-generated images of water that react to user action in real time. When a user tilts the phone, the direction, speed, and frequency of the user's hand motions determine how the water dynamically flows on the screen, yielding an illusion of a water-filled cell phone (Figure 10). Shaking more vigorously leads to other effects like turning off an incoming call. That means the user input motion is significant and embodies the user's intention. Meanwhile, because the water level actually represents the battery level, even when there is no user action, the water level drops very gradually according to the battery consumption. This subtle, but persistent, change inside the virtual container reflects a constantly changing environment. When the user resumes action to check the water level, the interface reflects the change and conveys a hidden message: "save the juice!" All in all, the reactive and transformative water image constitutes another example of the "becoming" whole. Engaging in this system develops a user's immediate sensitivity to energy consumption, which frees up one's attention to contemplate resource conversation at large. The subject matter ties the user and the system together.

Figure 10: The interface of the mobile phone N702iS showing computer-generated imagery of water reactive to user action

CONCLUSION AND IMPLICATIONS

With increased popular deployment of gestural interfaces in computer-based devices such as smart phones or tablet computers with multi-touch screens, built-in gyroscopes, and accelerometers, and laptop computers equipped with touchpads, it has become apparent that computational design objects engage users not just in classical turn-based interaction, but also in increasing degrees of enduring interaction. Many mobile phone interfaces allow users to run fingers across the touch screens to browse through database items. Some allow users to customize a gesture as a code to unlock the devices. Many interfaces of multimedia websites feature gradual visual feedback in response to users' continuous finger movement on the touchpad. Enduring interaction, seemingly first emerged in gaming environments, now has immense potentials in general user interface design, especially of those artifacts not purely for specific utility purpose but instead open to wider possibilities integrating entertainment, social communication, self-expression, well-being, cognitive training, or others. This paper has discussed a few examples based on the enduring interaction framework demonstrating how motion-based input and constantly changing environments bring about both practical and affective facets of user experience. The author (who also has ongoing projects carrying this objective) believes that attending to the temporal pattern of user engagement, as suggested in this paper, would lead to more intimate and affective computational design objects that are able to span multiple purposes. This resonates with the contemporary trend that computational artifacts usually provide us with diverse affordances.

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