Ambiguity as a Device for Creating Poetic Interactions

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Abstract
Ambiguity plays an important role in art as it brings richness to an artwork. In HCI, Gaver and others have shown that using ambiguity in design creates engaging artifacts. Our research explores ambiguity specifically at the level of interaction with an interactive work. This paper describes an observational study which investigates participants' responses to ambiguity in a series of interactive prototypes. These prototypes were designed to disrupt the user's mental model by introducing ambiguity within its interactive structure, particularly in terms of *visibility*. This research provides initial insight into how to characterization ambiguity in interaction at the micro level.

Author Keywords
ambiguity, observational studies, aesthetic interaction, interactive art

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

Introduction
This paper explores alternative approaches to interaction design that arouse a certain kind of aesthetic response through subtle poetic 'devices', which draws theoretical

inspiration from literary devices such as imagery, allusion, and choice of language, foregrounding the meaning of interactivity in the context of understanding the relationships, or engagement, between an interactive system and its user. This approach expands the traditional HCI studies on human factors and classical cognitivism, and complements the phenomenologically-based approaches in HCI [7], such as user-experience design, affective computing and aesthetic interactions.

There are a number of ways in which poetic devices, such as imagery, allusion and choice of language, are discussed in various art disciplines. For example, Tsur describes reading poetry as "involv[ing] the modification (or, sometimes, the deformation) of cognitive processes", and in the extreme, may become "organized violence against cognitive processes" [19]. These interferences, or the delay of the normal flow of cognitive processes, are essential to make a poem *poetic*. Poets can exploit these effects to create aesthetic responses. Similarly, Shklovsky suggests that "[b]y 'enstranging' objects and complicating form, the device of art makes perception long and 'laborious'" [17]. In other words, the key for an aesthetic experience to emerge is the use of a poetic device which forces the reader to modify and reorganize her thoughts. This in turn prolongs her perception and draws attention to the form of the poem, rather than the content itself. As Shklovsky argues, "the process of perception is an aesthetic end in itself and must be prolonged" [16]. This aesthetic end is achieved through the use of poetic devices.

Ambiguity is one such poetic device which has been used extensively in the arts. As defined by Abrams, ambiguity refers to "the use to a single word or expression to signify two or more distinct references, or to express two or more diverse attitudes or feelings" [1]. However, there is little agreement as to how ambiguity contributes to aesthetic value. Beardsley describes "bad style" in literature as "the diction and syntac of a discourse are such as to produce [...] ambiguity and obscurity" [3] (as cited in [18]). In contrast, Kris and Kaplan [9, 8] argue that some forms of ambiguity can draw the reader into being actively engaged in interpreting the work, and can serve as "the instrument by which a content is made poetic through the process of re-creation." They describe the use of ambiguity as "frequent and important, though not the sole stimulus, to aesthetic response "[18].

In interactive art, we propose that "poetic devices" such as ambiguity can be used in a manner similar to those used in poetry and prose as mentioned above. The main difference between traditional and interactive art is that an interactive work responds to a user's input, and in turn the user "responds to that response" [15], implying that an action is multiplied through the feedback loops between the user and the system. Rokeby [15] describes this phenomenon as "transforming mirrors", in which the interactive work reflect the user's actions back to her, in a form of transformed or distorted, mediated representations. Since interactive media give the user a strong sense of power, these simplified representations "replace the relationships to which they initially referred" and turn "the interesting ambiguities of control and subjectivity in interactive art into serious issues of control, manipulation and deception" [15]. These representations can have similar effects to the literary poetic devices described by Tsur and Shklovsky.

The rest of this paper is structured as follows. We start with a brief review of related works that study the issues of ambiguity in design. This is followed by a discussion of

the research problem, and the methodology we use to address these issues. Next, the paper includes a discussion of our observations, and the implications of these observations. The paper concludes by stating the research contribution and implictions for future studies.

Related Work

In HCI, Gaver, Beaver and Benford distinguish ambiguity from vagueness, confusion, fuzziness or inconsistency, and argue that "ambiguity is a property of the interpretative relationship between people and artifacts" [5]. They consider fuzziness or inconsistency to be attributes of things, whereas ambiguity is an attribute of our interpretation of them" [5]. There has been much work to explore ambiguity in HCI. Gaver proposes ambiguity as a resource in designing engaging and thought provoking interactive systems. Aoki and Woodruff suggest that ambiguous content can be used to mediate social situations through personal communication systems. Mathew and Taylor define ludic ambiguity as a way to create engaging activities. Finally, Rokeby discusses the richness of ambiguity of control in interactive art. We will now briefly look at each of these approaches.

In personal communication systems, Aoki and Woodruff [2] suggest that ambiguity is useful for faciliating multiple interpretations of users' behavior, to create ambiguous interpretative space for stories to help users "save face" in a social situation. Boehner and Hancock [4] argue that "ambiguity emerges from the multiple interpretations available for any intentional act in a social relationship". Both papers focus on the interpretive space for desiging ambiguity, since meanings arise out of different contexts.

Mathew and Taylor define ludic ambiguity as "interaction caused by abstraction", borrowed Maeda's idea of "a 'blur' effect" [10], which uses "soft edged representations carrying an allure of mystique and allows for abstraction and subjective interpretation" [12]. They suggest that ludic ambiguity can be used for designing a spatial system at the intersection of architecture and computation [12]. Similarly, Makice [11] utilizes ludic ambiguity in designing AuralScapes "as an engaging creative activity, and, through sharing of new social artifacts, as a rewarding reflective experience". These papers echo Gaver's observation that many works introduce ambiguity by presenting information which is "physically or conceptually blurred" [5], and his position that ludic design "should not be 'for' anything"; instead, it should "offer a range of possible actions and meanings for people to explore" [6].

Interactive art such as David Rokeby's *Very Nervous System*, Myron Krueger's *Videospace*, Chico *MacMurtrie* and Rick W. Sayre's *Tumbling Man* [15] make use of ambiguities of control and subjectivity to create artworks which unleash rich complexity and ambiguity through the complex relationships between artists and interactive artifacts, and between users and artifacts.

Research Problem

Although substantial work has been done to address various design issues relating to ambiguity, there is still much to explore. This paper differs from its related works as such: it looks at how ambiguity can be characterized at a *micro* level, focusing on analyzing its form, in this case the interaction, rather than its content. Whereas researchers such as Aoki and Woodruff concentrate on ambiguity in content, and Gaver, Mathew and Makice propose ludic ambiguity as a way of achieving the "blur' effect" and a sense of "purposelessness" in a design, this paper explores how ambiguity is actually at work *during* interaction. This paper reflects on Rokeby's notion of

ambiguity of control. Rather than encouraging a sense of control in the user, in this paper we deliberately remove control from the user, with the aim of finding out to what extent this can create a satisfying, aesthetic response.

According to Tsur and Shlovsky, a successful poetic device must be able to drive an aesthetic response through the "delay of normal flow of cognitive processes", and perception "must be prolonged". The main question this paper raises is, "How and to what extent can ambiguity be consider 'good', when use specifically as part of the design of interactivity in an interactive media design?"

Method

In order to explore this question, we use Norman's [14] model of interaction, particularly the ideas of the mental model and visibility. Norman argues that an interactive system designed for practical use must be "straightforward, reflecting a clear understanding of the users intentions, the required actions, and the results of that interaction." [13]. He presented two concepts as the fundamental principles of interaction design, namely that the design must "provide a good mental model and make things visible" [13]. Norman describes a mental model as "ones interpretation of a devices perceived actions and visible structure informed by prior experience, training and instruction" [13]. Visibility is the structure that indicates the "correspondence between a users intended actions and the actual operations of the devices." [13]. This visible structure consists of affordances, mappings and feedbacks. Affordances indicate the way in which an object can possibly be used. Mapping is the relationships between the use of an object and its behavior. Feedback is the way in which the object communicates its behavior to the user. In this paper, we created a set of interactive prototypes that are deliberately designed to disrupt this structure, carefully introducing ambiguity within the structure by making the mapping and feedback unclear. This leads to multiple possible interpretations as to how to interact with the work.

We then observed how people responded to this disruption of visibility through the use of a series of semi-structured interviews. The study involved 14 participants (9 male and 5 female, age 20-41) interacting with a set of 4-6 prototypes. The reason for choosing this method is because it allows flexibility for the researcher to ask probing questions, modify the prototypes, or change the sequence of the prototypes according to how participants react.

The protocol

In a typical one-hour interview session, a participant would be given a brief introduction and description of what she is expected to do during the session. She would provide some generic demographic data and then interact with the prototypes. The researcher would ask the participant to verbalize what she is doing, thinking, and feeling. The researcher would also probing questions, during and after she interacts with the prototype, such as:

- What is the first action you want to do with this work?
- Do you feel that the work gives a clear sign/hint to prompt for your next action?
- At what point did you start losing interest in the work?
- Comparing prototype 01 and 02, which one do you feel is more interesting and engaging? Why?

The subsequent questions and follow-up prototypes were carefully chosen and modified according to the individual responses. This helped the researcher to look for deeper insights as to how the participant feels, particularly when she is confronted with conflicting cognitive processes. The ways the participant resolves these conflicts gives valuable insights.

The prototypes
Three prototypes were created: "run-away", "pause" and "butterfly". Each design contains two variations, one with a cursor visible to the participants, and the other with the mouse cursor hidden. The mouse cursor on screen provides a direct mapping between the mouse input device and its cursor, through its visual feedback. By hiding the mouse cursor, we remove the direct reference between the mouse movement and what happens on screen, which creates an ambiguous relationship as there is no visual feedback, and the mapping between the mouse and its on-screen cursor is now unclear. Our intention when removing the visibility of the mouse cursor is to see how participants react, through forcing the participants' cognitive "modification", which leads to "prolonged" perception and a foregrounding of interactivity, thereby creating a chance for an aesthetic response to emerge.

We now describe each of the prototypes in detail.

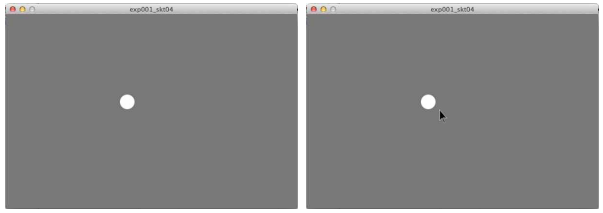

Figure 1: Prototype without (left) and with cursor (right)

The first set of prototypes, "run-away", presents a simple situation whereby when the mouse cursor is in close proximity to the white circle or touches the circle, the circle moves or jumps away from the cursor in random directions.

The second set, "pause", is slightly more complex in its design. The circle snaps to and follows the mouse cursor with a slight delay when they are in close proximity to each other, as well as when the cursor is moving at a slow and constant pace. However, if the cursor suddenly moves fast and away from the circle, the circle loses track of the cursor, and pauses at the position where the cursor and circle moved away from each other. As long as the cursor doesnt move, the circle remains static. When the cursor starts to move again, wherever it is, the circle would behave like it suddenly senses the cursor, and zooms forward and snaps onto the cursor.

The third set is "butterfly", which is quite similar to "pause". The circle snaps to and follows the cursor with a delay, as long as the cursor is moving at a slow and constant pace. Once the cursor moves quickly and abruptly away from the circle, the circle will start to move jerky and uncontrollably (like a flying butterfly) and moves all over the place, including going out of the screen, remaining out of sight for some time before finding its way back to the mouse position on screen. Once the circle moves into the detectable range of the cursor, it snaps back to the cursor.

Our prototypes are designed to fall into one of three categories: vague, ambiguous, or clear. All prototypes with cursor visible are considered clear, but with varying degrees of clarity. The design of "run-away" without a cursor is characterized as vague. What we were interested to find out is whether the participants would consider any

of the prototypes to be ambiguous in a way that creates interest and engagement.

Data collection and analysis
Data collection included screen recording, voice recording, and the researcher's hand-written notes. Data was coded and analyzed using qualitative research methods, to look for recurring patterns and incidents that raise issues regarding aesthetic response to interactive media systems.

Results

We now discuss our overall observations of the participants' responses to the prototypes.

Most participants found interacting with "run-away" with a visible cursor to be fun, enjoyable and engaging. For example, participant 7 describes it as "more responsive", as she can see how the cursor interacts with the circle. However, when confronted by the version without a visible cursor, her response was that it was "frustrating after a while" due to the fact that the circle "is not doing anything", and she got bored after 2 minutes interacting with it. "Run-away" was characterized as a simple systems, with both mental model and visibility easy to figure out. But when the cursor is hidden, it was almost impossible for participants to work out a mental model of how it works, due to the random movement of the circle, and the fact that the relationship between the mouse movement and the circle are vague. Most participants found this version frustrating, irritating and annoying. Most participants indicated that this feeling of frustration derives from their inability to control the circle's movement.

"Pause" gives two distinct feeling to the participants. Most of them feel secure as the circle mostly follows the mouse movement, although at a much slower pace. However, most participants feel frustrated when it "suddenly" pauses. Quite a number of them thought that the software or program or the mouse was broken. Some of them had the urge to restart the computer. Some participants were able to figure out or at least partially figure out a mental model for this prototype's behaviour without seeing the version with the cursor.

Most participants found "butterfly" interesting at first sight, as the "butterfly" flying effect attracts them. But soon, they find it challenging to try to control it, especially before they have gained an understanding of the mental model. Most of them commented that the "uncontrolable" and "jerky" movement made them feel "helpless", observing that "I can't do anything" and that there was "no predictability", expecially when the circle "flies" out of the screen. Once they gain understanding with the mental model, however, most of them find it quite satisfying to interact with it, although the slow pace of moving their mouse to ensure the circle is in control annoyed them.

Discussion

Although the results shown in the previous section tend to suggest that, as Norman argues, visibility and a clear mental model are essential, there are two notable observations from the study:

1. Participant 12 was initially frustrated when confronted by prototypes with no-visible cursor and no clear mental model. But, after he interacted with the version with the cursor, and came to understand or confirm his mental model, he found that the version without the cursor was more interesting when he revisited it. This suggests that this invisibility of the cursor adds some ambiguity, and

provokes a positive response. Interestingly, howver, this only happened *after* he has some idea as to what the mental model may be.

2. Participant 14 characterized the prototypes with visible cursor as a game, and described it as fun, and the version without a cursor as "art", as it "provokes" through the ambiguity of interaction. This implies that Norman's ideas about interaction are relevant in one context (where there is a clear goal to be pursued), but may be productively disrupted or subverted in another context, ie. if the work is intended to be "art".

We will now discuss these observations in more detail.

Developing mental model
When participants are shown the prototypes without a visible cursor, it's not surprising that all participants' first reaction is to find a pattern, or try to understand the connection between their mouse and the circle. At this point, all participants indicated that they treat the circle as their on-screen representation of their mouse, i.e. the cursor. They attempt to gain control over the circle, and seek visible cues from the circle's response in relation to their mouse movement. A typical reaction of participants in the exploratory mode is that they apply big movement all over the place, and examine the various ways the system responds. In the case of "run-away", participants get frustrated easily within a short duration. In contrast, with "pause" and "butterfly", even with the cursor hidden from view, some of the participants were able to find some familiar patterns, or partially understand how to interact with the prototypes. After knowing, or at least when they think they know some patterns, these participants start to spend more time analyzing and proving their mental model. Once they think they have a clear mental model of how the prototypes work, some of them moved on to seek new things to explore, or to see what they can do with it. Some created a game, with an impromptu set of rules, for their own entertainment. A few of them became bored and wanted to move on to the next prototype.

There is a distinct change in behavior before and after knowing the mental model of the works. Particularly in the case of "run-away", once they know the mental model, paticipants' action shifts from the large exploratory movement to a close circuit which revolves around the circle. However, the invisibility of the cursor still remained challenging for most of them, as they need to "concentrate", and imagine where the cursor is, in relation to the random movement of the circle. When comparing how they feel before and after knowing the mental model, most of them found it "quite fun", as compared to when they have "no idea what's going on", at which point they feel that it is "pointless" and "meaningless", and that "it doesn't make sense".

While most of them still prefer the version with a visible cursor, with reasons such as it's "easier", "less challenging", or "I am lazy, don't want to think so much", one participant prefered the version without the cursor - participant 12. This participant described his experience with "run-away" with no cursor as follows:

> I have found additional thing[s] I have to keep in my memory, which is some kind of mental idea of where the mouse is, in the other case ["run-away" with cursor visible], I know where the mouse is, I know where the ball [circle] is, and after a point of time, how much I ever explore at what point of the surface should I

> put the pointer [cursor] so that the it starts moving away, it still not very interesting, the interest kind of dies off after a while.

The participant's responses changed from negative to positive after shifting from no cursor (no visibility) to cursor (visibility) and back again. This suggests that a partial understanding of the mental model, even with no visibility, may give rise to an aesthetic response.

Changing context changes response
Another interesting observation is that its important to situate the context of the prototype. This observation was clear in the response from participant 14.

When he initially finds "run-away" with visible cursor more engaging and interesting:

> I feel better with the mouse, may be more direct, I can touch, it runs. This one [without cursor] I have to rely on what I feel, where the last mouse [position] was, not too immediate... feel frustrated when I lose it.

When ask, "if this is an interactive art, which one do you feel is more engaging and interesting?" his response was, "the one without the cursor." He explains, "it's more provocative. I have certain definition of art. Art must provoke, either frustrate you or whatever, but must provoke." He explains that "run-away" with cursor feels more like a game. A game "doesn't really have a message, it's just purely entertain." As in art, he says, "art or architecture doesn't entertain". He accepts "run-away" without a cursor if it situates itself as an interactive art piece. If this is a game, he would prefer the version with the cursor.

Norman's position that all interactive media must have a clear mental model and visibility is only true in the right context, such as, for practical use or where there is a clear goal. But, if put in the context of a work that is intended to be "art", which is meant to be disruptive and subvertive, a design which is straightforward, with a clear mental model and visibility, may be seen as boring and meaningless.

Conclusion

The paper presents an observational study which explores the ways in which ambiguity can be used in interaction design as a poetic device to create an aesthetic response. Disrupting Normans model of interaction, particularly in terms of visibility, gives us an opportunity to study whether ambiguity can be carefully introducing within the structure of interaction to arouse aesthetic responses. In our interactive prototypes, we deliberately hid the on-screen cursor, which maps directly to the mouse input device.

There are two interesting observations which emerge out of the study:

1. A participant's responses changed from negative to positive after shifting from the prototype with no-visible cursor to the one with a cursor and back again. This suggests that a partial understanding of the mental model, even with no visibility, may give rise to an aesthetic response.

2. Aesthetic response is context driven. When a work is framed as art, users are more open to interaction where visibility and the user's mental model has been disrupted and subverted. Ambiguity is well suited to this context.

Future work
The results from this study raise a number of questions which can be pursued as future work. Where is the boundary between "good" and "bad" ambiguity? How much visibility is needed in order for the "right" amount of ambiguity to emerge? How does ambiguity relate to complexity?

This study has suggested that a careful disruption of visibility, and as a result the user's mental model, is a possible way to introduce ambiguity into the structure of interaction. The next step is to design a series of studies to explore these research questions in a more systematic way, so as to identify a set of poetic devices for creating aesthetic responses in interactive media.

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