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An Artist's Perspective on Ambiguity as a Creative Instrument in Human-Computer Interaction for Digital Interactive Art

Rezumat

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Summary

I. Introduction

Much of the discourse in Human-Computer Interaction (HCI) has traditionally regarded ambiguity as a usability flaw: an obstacle to clear communication, efficiency, and user satisfaction. Yet in the context of interactive art, ambiguity may serve as a deliberate design choice that fosters deeper engagement, personal interpretation, and emotional resonance. This thesis therefore asks whether purposely integrating ambiguity into interactive artworks genuinely enhances the audience's experience, challenging the notion that ambiguity should be avoided at all costs.

With this central concern in mind, my research pursues several key objectives. Firstly, it explores how interactive artists can strategically incorporate ambiguous elements to spark curiosity, reflection, and a sense of open-ended discovery. Secondly, it investigates the emotional impacts of uncertainty on participants, particularly with regards to its influence on the immersive enjoyment and potential feelings of confusion or frustration. Finally, by drawing together practice-led insights, audience feedback, and expert perspectives, the thesis aims to provide a nuanced framework for understanding ambiguity not as a design flaw, but as a valuable resource in creating meaningful, immersive interactive art experiences.

To achieve these objectives, I developed an original interactive art installation titled *Natura ex Machina*, specifically informed by both my practice-led methodology and the existing body of literature on ambiguity, HCI, and interactive art. Conceived and refined expressly for this research, the work served as a testing ground for design strategies that deliberately weave uncertainty into user experience. In placing *Natura ex Machina* within a real art exhibition context, I was able to systematically observe and measure how carefully calibrated ambiguity influences audience engagement, emotional reactions, and interpretative freedom ultimately contributing to a broader, evidence-based understanding of ambiguity's role in interactive art.

This research is situated within a broader context where the relationship between art, technology, and human experience is undergoing a profound transformation. The interplay between creativity, digital media, and interactivity have become a vital frontier of contemporary artistic production and theoretical inquiry. This PhD thesis situates itself within

this rapidly evolving context by examining how ambiguity in interactive art can foster deeper engagement, reflection, and meaning making for participants. By intentionally designing for certain forms of "not knowing," interactive artworks can challenge our assumptions, invite us to reevaluate our relationship to technology, and reexamine our place in a fast-urbanizing, digital era.

II. Methodology

In this study, I employed a multi-method approach to investigate how intentionally designed ambiguity influences audience engagement, interpretation, and emotional response in interactive digital art.

Content analysis to determine the effects on the users was conducted on a wide array of artistic works, spanning non-interactive performances and fully interactive digital installations. By examining how different artists intentionally employ I gained further insight into the mechanisms that provoke curiosity, reflection, or emotional engagement.

Practice-led research provided the foundational framework: by creating and refining the interactive artwork itself, I could observe first-hand how design choices shaped user experiences. This iterative artistic process helped surface key decisions about where and how to incorporate ambiguity.

In-the-wild research occurred during the public exhibition of the artwork at the Ars Electronica Festival in 2024, allowing me to observe participants' spontaneous behaviours and collect on-the-spot feedback. Gathering data in a real-world setting, rather than a controlled environment, offered authentic insights into how different visitors engaged with the piece and interpreted its ambiguous elements.

Survey as a method to capture audience insights followed the exhibition phase. I distributed a post-exhibition survey, which elicited both quantitative ratings and qualitative reflections from 58 respondents. By combining structured response scales with open-ended questions, I could pinpoint recurring patterns, such as levels of enjoyment and clarity, while also capturing the nuanced emotions, interpretations, and challenges participants experienced.

Expert interviews complemented audience-focused data with broader professional perspectives. Conversations with experienced an art critic and three established new media artists highlighted multiple strategies for designing ambiguity, reflected on user engagement challenges, and grounded my research findings in a wider context of interactive art practice.

The thesis addresses several interconnected research questions:

1. How can artists intentionally include ambiguity in the design of their interactive artworks to develop deeper engagement and encourage reflection among participants? This question examines the different design strategies that can be employed to integrate interpretive openness into digital artworks, drawing on frameworks by Gaver et al. and others.
2. What is the emotional impact of ambiguity in interactive artworks, particularly regarding user curiosity, confusion, and aesthetic immersion? Here the focus is on how users respond subjectively to uncertainty. Does it heighten curiosity, or cause frustration? Does it foster immersion, or deter engagement?

Through this blended methodology, I was able to triangulate multiple data sources. Practice-led creation guided the design and technical nuances of building intentionally ambiguous systems, in-the-wild observation revealed genuine audience reactions, survey findings quantified and contextualized participants' subjective impressions, and expert interviews situated these insights within contemporary art discourse. Together, these methods offer a robust foundation for addressing my research questions regarding how ambiguity can be both orchestrated and experienced in interactive digital art.

III. Ambiguity

William Gaver is a significant researcher in my exploration of ambiguity as a resource design for HCI's interactive systems. His novel contributions challenge the status quo of HCI design practices by introducing approaches that enrich traditional methodologies. Ambiguity represents Gaver's most relevant contribution to HCI for this thesis. He influenced the design methodologies by researching and incorporating concepts that challenge the traditional design methodologies, notably critical design practices, and incorporating the play aspect, notably ludic design contributions.

Gaver and his colleagues propose a novel approach regarding ambiguity in HCI design. They suggest using ambiguity to enhance user interaction with systems by provoking deeper personal engagement. Rather than viewing ambiguity as a usability issue, they argue it can create more meaningful and enjoyable user experiences, especially in domestic technologies, by encouraging users to interpret and assign personal meaning to their interactions with designed artefacts.

Gaver and colleagues identify four types of ambiguity that can be used as a resource in interaction design: ambiguity of information (uncertainty in what is presented, often using imprecise or conflicting data), ambiguity of context (objects or actions made unclear by placing them in unexpected settings), ambiguity of relationship (leaving the user unsure of the artefact's intent or their own role in the interaction), and ambiguity of semantics (disrupting straightforward interpretation through symbolic, incomplete, or open-ended meanings). These forms of ambiguity invite users to interpret, question, and personalize their engagement, fostering a more participatory relationship with technology and art.

The effects of these ambiguities vary but often aim to deepen engagement. Ambiguity can evoke curiosity, play, creativity, and reflection, enhancing emotional and intellectual involvement. It can make experiences more entertaining, immersive, and interpretable, supporting open-ended exploration and user agency. However, if misused, it can also result in frustration and confusion, especially when the design lacks a clear framework or fails to balance uncertainty with navigability. Thus, ambiguity must be carefully calibrated to function as a productive design strategy.

IV. Interviews with Experts

This chapter presents and analyses interviews with established experts in the fields of digital art, interactive media, and critical art theory. Here the spotlight is on each expert's perspective regarding the intentional use of ambiguity in interactive art, the impact of technological mediation, and the broader socio-cultural contexts in which these works exist. By discussing these interviews on a person-by-person basis, rather than question by question, this chapter aims to synthesize key insights, reveal points of agreement or debate among the experts, and situate their views within current discourse on interactivity, aesthetics, and user experience.

Horea Avram, Klaus Obermaier, Ioana Mischie, and Adrian Grecu each highlight ambiguity's potential to open interpretive space and deepen emotional involvement. Avram emphasizes the balance between clarity and openness, noting how ambiguity can subvert expectations and invite critical thought, especially when technological features are subtly revealed or concealed. Obermaier draws parallels to game design, advocating for layered experiences that spark curiosity without overwhelming users. Mischie underlines the importance of structured user transitions and thoughtful user experience (UX) design,

especially in immersive formats like VR, while Grecu connects ambiguity to traditional artistic strategies, insisting that conceptual vagueness must be paired with intuitive navigation.

V. Natura ex Machina

This chapter provides an in-depth examination of *Natura ex Machina*, the thesis' central interactive art project designed to explore ambiguity as a creative resource in human-computer interaction. The chapter opens with a brief discussion of an earlier work, *Break the Bubble!*, before delving into the conceptual and technical development of *Natura ex Machina*. Inspired by ecological themes and the tensions between nature and technology, the installation features sensor-based interaction, a transparent screen, and shifting digital imagery responding to viewer presence and actions. The design deliberately employs ambiguity to encourage reflection, emotional engagement, and interpretive freedom.

The chapter then explores how ambiguity functions within the thematic framework of the piece, particularly in relation to the human-nature relationship. The installation avoids offering a fixed narrative or clearly defined message, instead prompting users to engage with open-ended symbols and partial information. Elements such as animated plant visuals and informational data overlays are intentionally unclear, encouraging participants to construct their own meanings. This ambiguity is not random but carefully calibrated, striking a balance between provoking curiosity and avoiding complete disorientation. The chapter also emphasizes how the project fits within broader discussions on aesthetics and user experience in interactive art.

Finally, the chapter presents the exhibition context at Ars Electronica 2024, where audience responses were gathered through surveys, direct observation, and informal interviews. Results showed that while many participants found the ambiguity intellectually and emotionally stimulating, others expressed moments of confusion. Nonetheless, most respondents appreciated the installation's openness and its invitation to explore meaning independently. The chapter concludes by reflecting on how *Natura ex Machina* successfully illustrates ambiguity's potential to enhance engagement and critical thinking in interactive art, while also acknowledging the challenges of maintaining user accessibility.

VI. Conclusions

The exhibition of *Natura ex Machina* at Ars Electronica 2024 offered a unique opportunity to engage directly with a wide range of audience in a dynamic, real-world setting.

Through detailed observations and informal discussions, I gained valuable insights into how users interacted with the installation, what they expected from it, and how they connected with the digital plant. These findings helped deepened my understanding of how ambiguity functions as a key resource in interactive art.

Survey responses highlighted both the strengths and challenges of incorporating ambiguity into *Natura ex Machina*. Many participants praised the installation's ambiguous elements, describing their experience as "intriguing," "unexpected," and "thought-provoking." Ambiguity encouraged exploration and experimentation, enabling users to engage with the installation on their own terms. One respondent noted how the absence of immediate feedback "created space for reflection," while others appreciated how the hesitation caused by the visible moisture sensor made them more mindful of their interactions.

However, the survey also revealed that ambiguity posed challenges for some participants. A portion of users expressed frustration with the lack of clear guidance or immediate feedback, describing the experience as "confusing" or "uncertain." For example, some participants struggled to understand the purpose of watering the plant when no immediate or obvious change occurred. This mismatch between their expectations and the system's behaviour left a minority feeling disengaged or unsure how to interact with the installation effectively.

Despite these challenges, ambiguity played a key role in fostering deeper engagement for many. For those who resonated with the installation's themes, the delayed feedback and open-ended interaction aligned with the broader message of ecological patience and care. Yet, the frustration expressed by some highlights the importance of finding a balance between fostering intrigue and providing sufficient guidance to avoid alienating users.

These mixed responses underscore both the potential and the limitations of ambiguity as a design strategy. While ambiguity can inspire meaningful reflection and curiosity, its success depends on carefully balancing it with accessible interaction models. This feedback suggests that refining the installation's design could help bridge the gap between users' expectations and the intended experience, maximizing the positive impact of ambiguity while minimizing confusion.

My thesis demonstrates that ambiguity in interactive art is not merely a theoretical notion or niche interest: it constitutes a tangible, practicable design principle with broad

implications for audience engagement, ecological awareness, and the future of user experience. The thesis underscores four overarching takeaways:

Intentional ambiguity for engagement. When ambiguity is consciously integrated, rather than arising from poorly executed design, it can ignite curiosity and intellectual engagement. Users describe such experiences as "thought-provoking," "intriguing," and "memorable," underscoring the potent pull of interpretive discovery.

Ecological resonance. By entwining ambiguous design with environmental motifs, *Natura ex Machina* highlighted how open-endedness can underscore the fragility and complexity of human–nature connections. Rather than imposing a single ecological message, the piece invited participants to consider the uncertain boundaries between artificial systems and organic processes.

Necessity for clear interaction models. Even though conceptual ambiguity can be beneficial, the interface itself must maintain a baseline level of clarity. Sensor feedback and user cues must be transparent enough to guide basic participation without derailing the interpretive journey. Where that balance lies may differ across artworks and audiences.

Hermeneutic expansion. The integration of user feedback, expert perspectives, and practical design experiences suggests a broader "hermeneutic circle," wherein the artwork, the participants, and the theoretical discourse continuously shape one another. This dynamism reflects the adaptive, evolving nature of interactive art as both aesthetic proposition and experiential event.

In sum, the project advances an understanding of "designed ambiguity" that is simultaneously aesthetic, experiential, and ethical: participants assume interpretive responsibilities, bridging the gap between technology's coded structures and the broader symbolic or conceptual domains they inhabit.

VII. Future Research Directions

The study's findings open several promising pathways for continued inquiry. While *Natura ex Machina* and related analyses underscore the value of ambiguity, there remain numerous unresolved questions and fertile areas for deeper exploration.

One of this directions could be a comprehensive quantitative research on user experience (UX) techniques. Although the qualitative feedback I used in my study has proven

invaluable for capturing nuanced user interpretations, future work might incorporate more systematic quantitative approaches. I am including here just two directions:

Comparative UX testing. Parallel installations, one “ambiguous” and one “direct”, could be tested across user groups, systematically recording dwell times, revisit rates, or recall of conceptual themes. Such controlled experiments would yield robust evidence on the impact of varied ambiguity levels.

A second future research direction could address the concept of ambiguity in the context of the **emerging artificial intelligence (AI) technologies** that opens new frontiers for dynamic, evolving ambiguity. Here a researcher may look at adaptive ambiguity. An AI-driven systems can tailor uncertainty in real time based on user behaviour. For example, if a participant appears disengaged, the system might become more transparent; if the participant is deeply curious, the system might introduce fresh interpretive gaps.

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