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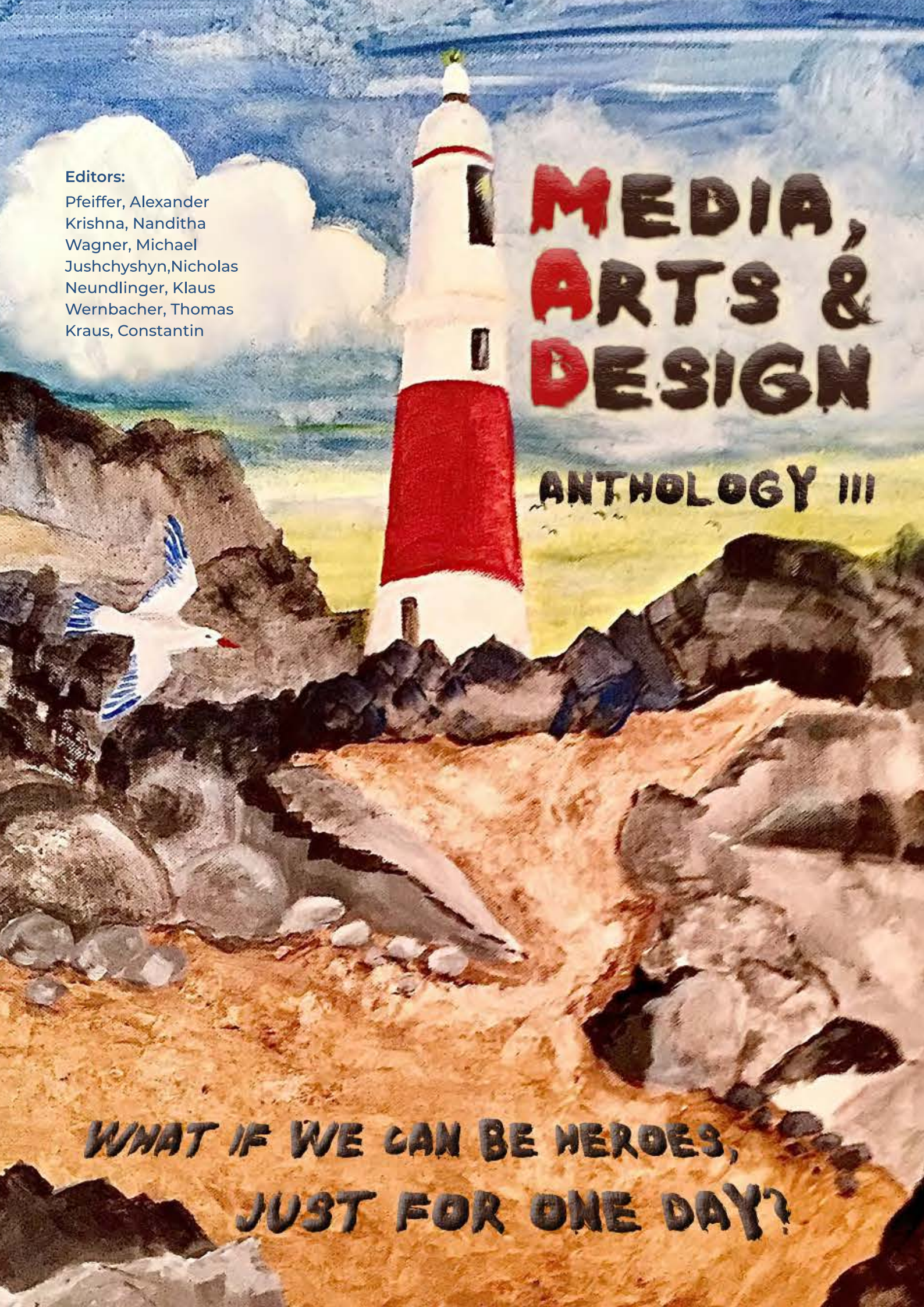
MEDIA, ARTS & DESIGN

ANTHOLOGY III



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MAD (MEDIA, ARTS AND DESIGN) ANTHOLOGY III: FOREWORD

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From the early days of print to the rise of radio and TV, then the digital boom of the internet and cyberculture, and now game-changing tech like AI and blockchain, media and technology have come a long way—shaping society every step of the way.

From a media psychology perspective, these advancements aren't just milestones—they're a powerful, constantly growing force that deeply connects with both personal and shared experiences. Driven by the creativity and insight of thinkers, creators, and scholars, media, arts, and design have become more than just areas of study. They reflect society itself, capturing our shifting values, aspirations, and the changes shaping our world. This makes media more than just a tool—it actively influences public conversations and even the way those conversations take shape. As we stand at the edge of incredible new advancements and challenges, this progress matters more than ever. With each breakthrough, technology continues to push the boundaries of media, opening up creative possibilities we once thought impossible.

The Media, Art, and Design (MAD) conference was launched in 2020 with a bold vision: to create a dynamic, inclusive space where experts and practitioners from media, arts, and design could come together to share ideas, insights, and innovations. More than just an academic event, MAD was designed as a collaborative hub—bringing scholars, creators, and industry professionals into conversation, sparking interdisciplinary thinking, and fostering a community dedicated to pushing these fields forward. Over the years, the conference has explored cutting-edge topics like AI, virtual and augmented reality (VR/AR), the metaverse, NFTs, blockchain, machine learning, quantum computing, digital ethics in gaming, cybercrimes, and the impact of the COVID-19 pandemic.

The MAD conferences have always pushed boundaries, exploring new frontiers and redefining what's possible. Every contribution—whether a talk, presentation, academic paper, position paper, or poster—has tapped into collective creativity, expanding the ways interactivity, AI, and media shape our experience of art and design. With online and hybrid formats, MAD has made participation accessible to a global audience, fostering a community dedicated to driving media, arts, and design forward. These proceedings capture the depth and diversity of ideas shared at MAD, reflecting the interdisciplinary nature of today's creative landscape. More than just a record of the conference, we see this volume as a lasting resource—one that will continue to inspire new exploration and research.

We hope this anthology serves its larger purpose: to sustain, enrich, and deepen the ongoing conversation in these ever-evolving fields. By keeping the dialogue alive, it highlights how new developments continue to shape our shared experiences. More than just a collection of ideas, we see it as a resource that captures the innovative spirit of the MAD conference—one that sparks curiosity and inspires further exploration in media, arts, and design.

Each MAD conference builds on this growing legacy, blending technology and creativity to shape a dynamic discussion about the future of these fields. We look forward to seeing this effort continue to welcome fresh ideas, research, and creative works—offering both a snapshot of where we are now and a glimpse into what's ahead for media, arts, and design.

So, with that in mind, we're excited to introduce the content of MAD Anthology III. This edition brings together a diverse range of ideas, research, and creative works that reflect the ever-evolving intersections of media, arts, and design. Through insightful discussions, groundbreaking studies, and innovative projects, this anthology captures the spirit of exploration and collaboration that defines the MAD conference. Let's dive into the contributions that continue to push boundaries, challenge perspectives, and shape the future of these dynamic fields.

Peer-reviewed papers

1. **Presto Manifesto! Using Game Design Lenses to Boost Self-Efficacy in Addressing Climate Change – Anuraj Bhatnagar**

   This paper presents Presto Manifesto, a strategy-based climate change game designed to enhance collective efficacy and promote sustainable action through interactive experiences.

2. **Emphasizing Function in Design for Disabilities: The Role of AI and ML in Assistive Wearable Technology and Smart Jewellery - Arefeh Ahmadi, Emil Polyak & Michael G. Wagner**

   This paper examines how AI and machine learning can enhance assistive technology, particularly in the design of smart jewelry for people with hearing impairments, by emphasizing function and personalization.

3. **Adrift in the Anthropocene: Reconnecting Through Aesthetic Experience – B. Colby Jennings**

   This study explores how art can transform climate change data into emotionally resonant experiences. By analysing the work of artists such as Maya Lin, Trevor Paglen and Olafur Eliasson, the paper argues that aesthetic experiences can enhance public engagement with ecological crises.

4. **Motifs of Future Metamorphosis: Afrofuturism in Media Art and Design - Darren Woodland Jr.**

   This paper traces the evolution of Afrofuturism from early speculative fiction to contemporary visual art, music and digital media. It explores how Afrofuturism reshapes narratives of identity, technology and futurism while challenging Western cultural dominance.

5. **Exploring the Integration of Non-Fungible Tokens in Blockchain Gaming - Darya Ramezani, Golshid Jaferian & Michael G. Wagner**

   This paper examines NFTs in gaming and discusses their implications for digital ownership, player economies, and virtual world creation. It also highlights challenges such as market speculation, scalability, and regulatory concerns.

6. **Smart Contracts and Decentralized Gaming Ecosystems – Golshid Jaferian, Darya Ramezani & Michael G. Wagner**

   Focusing on blockchain-based gaming, this study explores the role of smart contracts in creating decentralised, trustless environments. It discusses issues of transparency, security and governance in blockchain gaming.

7. **Hearing Silence: The Absence of Sound as a Tool for Communicating Meaning in Video Games - Nicolas Eduardo Losada Martinez**

   This paper presents a new framework for understanding silence in video game design, analysing how games like Halo: Combat Evolved and Hollow Knight use silence to create emotional depth and immersive storytelling.

8. **Reflections in Silicon: The Emergence of the Artificial Intelligence Character Archetype in Creative Media - Kevin Mercer**

   Tracing the evolution of AI in speculative fiction, this study examines AI archetypes in literature and digital media and discusses how they reflect human anxieties about technology, autonomy, and control.

9. **Living in the Loop: From Transparency to Technological Tyranny- Digital Wellbeing, Surveillance and the Costs of Connection in The Circle (2013) - Nanditha Krishna & Arun S.**

   Analyzing Dave Eggers' The Circle, this paper critiques the pervasive influence of digital surveillance and social validation on personal autonomy. It explores speculative fiction as a lens for examining contemporary concerns about privacy and the ethical responsibilities of technology corporations.

10. **Sound Sponges: A Speculative Approach to Tangible Urban Interaction and Urban Prosthetics for Persons with Hearing Impairment – Sasan Bahrami**

    This paper introduces Sound Sponges, a speculative urban intervention that uses interactive urban prosthetics to reduce noise pollution and improve accessibility for people with hearing impairments.

11. **Everyday Heroes: Empowering Lifelong Learners Through Game-Based Learning – Stephanie Wössner**

    Using the game-based learning adventure SERASUM, this paper explores how educational games can foster agency, resilience and sustainability skills in young learners.

12. **A New Charter for the Preservation of Digital Game Heritage - Tony A. Rowe**

    This study advocates a universal charter for the preservation of digital game history, outlining principles for archiving and maintaining video game heritage in the face of rapid technological obsolescence.

Position Papers | Poster-Session Papers | Short-Project Papers

13. **Feminism, Media and Technology: Navigating the Digital Landscape - Dorsa Charkhian**

    This paper explores feminist human-computer interaction (HCI) as a tool for challenging gender biases embedded in digital platforms. Drawing on feminist technoscience and design justice, it critiques the ways in which AI and algorithmic decision-making perpetuate systemic inequalities and proposes a framework for more inclusive digital environments.

14. **ESCape: Sharing Experiences Through Visual Storytelling During COVID – Hana Pokojná**

    This personal reflection explores how visual storytelling, from street art to masked statues, helped individuals cope with isolation and uncertainty during the COVID-19 pandemic.

15. **Digitization of Museum Exhibits and Archives: Reconstructing the Admiral Tegetthoff - Joachim Tacha**

    This paper discusses the process of digitising historical artefacts, focusing on the 3D reconstruction of an Austro-Hungarian polar expedition ship and its implications for museum accessibility.

16. **Environmental Media-Center: Empowering Youth for Climate Action - Jasmina Alam-Yalcin**

    This paper describes a project that engages young people in climate activism through media literacy, encouraging them to create digital content that raises awareness about environmental sustainability.

17. **Beyond the Coffee Shop: The Transition of Third Places in the Digital Age - Rghad Balkhyoor**

    Exploring how digital platforms such as clubhouses function as 'third places', this paper examines how social interaction, inclusivity and public discourse have shifted from physical to virtual spaces.

Speculative Fiction Essay

18. **DAVE: Integrating Personalized AI Tutoring for Engaged Learning – Benjamin Joseph Spiteri & Alexiei Dingli**

    This paper presents DAVE, an AI-powered tutoring system integrated into the FAIE platform for Maltese primary schools. Using Large Language Models and real-time data, DAVE provides personalized support in mathematics. Evaluations show improved performance and satisfaction, especially among lower-performing students. The system demonstrates how AI can enhance educational equity through adaptive, student-centred learning.

19. **Reimagining the Zombie Apocalypse in 2024: A Dialogue - Dr Alexander Pfeiffer, Dr Alexander K. Seewald & Nanditha Krishna**

    This speculative essay blends humour, philosophy and technology to explore how modern AI, blockchain and renewable energy will shape a zombie apocalypse scenario, raising ethical questions about sentience and human rights.

We hope this anthology sparks new ideas, inspires fresh conversations, and encourages even more exploration in media, arts, and design. Here's to pushing boundaries and imagining new possibilities together!

With curiosity, gratitude, and excitement,

Your Editors

Alexander Pfeiffer | Nanditha Krishna | Michael G. Wagner | Nicholas Jushchyshyn | Klaus Neundlinger | Thomas Wernbacher | Constantin Kraus

P.S.: We'd like to give a heartfelt shoutout to the amazing supporters of the MAD 2024 conference—your contributions and encouragement mean the world to us!

Edith Blaschitz | Viola Rühse | Eva Mayr | Olga Kolokytha | Michaela Wawra | Natalie Denk | Alexiei Dingli | Stephen Bezzina | André Thomas | Hana Pokojna | Simone Kriglstein | Arno Görgen | Lukas Daniel Klausner

PRESTO MANIFESTO!

USING GAME DESIGN LENSES TO BOOST SELF-EFFICACY IN ADDRESSING CLIMATE CHANGE

Anuraj Bhatnagar

Climate change is the defining crisis of the 21st Century, with its effects already manifesting in various parts of the world. The case of the famine in Syria, the farmer suicides crisis in India, and the rising water levels in coastal parts of the world serve as poignant examples of tangible consequences either partially or wholly caused by global warming. Despite efforts to mitigate these effects, existing strategies often fall short due to their inadequacy, limited scope, or short-term nature. In response to this pressing issue, the concept of climate change games, or global warming games, has emerged as a novel approach to raise awareness and explore alternative solutions to combat global warming. This research paper constitutes part of a comprehensive 2-part plan aimed at bridging the gap between theoretical frameworks and practical application. It introduces the design and development of "Presto Manifesto," a macro-oriented clicker strategy game centred on climate change. Drawing from Schellian game design lenses, particularly the Lens of Transformation, the game seeks to boost the collective self-efficacy of climate policymakers and stakeholders by simulating the leadership role within a fictional society's Department of Energy. Future work will shift focus to an evaluative approach, encompassing the collection of empirical data to measure self-efficacy using a customized scale based on Bandura's guide to constructing self-efficacy scales. By combining theoretical insights with empirical data, this research aims to contribute to the advancement of climate change engagement strategies through games.

Keywords: climate, videogames, persuasion, self-efficacy, strategy

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Introduction

Water scarcity and climatic changes have played a critical role in Syria's economic decline (Gleick, 2014). In India, where 60-70% of the population relies on agriculture, contributing about 15% to GDP (CIA Factbook, 2020), climate change has disrupted monsoon patterns, creating unreliable rainy seasons (Bottollier-Depois & Hood, 2018). Combined with long-standing policies, these shifts have fueled an agrarian crisis, notably in the state of Maharashtra (People's Archive of Rural India, 2014). The historic floods across Europe in 2024 (Kimutai et al., 2024) further illustrate the widespread impacts of shifting climate patterns, adding to a growing list of climate-induced challenges faced globally.

Climate science models 4 standard scenarios called Representative Concentration Pathways or RCPs (Wayne). Of these scenarios, RCP 2.6 is the best case, and RCP 8.5 is the worst case, which will come about if companies and governments do not change their approach. The implications of RCP 8.5 have been researched to show potentially irreparable and disastrous consequence (Hausfather, 2019). A 4.9C rise in average world temperature could mean meters of sea level rise, massive biodiversity extinction, frequent extreme weather, water supply stress and more. Although the world is unlikely to be heading towards that scenario (Meyer, 2019), it is still clear from these RCP projections that it is imperative to make substantial changes now rather than later.

This game is an evolution of the author's Master's Project at Georgia Institute of Technology in 2020.

Problem Statement

'To what extent does the application of game design lenses, such as the Lens of Transformation, enhance collective efficacy among climate policymakers and stakeholders?'

Climate change is often regarded as a problem of the future, or a challenge that might be mitigated by current climate programs. However, according to the IPCC climate report, there were 12 years left to readjust for the 1.5-degree climate change scenario as of 2018, one that would see the least damage to human civilization (Rhodes, 2019).

Climate science has advanced significantly over the decades, yet existing efforts to address the crisis are inadequate. There is significant focus on what individuals can do, but this is a collective, structural problem, with collective responsibility (Hormio, 2023), a wicked problem (Sun & Yan, 2016) with no singular solution. It requires a fundamental change in the structure of modern society, and unprecedented international cooperation.

Amongst developed countries, the US is the leading emitter by capita, and is also responsible for 15% of current global emissions (Ritchie and Roser 2020). Developing countries have significantly lower per-capita emissions but are still responsible for an overall high percentage. In addition, some developing countries such as China, have per-capita emissions equal to or greater than several developed countries (World Bank 2014).

For the design of Presto Manifesto, the goal was to create an interactive experience focused on policy change, with the goal of boosting the self-efficacy of policymakers and stakeholders in addressing this crisis. This experience draws from theories related to environmentalism, game design lenses, and the concepts of transition design (Irwin & Steagall, 2021) to address this wicked problem.

Literature Review

A literature review was conducted to examine existing work in climate games and the broader domain of persuasive game design. In the literature review, the work of 20 peer-reviewed sources was explored and characterised as a typology of two broad categories based on their central

purposes. These papers were examined to discover opportunities for further exploration of the domain and build on the work of prior developers. Alongside that, the evaluation processes were scrutinised, with the aim of further fine-tuning the design process and reducing the risk of pitfalls.

Persuasive Games offer designers and researchers opportunities to influence audiences directly towards areas that they deem to be of significance or impactful for sections of society (Bogost, 2010). While this is a laudable goal, the review sought to delve deeper into the literature around the strategies and tactics used in games and frameworks that are explicitly considered to fall within the domain of Persuasive Game Design (PGD), as well as explore the work that has been done in evaluating their effectiveness. When designing these games and frameworks, developers are explicitly or implicitly seeking to gamify persuasion, whether in the fields of healthcare (Gerling et al., 2014; Orji et al., 2013; Khaled et al., 2007), socio-economics (Lavender, 2007), geopolitics (Jacobs, R. S., 2018; Soekarjo, M., & van Oostendorp, H., 2015; Van't Riet et al., 2018), as well as climate change, (Abraham & Jayemanne, 2017; Fernández Galeote & Hamari, 2021; Ouariachi et al., 2019), energy conservation(Gamberini, 2011), climate education (Kwok, 2019; Meya, & Eisenack, 2018), and sustainability (Douglas, & Brauer, 2021; Koroleva & Novak, 2020).

The papers explored in the review can be described in two categories - Type 1, or PGD strategies, and Type 2, or Efficacy Studies. All the games covered had some form of impact on players. However, there seem to be conflicting results on the effectiveness of commonly utilised PGD principles in comparison to other forms of persuasive media.

The typology is not based on firm categories but a broad indication of how these papers can be grouped. Each of the papers proposed a variety of methodologies and deal with different topics, however, they shared certain similarities - the intent being to lay out a proposal for a particular approach, a way of testing that approach in game design practice, as well as general tips for broader usage.

A methodology proposed by Siriaraya et al. drew a cookbook analogy for the PGD process, using terms such as ingredients(components), dishes(steps) and utensils(tools)(Siriaraya et al., 2018). de la Hera Conde-Pumpido laid out a paradigm to study this domain, that mapped out the structures of PGD based on 3 layers - signs, systems, and context (de la Hera Conde-Pumpido, 2013). This paradigm was used by Jacobs et al. in further building a structure outlining the major characteristics of 11 games in this space (Jacobs et al., 2017). She was able to map out a typology of different forms of persuasion based on analysis of games (de la Hera Conde-Pumpido, 2017), consisting of three types based on exo-centrism, endo-centrism, and game-mediation.

Khaled et al. highlighted several PGD design problems based on the results of a pilot test on Smoke. Based on the feedback collected, they created a typology of 5 different problems - the question of managing attentiveness, forming balance between replay and reality, balancing player agency vs system control, dealing with issues of identity, as well as explicitly catering towards the ranges of people for whom the persuasive design is intended (Khaled et al., 2007). The issue of target audience can be viewed as a focus of the work of Orji et al. on mapping the BrainHex (Nacke & Mandryk, 2014) model of player types to the Health-Belief Model (HBM) (Rosenstock, 1966). They found that the BrainHex classes respond differently to the characteristics of the HBM (Orji et al., 2013).

Climate change is one of the major existential crises of our time (Schroeder & Kobayashi, 2021), and it has been occupying an increasingly visible space in PGD. Abraham & Jayemanne examined how the environment plays a role in digital games through 4 modes of engagement - as backdrop, as resource, as antagonist, and as text (Abraham & Jayemanne, 2017). Kwok explored the potential of digital and physical games for spreading climate awareness through highlighting the works of EarthGames and projects like KEEP COOL (Kwok, 2019). Koroleva & Novak engaged with the question of gamifying climate awareness, especially around issues that may not directly impact the end-users of the projects (Koroleva & Novak, 2020).

Aside from individual projects, researchers have been working on constructing frameworks for climate engagement. Ouriachi et al. made use of grounded theory to create a model specifically for

climate change engagement through video games. This consisted of 15 key attributes that are classified into three dimensions - cognitive, behavioural, and emotional (Ouariachi et al., 2019). 150 climate change-oriented games were reviewed using this framework, of which 109 were considered as belonging to the serious games domain, with the general observation being that most games adhered to the most recommended attributes of the model, and that six attributes were most commonly associated with serious games, versus one that was most commonly associated with games for entertainment (Fernández Galeote & Hamari, 2021).

Douglas and Brauer conducted a literature review of sustainability-oriented games, classifying them into four avenues - sustainability education, energy management, management of waste and water, as well as transportation and air quality (Douglas & Brauer, 2021).

Such reviews have been conducted across the broader PGD field as well. Ndulue & Orji laid out PGD strategies, based on a review of 130 persuasive games from the years 2001-2021, seeking to find correlations between them and behaviour change. They found that these strategies do influence behaviour positively, but the influence becomes inversely proportional as the number of strategies applied increases (Ndulue & Orji, 2022).

The second type of paper covered in this review deals with evaluations and tests of Persuasive Games and strategies. Lavender designed a game around homelessness and set out a methodology for testing its efficacy (Lavender, 2007). Gerling et al. noted the positive effects of embodied interaction on spreading awareness about the challenges faced by wheelchair-bound people (Gerling et al., 2014). Meya & Eisenack conducted pregame and postgame surveys of 200 students who played KEEP COOL and noted increases in perception of personal responsibility, faith in international cooperation as well as increased support for mitigation (Meya & Eisenack, 2018). Soekarjo & van Oostendorp highlighted characteristics of studies on persuasive games, noting a lack of empirical evidence. They found that 3 out of 4 games lacked studies to evaluate their effectiveness or only had plans for future studies. For the games with empirical data, there was little evidence of sustained long-term change in attitude or knowledge. However, they did observe long-term indications of behaviour change in 3 out of 4 papers. The literature also lacked control conditions, prompting the authors to compare the effects of the game EnerCities to an informative document. They found no significant difference in positive results between the two forms of media. (Soekarjo & van Oostendorp, 2015). By contrast, Jacobs conducted a study on My Cotton-Picking Life, with a control being a video about the same subject of cotton child labour in Uzbekistan. They noted that the game was more effective (Jacobs, 2018). Van't Riet et al. conducted a three-part study, making use of control conditions, with each phase of the study being a comparison between the game Against All Odds and a different type of control condition, noting no significant differences between either game or other forms of media (Van't Riet et al., 2018).

Thus, all games covered in the review had some form of impact on players. It was also evident that these strategies could be shaped into frameworks and models. However, there seemed to be conflicting results on the effectiveness of commonly utilised PGD principles in comparison to other forms of persuasive media.

Several gaps can be found in the literature. One of the most notable gaps is the limited number of climate games – games such as EnergyLife centre around managing a single household, for example, and the domain of what Abraham, B. J., & Jayemanne term as cli-fi games remains small (Abraham, B. J., & Jayemanne, 2017). Notable exceptions to a focus on individual behaviour include board games such as KEEP COOL and videogames such as Red Redemption's Fate of the World (Galeote & Hamari, 2021), but the space remains limited. A second gap lies in the selection of subjects. The participants of these studies were students enrolled at universities, domain experts, academics, game design professionals among others, all of which are fields tied to education or games.

A third gap lies in the limited attention directed towards player motivation. As was noted earlier, the evidence for games providing a unique form of persuasive impact is limited. However, none of

the papers covered looked at addressing the motivations of users to play a game versus engagement with other forms of persuasive media.

The role played by level of engagement is also a gap. In Van't Riet et al.'s work, Against All Odds was explicitly noted in test results as being considered less immersive than the control conditions.

Therefore, the next part of the study is to evaluate, keeping in mind these gaps and drawing from a custom self-efficacy scale to collect data with the help of Albert Bandura's guide (Bandura, 2006) and the General Self-Efficacy Scale (Schwarzer & Jerusalem, 1995). Self-efficacy forms part of Bandura's social cognitive theory. Bandura argued that self-efficacy was a measure of one's perceived capability to perform tasks within a given domain on a regular basis, and collective efficacy was an extension of that concept to apply to a group of people. It should be noted that it is different from self-confidence, which is a broader concept, as self-efficacy is contextual in nature (Bandura, 1997).

Game Discussion

Presto Manifesto broadly falls into the clicker game genre, drawing on elements from persuasive games () in addition to strategy games. For this project, the game was abstracted to its core elements: interactions of policies on each other, and their effects on environment and civilization. The game puts players in charge of policy management for a civilization, where they oversee the development of research and facilities. The Research Tree is the main hub for researching technology and policy, while the facilities tree is where the players use resources and researched technology to manage facilities for their city.

The research tree consists of nodes that represent socioeconomic policy. These policies can be implemented only once. For example, the node "Coal Mining" unlocks the technology of coal mining, allowing the player to have the option to build coal mine facilities.

The facilities tree consists of nodes that are each dedicated to one specific facility. These policies can be implemented multiple times. For example, the facility node "Coal Mine" will create a coal mine each time it is used, provided the player has the resources available.

In both trees, each node lists the name of the research/facility, policy requirements to activate, resource requirements, as well as how it modifies resource growth/loss. Facility nodes also display the number of that facility currently in the game. Certain nodes block others from being possible to activate. To research or create a facility, the player has a set of resources that grow or shrink based on what has been researched and built so far in the game.

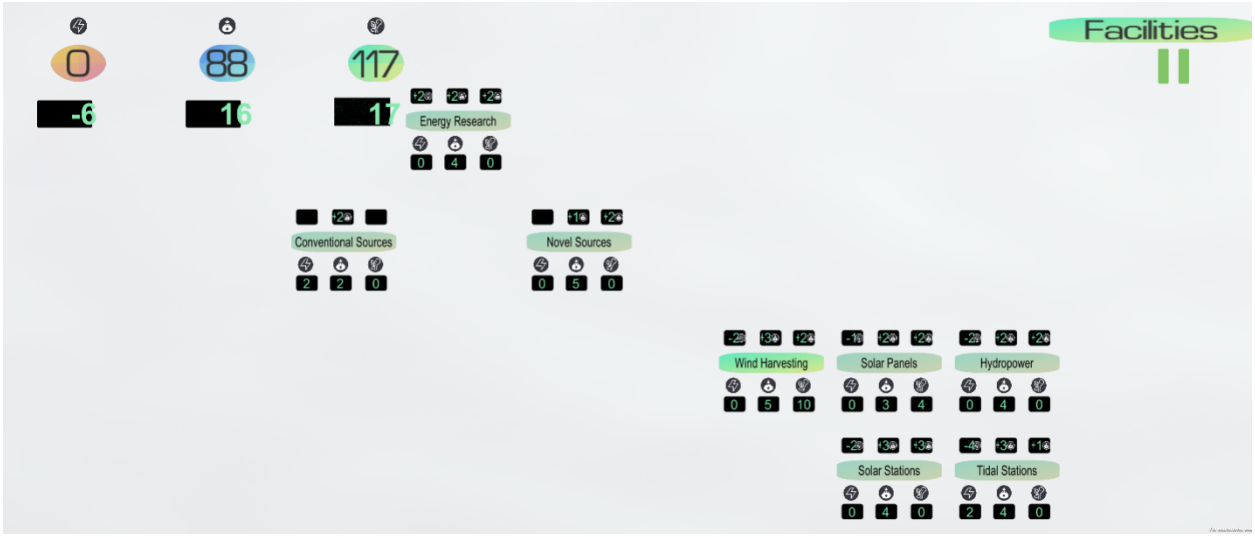

Figure 1. An ingame screenshot of the Research Tree from Presto Manifesto

Figure 2. Another ingame screenshot of the Research Tree

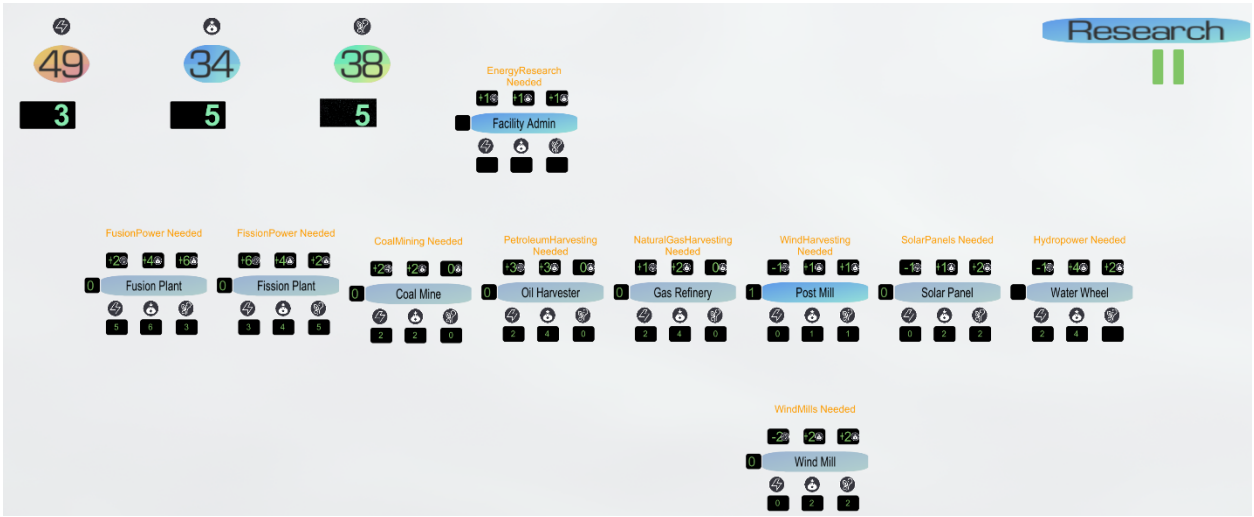

Figure 3. An ingame screenshot of the Facility Tree

Figure 4. An ingame screenshot depicting the pause menu overlay, with the city in the background

The game's backdrop is white, reminiscent of a blank canvas or a vast whiteboard. This deliberate design choice evokes the image of a planning tool, or a brainstorming space often utilized by policymakers. When players enter the pause menu, they are greeted by an image of an isometric cityscape adorning the background. This serves as a reminder of the real-world implications and impact of the decisions made within the game.

Genre

Presto Manifesto is a policy simulator, drawing inspiration from city-building games, real-time strategy (RTS) games, and turn-based strategy games such as Rise of Nations (Microsoft, 2003), StarCraft I (Blizzard, 1998) and II (Blizzard, 2010), Civilization VI (Firaxis, 2016) and Caesar III (Impression Games, 1998).

Because the focus is to bring attention to policy, the game needed to include policy decisions as part of gameplay. City-building and civilization-building strategy games are good bases for building experiences around policy decisions. Although most of these games may not be particularly useful as simulations of human society, they provide opportunities for insight into its complexities (Glean, 2005).

Therefore, to create a strong feedback loop between the interactor's actions and the civilization they were acting within, these games played a major part in shaping the design. They often use policy and policy implementation as a central part of their game loop.

The 'urgency' exemplified in survival games, like in the Armageddon system from Rise of Nations, and in the weather effects from Cities Skylines and Civilization 6 Gathering Storm, are used to model the win-loss conditions in this project. The intention was to make a highly time-intensive gameplay loop, in line with the theme of the brief time left to make changes to the underlying systems responsible for aggravating the climate crisis.

The game genre has shifted through the process, from its start as a walking simulator to a RTS and finally to a clicker game. The project originally started as a post-apocalyptic Walking Simulator, traversing through a dreamlike scenario consisting of elements and memories of a person's life pre- and post-climate apocalypse. However, as the problem statement indicates, the goal of this project is to boost self-efficacy, rather than to create a narrative-based game about the life of an individual and what they lose from the crisis. Therefore, the project shifted towards a strategy game. The intent was to show the need for change from the top, removing the focus on individual accountability and replacing it with a focus on collective responsibility and state

intervention. The project's design initially involved aspects such as unit control, AI, combat, diplomacy, base-building, and many other aspects of RTS games. These aspects took attention away from the core message of the game, so the focus moved towards the elements required for that message. Going back to the problem statement whilst evaluating scope, it was felt that the prototype would be most effective as a clicker game with persuasive elements. This genre would provide a plausible space for the core of the game to shine.

Characters

There are two major characters in the game: the player character, and one NPC, known as the Hidden Player. The player character (PC) represents the Department of Energy as an administrator. In this role, they must research policies and build facilities related to that research. The PC is intentionally left without a clear identity or designation to represent the universality of the game- they could be a part of any government anywhere in the world. The details of the internal bureaucracy are avoided, to broaden the context as widely as possible. The player character's actions are inherently tied to both the other characters. The player has three types of resources at their disposal, and the hidden player is a representation of factors that the player does not have direct control over. More information about these resources is provided in a subsequent section. The Hidden Player keeps track of resources associated with civilization and energy. Every action the player takes affects the hidden player. For instance, there are only a finite number of non-renewable resources that can be harvested. When the player's stock increases, the Earth player's stock decreases.

Goals

This prototype was designed with goals based on sustainable development and utilisation of resources. The objective of the player is to move towards a policy platform built upon 100% novel energy. However, the game does not openly instruct the player to do this. The way to reach this goal is to be discovered by the player, using trial and error. This obfuscation is intentional - done to give players opportunities to question and evaluate the standard strategy game perspective of maximising resources to win - strategies which model current policy strategies.

To reach the win state, the player needs to bring their conventional energy change rate down to zero (i.e., using no conventional resources) and increase their novel energy and wealth rate past a certain threshold within the given time limit. This has the effect of bringing up the civilization's wealth and satisfaction, as well as bringing down discontent. This is how the player "saves their civilization" and wins the game. To attain these goals, the player needs to level up renewable research and build facilities related to that research. They must avoid the route of conventional energy, more profitable and lucrative in the short term though it may be. At this stage, it is up to the player to keep civilization running and to win the game. The game is won if the player can move to a renewable policy platform. The player will face not just climate-related issues but potential dissent from within their civilization. Climate effects occur because of issues faced by the hidden players- exploitation of primary sources will lead to these problems.

These goals have been designed keeping in mind the Lens of the Tetrad, specifically the Lens of the Story (Schell 2008). As per the Lens of Story, stories and games take place in the world, and this project's world is a setting which is in the middle of the Information Age. More information about the game design lenses can be found in the game design lenses section.

Mechanics

A game is made up of objects, and the verbs are how players interact with them (Anthropy & Clark, 2014). Real-Time Strategies like Rise of Nations, Caesar, and Cities Skylines (Colossal Games, 2015) and even turn-based strategy games like Civilization are the inspiration for the objects

and verbs for the game. These include objects such as resources, research, and policies, and verbs such as the methods to implement those objects: harvesting resources, upgrading technologies, researching policies.Presto Manifesto has primarily been designed using traditional RTS mechanics. The primary interaction involves players choosing which research or facilities they would like to spend resources on.

Resources

For any human civilization to prosper, it needs resources. A basic resource management system is therefore central to many RTS and civilization-building games, such as those indicated in the previous section, and is the crux of this game's experience.

This is a climate change experience and draws from ecological principles rather than the "4X" model- 'eXplore, eXpand, eXploit, and eXterminate' model used by some of the strategy games cited. As such, sustainable harvesting and utilisation of resources needs to be considered. To accomplish a 'check' or 'measure,' the hidden player exists, representing the civilization and the Earth. This NPC is analogous to the Director from Left 4 Dead (Valve, 2008).

This hidden player has its own rate of collecting resources behind the scenes. The human player's actions of gathering conventionals and wealth shall reduce this bank. Should energy or wealth fall to zero, or negative, the player will lose the game. The same applies to the rate of collecting those.

The following resources are a part of the game design, alongside the character they are associated with.

Player

The set of resources available to the player are: conventionals, novels, and wealth. Conventionals, indicative of non-renewable energy, are finite in nature. Although the player can utilise their research and facilities to increase their accumulated conventional energy, the amount of energy is drawn from a hidden resource pool representing Earth's finite resources, that replenishes at a much slower pace. A growth for conventionals means that this hidden pool is diminishing at an equal loss rate. Should resources be completely depleted from the pool, the player loses the game. This value is reduced not just by a constant growth rate, but also by the player's utilisation of their accumulated conventional energy.

A similar scenario exists for the wealth resource, where the player's wealth is drawn from a hidden background value, representing real wealth. If this bank is depleted, then the player loses the game. However, this hidden value replenishes significantly faster, representing the production of wealth by the civilization.

Finally, novels are indicative of renewable sources. These include solar, wind and hydroelectric power, but also nuclear power generated from fusion plants. On the other hand, power from fission is considered as part of conventionals. This differentiation is borne because fusion reactors are considered as safer and generate less hazardous waste (IAEA, 2016), although it should be noted that improvements in fission reactor design in the last couple of generations (Gen III and Gen IV reactors) have greatly reduced the likelihood of major disasters such as Chernobyl or Fukushima Daichi (Baudrand et al., 2012; World Nuclear Association). It should also be noted that in both cases, the reactors that failed were Gen II (World Nuclear Association).

Hidden Player

The Hidden Player has the same types of resources as the player, except for two additional civilization metrics and time, representing the time left for the player to act before it is too late to deal with the climate emergency. Once time has run out, the game is over. To design the time

variable, StarCraft 2's multiplayer served as a key inspiration, specifically, the timing aspects. In a 1 versus 1 multiplayer match, time is of utmost urgency. Depending on the skill level of the league, a player can fall well behind their opponents if they waste even a few seconds. This aspect is one of the key parts of the project's gameplay loop- emphasis on the limited time available. As such, this project is one where the game, as opposed to an enemy player, puts pressure on players to be fast.

Civilization metrics are represented by internal values of wealth, satisfaction, and discontent. These values are tied to the 3 resources available to the player alongside their change rates. The values of these are tied to the game's ending. Civilization metrics represent the denizens under the player's governance. Their satisfaction is key to continued prosperity. The net satisfaction is affected by not just already-collected resources, but also by the question of resource collection for the near future, as well as by the policies passed by the player. This means that the player should not just have a stockpile of resources, but also a method to ensure that resource collection is continued. This can only happen via a careful moderation of resource-harvesting in the case of primary sources, and a move towards renewable sources. Similarly, discontent serves the purpose of gauging how unhappy the populace is, and the player gets different defeat states depending on these values. Thus, there is an element of granularity in this simulation – it is possible for the player to have both elevated levels of satisfaction as well as elevated levels of discontent, reflecting that they may have pleased some groups while upsetting others.

The energy metrics serve as representations of the finite nature of Earth's resources, acting as a counterforce to the prevalent strategy of unsustainable harvesting and maximal resource utilization in many games. These metrics encompass tracking, with player-implemented policies capable of impacting one or more of these resources, while the resource change rate from built facilities also exerts influence. Although the changes in the rate and sum of these resources are identical for both the player and the hidden player, their starting rates and stockpiles differ. The player starts at 0, whereas the hidden player commences with a certain threshold of resources.

Tech Tree

There are 2 main Tech Trees: research and facilities. The research tree nodes involve research concepts related to energy production, while the facilities tree nodes are unlocked based on the research concepts chosen by the player and are used to build structures. These trees are the main way the player interacts with the game and are how they pass policies. The player traverses through the tech trees via implementing research and facilities. Starting off from the root node in either case, they proceed downwards, moving through branches and sub-branches. Each branch of the tree is dedicated towards research/facilities related to its root node. Certain nodes may restrict access to other nodes, and certain nodes may have prerequisite nodes to activate. Therefore, a player could potentially be locked out of a whole branch. The core progression loop has been designed keeping in mind the Lens of Surprise (Schell 2018). This Lens argues that surprise is essential for concepts like intrigue, suspense, and unexpectedness within a game. As such, the existence of the hidden players and their relation to events provide a layer of abstraction but also provide an element of surprise. Some of the policies in the facilities tree and the research tree are shown in the tables below. Note that the numbers indicated are subject to change based on accuracy, playtesting, and game balance. These policies have an impact on either the hidden player or the player or both, in the metrics of rate of conventionals, novels and wealth, as well as satisfaction and discontent in the case of the hidden player.

Research Policies

Policy	Energy cost	Wealth cost	Time	Satisfaction	Discontent	Research pre-reqs	Conventional change	Novel change	Wealth change
Energy Administration	2	2	1	4	-2		2	2	2
Coal Power	3	2	5	-8	10	Conventionals	3	0	3
Wind Power	3	4	4	5	-2	Renewables	0	4	3
Novels	3	3	3	5	-3	Energy Administration	0	3	2
Wind Turbines	2	3	1	4	-2	Wind Power	0	3	4
Windmill	4	5	2	4	-3	Wind Turbines	0	5	6
Wind Farm	6	8	6	5	-4	Windmill	0	10	10
Hydropower Turbine	2	3	1	4	-2	Hydropower	0	3	4
Hydropower Plant	4	5	2	4	-3	Hydropower Plant	0	5	6
Solar Cells	2	3	1	4	-2	Solar Power	0	3	4
Solar Farms	4	5	2	4	-3	Solar Farms	0	5	6
Solar Installations	6	8	6	5	-4	Solar Installations	0	10	10
Thermal Reactor	3	2	5	-3	-1	Coal Power	4	0	10
Subcritical Plant	3	2	5	-3	-1	Thermal Reactors	4	0	10
Supercritical Plant	3	2	5	-3	-1	Subcritical Plants	4	0	10
Fission Reactor	3	2	5	-3	-1	Nuclear Power	4		
Fusion Reactor	4	5	20	4	-3	Nuclear Power	0	5	6

Petroleum Harvester	4	3	20	-4	-3	Conventionals	7	0	6
Oil Rig	4	3	20	-4	-3	Petroleum Harvester	7	0	6

Figure 5. Research Tree

Facility Policies

Policy	Energy cost	Wealth cost	Time	Satisfaction	Discontent	Facility pre-reqs	Research pre-reqs	Conventional change	Novel change	Wealth change
Energy Department	2	2	1	3	-2		Energy Administration	2	2	2
Coal Mine	3	2	5	-3	-1	Energy Department	Coal Power	4	0	5
Thermal Reactor	3	2	5	-3	-1	Coal Mine	Coal Power	4	0	10
Subcritical Plant	3	2	5	-3	-1	Thermal Reactor	Thermal Reactors	4	0	10
Supercritical Plant	3	2	5	-3	-1	Subcritical Plant	Subcritical Plants	4	0	10
Wind Turbine	2	3	1	4	-2	Energy Department	Wind Turbine	0	3	4
Windmill	4	5	2	4	-3	Wind Turbine	Windmills	0	5	6
Wind Farm	6	8	6	5	-4	Windmills	Wind Farm	0	10	10
Hydropower Turbine	2	3	1	4	-2	Energy Department	Hydropower Turbines	0	3	4
Hydropower Plant	4	5	2	4	-3	Hydropower Turbine	Hydropower Plant	0	5	6
Solar Panel	2	3	1	4	-2	Energy Department	Solar cells	0	3	4
Solar Farm	4	5	2	4	-3	Solar Panel	Solar Farms	0	5	6

Solar Installation	6	8	6	5	-4	Solar Farm	Solar Installation	0	10	10
Fission Reactor	3	2	5	-3	-1		Nuclear Power	4	0	10
Fusion Reactor	4	5	2	4	-3		Nuclear Power	0	5	6

Figure 6. Facility Tree

Victory/Defeat States

The game uses common civilization-building stereotypes to imply that the interactor's goal is to maximise their resource gathering and to research to reach the end of the research tree. However, the reality is that there is only one way to achieve a victory condition, and that is by switching to a 100% renewable policy platform. This design choice was made to model the current thinking that has led to the climate crisis. However, it is through breaking from these assumptions and switching to a 100% renewable policy platform that allows the player to achieve a victory condition in which the civilization is saved.

Victory State

There is only one victory condition in the game, and that is met when the civilization's satisfaction, resource growth rate and wealth meet a certain positive threshold, alongside the player's conventional energy growth rate reaching zero or negative.

This singular victory state broadly considers all the aspects needed for a solution to climate change in real life. This victory state means that the player's government has intervened for the better, moving their civilization towards the path of sustainable development without crashing their economy or burning bridges with their people.

Defeat States

There are 5 different defeat states. The first state involves energy, specifically conventionals, being depleted and the ecological collapse that follows. The second state involves a depletion of wealth, leading to an economic collapse. The third state involves revolution, when the values of discontent are too high. Low satisfaction threshold, on the other hand, leads to the player getting voted out of power. The final defeat state is related to time running out, without the player achieving the win state.

Game Design Lenses

The game's design and genre were chosen keeping in mind several game design lenses- especially the Lens of Transformation (Schell 2008). Alongside transformation, the other lenses are problem statement, player, elemental tetrad, and surprise.

As per Schell, transformation poses the question of how the game influences the player – for better or worse. Hence, this is the most important lens for this project. The goal is to provide a climate change gameplay experience in the vein of City-building games, and to ensure that players walk away from it with purpose and determination in their ability to combat climate change.

Problem statement poses the question of the problem to be solved and about assumptions that may have an impact on the design, and whether a game can be considered the best solution to them. As a result, it allows designers with a tool to problematize (Alvesson & Sandberg, 2011) their work as well as existing designs. Problematization allows for generating interesting research questions and is part of the rationale behind the question this paper seeks to answer and its second part.

The player lens poses questions related to the target audience – their preferences, likes, dislikes, expectations, and context.

The elemental tetrad is further subdivided into 4 lenses – story, aesthetics, technology, and mechanics. It poses questions related to these elements and whether they work in harmony in the existing design.

The final lens poses the question of whether the design provides opportunities for surprise – unexpected circumstances, consequences of choices and more have the potential of providing dynamic gameplay. The capabilities of the hidden player and the similarities to the Director from Left 4 Dead are essential for concepts like intrigue, suspense, and unexpectedness.

Conclusion

Presto Manifesto is about boosting the self-efficacy of policymakers, and focuses on policy making, with the winning strategy being one that broadly aligns with the principles of sustainable ecology - responsible to its people and responsible to its environment. Outside of the game, considering factors such as time, such policies are some of the few remaining paths that would allow our species to cut global emissions in half by 2030 and reach the 1.5C threshold.

The design of Presto Manifesto, however, does not consider additional factors. Climate change is a global problem, and the current design only focuses on one specific state. Additional AI players would address this and could be a part of future work for this project, alongside the features that would be a part of such a broader project (including diplomacy, trade, etc). Similarly, factors such as satisfaction and discontent are monolithic in the current game, ignoring variances in class, gender, age, race, or origin. These factors need to be considered as well, in a manner that does not make harmful assumptions about different communities or reinforce stereotypes.

Similarly, additional climate effects need to be incorporated into the design. This problem is not one that necessarily hits the player all at once, rather it is one that starts off gradual and intensifies rapidly. The solution is remarkably specific, focusing primarily on the time limit left, rather than the consequences. However, a feature-complete game would also simulate the consequences and the magnitude of their growth.

An additional direction for future work could be integrating real-world scenarios as individual levels informed by scenario-specific data. For example, France's transition to nuclear power in the 1970s (Hecht, 1992) could illustrate the inception, process, and outcomes of such transitions.

Furthermore, while the current design incorporates energy categories and sub-categories, greater granularity is possible. A more detailed approach could capture nuanced cases, like fission power, with specifics on reactor designs and regulations.

Finally, expanding the project to engage the public, beyond policymakers, could enhance grassroots-level self-efficacy through community-focused gameplay that emphasizes collective efficacy.

However, in its current state, the design of Presto Manifesto does meet the research goal of this project. Throughout the design process, decisions were made that highlighted both the urgency and need for high-level policy change and enabling policymakers to test different policies in a virtual setting. This led to an interactive experience that draws attention to the need for urgent policy change and boosts the self-efficacy of players by giving them opportunities to explore the ramifications of their actions.

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EMPHASIZING FUNCTION IN DESIGN FOR DISABILITIES:

THE ROLE OF AI AND ML IN DESIGN PROCESS OF ASSISTIVE WEARABLE TECHNOLOGY AND SMART JEWELRY

Arefeh Ahmadi, Emil Polyak, Michael G.Wagner

This paper ventures into the pivotal role of design functionality in creating assistive technology for disabilities, with a specific focus on the integration of Artificial Intelligence (AI) and Machine Learning (ML). It posits that in the realm of assistive technology, particularly wearable devices like smart jewelry design, function is as critical as form. At the heart of this discussion is the concept of 'functionality' in design, especially for individuals with disabilities. This is not merely about the aesthetic or physical attributes of a product but about how effectively it can meet the specific needs and challenges faced by people with disabilities. The paper argues that while traditional design aesthetics are important, the true measure of success in assistive technology lies in its functionality. The paper will explore several key areas where AI and ML are making significant strides in enhancing the functionality of design for disabilities. These include acoustic modeling and optimization, where AI algorithms are used to simulate and analyze how various jewelry designs can affect sound movement, thus aiding individuals with hearing impairments. Additionally, the concept of generative design is examined, highlighting how AI can craft jewelry shapes that are not only aesthetically pleasing but also customized for acoustic needs and ear anatomy. Personalization is another critical area discussed, emphasizing how AI and ML can gather data on individual hearing impairments and ear anatomy to create bespoke jewelry designs, thereby ensuring a higher level of functionality and comfort for the user. The paper will also touch upon how AI-driven tools like virtual try-on with augmented reality (AR) technologies are redefining the user experience, enabling individuals to visualize and choose designs that are not only visually appealing but also functionally apt.

Keywords: Smart Jewelry Design, AI-Driven Customization, Functional Design for Disabilities, Acoustic Optimization, Inclusive Wearable Technology, Artificial Intelligence (AI), Machine Learning (ML), Ergonomic Design for Disabilities, Design Process, Ecofriendly Smart Designs

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Introduction

The evolution of assistive technologies, particularly in the domain of smart jewelry for individuals with hearing impairments, necessitates a paradigm shift in design philosophy. This paper explores the innovative intersection of aesthetics and functionality, facilitated by the integration of Artificial Intelligence (AI) in the design process. While traditional approaches often struggle to balance form and function, we propose a new paradigm: an "organic digital medium" where designers can focus primarily on aesthetics while AI continuously optimizes for acoustic performance.

In this new approach, the efficacy of assistive technology is measured not only by its capacity to address specific user needs but also by its ability to do so while maintaining high aesthetic standards. The advent of AI and Machine Learning (ML) has ushered in unprecedented possibilities for augmenting the functionality of smart jewelry without compromising its visual appeal.

AI algorithms attempt to facilitate sophisticated simulation and analysis of sound propagation in relation to jewelry design, offering substantial benefits for individuals with auditory impairments. Through this continuous optimization, designers attempt to create jewelry that effectively attenuates unwanted noise or enhances sound clarity, all while preserving their intended aesthetic vision.

The true potential of smart jewelry lies in this seamless integration of form and function. By leveraging AI, we can create designs that are not just visually appealing or functionally effective, but a harmonious blend of both. This approach promises to Innovate the field of assistive technology, making it more inclusive, personalized, and aligned with user preferences.

However, as we delve into these technological advancements, it is crucial to acknowledge the ethical considerations that accompany the integration of AI in assistive design devices. Later in this paper, we will explore important aspects such as data privacy, user consent, and the potential implications of relying on AI-driven systems for essential daily functions. These ethical considerations are integral to ensuring that our pursuit of innovation remains responsible and user centric.

In the following sections, we will explore how this AI-driven design process works, its implications for both designers and users, and the challenges and opportunities it presents for the future of smart jewelry design for hearing impairments. We will also address the ethical framework necessary to guide the development and implementation of these technologies, ensuring that they not only enhance functionality but also respect user rights and privacy.

2. Literature Review

The intersection of design and functionality in assistive wearable technology has evolved significantly over the past decades. Early assistive devices were primarily focused on functionality with little attention to aesthetics. As technology advanced, the integration of design elements began to take shape, with an increased emphasis on creating products that were not only functional but also visually appealing (You et al., 2020).

Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have opened new avenues for the development of assistive wearable technology. AI and ML algorithms are now being utilized to enhance the functionality and personalization of these devices, making them more effective for individuals with disabilities (Ottoboni et al., 2022). AI-driven tools are being employed to optimize acoustic properties and improve sound clarity in hearing aids and smart jewelry. Techniques such as real-time acoustic modeling and optimization are enhancing the user experience for individuals with hearing impairments (Aung et al., 2021).

ML algorithms gather data on individual users to create bespoke designs that cater to specific needs, such as unique hearing profiles and ear anatomy. This personalization is critical for improving the efficacy and comfort of assistive devices (Lonini et al., 2017). AI-powered generative design is being used to create jewelry shapes that are both aesthetically pleasing and functional. This approach allows for the creation of custom-fit designs that optimize both form and function (Cheein et al., 2010).

Augmented Reality (AR) and virtual try-on technologies enable users to visualize and choose designs that meet both aesthetic and functional requirements. This technology enhances the shopping experience and ensures that users select the most suitable devices (Madahana et al., 2022).

Ethical Considerations in AI-Powered Assistive Technology

As AI-powered assistive technologies become more prevalent, ethical considerations have gained increasing attention in literature. Wangmo et al. (2019) conducted a qualitative study with professional stakeholders, highlighting key ethical concerns such as privacy, data security, and the potential for reduced human interaction. Their findings emphasize the need for a balanced approach that maximizes the benefits of AI while mitigating potential risks.

Ienca et al. (2018) provided a comprehensive review of ethical design principles for intelligent assistive technologies, particularly focusing on applications for individuals with dementia. They identified key ethical issues including privacy, autonomy, beneficence, and justice, and proposed a framework for ethically aligned design of these technologies.

Mittelstadt et al. (2016) mapped the ethical challenges posed by algorithms, many of which are directly applicable to AI-powered assistive devices. They highlighted issues such as opacity of decision-making processes, bias in data and algorithms, and the potential for discrimination or unfair treatment.

Brey (2005) explored the ethical implications of ambient intelligence technologies, which share many characteristics with modern AI-powered assistive devices. His work emphasized the importance of user control, transparency, and the preservation of privacy in these increasingly pervasive technologies.

Despite these advancements, several gaps and challenges remain in the field of assistive wearable technology. While significant progress has been made, achieving a perfect balance between aesthetics and functionality is still a challenge. Many devices tend to prioritize one aspect over the other, leading to compromised user experience (Wangmo et al., 2019). The ability of assistive devices to adapt in real-time to changing environmental conditions and user needs is still limited. Enhancing the adaptability of these devices through advanced AI algorithms is a crucial area for future research (Cincotti et al., 2008). Ensuring that assistive technology is accessible and inclusive for all individuals with disabilities remains a significant challenge. Research needs to focus on developing designs that cater to a broader range of disabilities (Standen et al., 2020).

3. Design Methodology

This study aims to address some of these gaps by exploring the role of AI and ML in enhancing the functionality of assistive wearable technology, specifically smart jewelry design for individuals with hearing impairments. By integrating Dynamic acoustic management, AI-driven personalization, and advanced design techniques, this research seeks to create devices that are both aesthetically pleasing and highly functional. The emphasis on user-centric design and the use of AI to continuously optimize and personalize the user experience highlight the innovative approach of this study. It aims to contribute to the existing body of knowledge by providing new insights into the seamless integration of form and function in assistive wearable technology, while also addressing the ethical considerations that arise from the use of AI in these critical applications.

The integration of AI and ML in assistive wearable technology represents a significant advancement in the field. However, achieving a balance between aesthetics and functionality, ensuring real-time adaptability, and enhancing accessibility and inclusivity remain key challenges. This study's focus on AI-driven especial design and personalization aims to address these challenges and contribute to the development of more effective and aesthetically pleasing assistive devices.

Figure 1 (Smart Design methodology framework)

3.1 User-Centric Research and Needs Analysis

The design process begins with comprehensive user research to identify the needs and challenges of individuals with hearing impairments. This phase involves interviewing potential users, caregivers, and audiologists to gather insights. Existing assistive technologies are analyzed to understand their limitations. Quantitative data on user preferences and desired functionalities is collected. User personas are developed to guide the design process. This user-centric approach ensures the resulting smart jewelry addresses real-world problems while meeting aesthetic preferences.

3.2 AI-Driven Acoustic Modeling and Dynamic Acoustic Management

AI algorithms can create acoustic models that interact dynamically with the design process. AI algorithms are developed to simulate sound propagation in various environments. Digital models of different ear anatomies are created to test acoustic properties. Real-time adaptive algorithms are implemented to adjust acoustic properties based on design changes. Natural language processing is integrated to improve speech recognition and sound filtering. The key innovation is Acoustic Management, where AI continuously adjusts the internal structure of the jewelry design to maintain optimal acoustic performance as designers make aesthetic choices.

3.3 Aesthetic Design with AI Assistance

AI focuses on jewelry design, with AI serving as an assistive tool. Designers create initial concepts emphasizing aesthetic appeal and wearability. AI provides real-time feedback on how design choices impact acoustic performance. Designers iterate on their designs, guided by AI suggestions for maintaining functionality. AI offers alternative design elements that could enhance acoustic properties while preserving aesthetic intent. This collaborative process between designer and AI ensures the final product is both visually appealing and functionally effective.

3.4 Prototyping and AI-Assisted Testing

This phase involves creating physical prototypes and using AI for testing. Rapid prototyping techniques produce multiple design variations. AI-driven testing protocols simulate various use scenarios and acoustic environments. Machine learning algorithms analyze test results and suggest improvements. User testing is conducted with AI-enhanced data collection and analysis. This combination of physical prototyping and AI-assisted testing ensures thorough evaluation of each prototype from technical and user-centric perspectives.

3.5 Iterative Refinement

The final phase focuses on refining the design based on collected data. AI synthesizes insights from user feedback, acoustic performance data, and aesthetic evaluations. Designers make final adjustments to optimize the balance between form and function. The AI system continues to learn from this process, improving its ability to assist in future designs. This methodology emphasizes the interplay between human creativity and AI optimization, ensuring the final product achieves both aesthetic excellence and functional superiority.

3.6 User Feedback Integration and Iterative Design

This phase incorporates user feedback and iteratively refines the design. User trials are conducted with functional prototypes. Qualitative and quantitative feedback on usability, comfort, and effectiveness is gathered. AI analyzes feedback data to identify areas for improvement. Design changes are implemented based on user feedback and AI-generated insights. The prototyping and testing process is repeated with refined designs. This iterative approach ensures the final product meets the real-world needs and preferences of users.

3.7 AI-Enhanced Manufacturing and Quality Control

The transition from finalized design to manufacturable product is a critical phase enhanced by AI technologies. At the forefront of this process is the development of AI-optimized manufacturing processes specifically tailored for smart jewelry production. These processes are complemented by machine learning algorithms that enable predictive maintenance and quality control, anticipating potential issues before they occur and thereby reducing waste and improving overall efficiency. Computer vision and AI play a crucial role in the automated inspection of finished products. Advanced systems can detect defects that may be imperceptible to the human eye, ensuring each piece of smart jewelry meets exacting standards of quality and functionality. To further optimize production, digital twins of the manufacturing process are created, allowing for continuous refinement and improvement of the production line. Lastly, the implementation of blockchain technology adds an extra layer of quality assurance by ensuring the traceability and authenticity of materials and finished products. This not only enhances the reliability of the supply chain but also provides consumers with confidence in the provenance of their smart jewelry.

Through these AI-driven innovations, the manufacturing process becomes a seamless extension of the design phase, maintaining the integrity of the original concept while ensuring consistent, high-quality production.

4. AI-Assisted Design Process for Acoustic Optimization

The integration of AI in jewelry design for individuals with hearing impairments represents a revolutionary approach to balancing aesthetics with acoustic functionality. This section elaborates on the sophisticated processes involved in real-time sound simulation and design optimization.

4.1 Dynamic Acoustic Management Simulation

The AI system employs advanced computational acoustics to simulate sound propagation and clarity in Dynamic Acoustic Management. It uses Finite Element Analysis (FEA) to model sound wave interactions with jewelry designs. It divides the 3D space around and within the jewelry into small elements, calculating

sound pressure and particle velocity for each element. For external sound fields, Boundary Element Method (BEM) is employed to efficiently compute sound radiation and scattering, crucial for understanding how jewelry affects ambient sound. Frequency Domain Analysis is performed. The AI performs Fast Fourier Transforms (FFT) to analyze the jewelry's acoustic response across different frequencies, typically ranging from 20 Hz to 20 kHz to cover the full spectrum of human hearing. For transient acoustic events, like speech or sudden noises, the AI uses time-domain methods to model how the jewelry affects sound clarity over time.

4.2 Adaptive Mesh Refinement

To maintain real-time performance while ensuring accuracy, the AI uses adaptive mesh refinement. Dynamic Meshing is employed. The AI continuously refines the simulation mesh, increasing resolution in areas of complex geometry or significant acoustic activity. Multi-Resolution Analysis is used. Less critical areas use a coarser mesh to save computational resources, allowing for real-time updates even on complex designs.

4.3 Material Acoustic Properties Integration

The AI incorporates detailed acoustic properties of materials. Absorption Coefficients are modeled. Frequency-dependent absorption is modeled for each material, affecting how sound energy is dissipated. Impedance Modeling is considered. The AI considers the acoustic impedance of materials crucial for understanding sound transmission and reflection at material interfaces. Resonance and Damping are factored in. Natural frequencies and damping characteristics of materials are factored into the simulation.

4.4 Psychoacoustic Modeling

Beyond pure acoustics, the AI integrates psychoacoustic principles. Loudness Perception is modeled. The AI models how the human ear perceives loudness across frequencies, using models like Stevens' power law. Masking Effects are considered. Simultaneous and temporal masking are considered to predict how the jewelry might affect speech intelligibility in noisy environments. Binaural Integration is simulated. For pairs of earrings or hearing aids, the AI simulates binaural hearing effects, including interaural time and level differences.

4.5 AI-Driven Design Adjustments

As the designer works, the AI suggests subtle modifications to optimize acoustic performance. Topology Optimization is used. Using algorithms like SIMP (Solid Isotropic Material with Penalization), the AI proposes internal structural changes that maximize acoustic performance while adhering to manufacturing constraints. Shape Morphing is employed. The AI employs gradient-based optimization to suggest small shape adjustments, visualized as heat maps overlaid on the design. Material Distribution Optimization is recommended. Using multi-material optimization techniques, the AI recommends optimal distribution of different materials within jewelry.

4.6 Aesthetic Preservation Algorithms

To maintain the designer's artistic vision, aesthetic preservation algorithms are used. Style Transfer Networks are employed. The AI uses neural style transfer techniques to ensure that any suggested modifications align with the overall aesthetic of the piece. Generative Adversarial Networks (GANs) are utilized. GANs are employed to generate multiple design variations that improve acoustics while closely matching the original style. Constraint Satisfaction Problems (CSPs) are solved. The designer can set specific aesthetic constraints, and the AI uses CSP solvers to find acoustic optimizations within these constraints.

4.7 User-Specific Customization

The AI can tailor designs to individual user needs. Audiogram Integration is possible. The system can incorporate a user's audiogram, optimizing the jewelry's acoustic properties for their specific hearing profile. Head-Related Transfer Function (HRTF) Modeling is considered. For more advanced applications, the AI can consider individual HRTFs to fine-tune spatial audio effects.

4.8 Iterative Learning and Improvement

The AI system continuously learns and improves. Reinforcement Learning is used. The AI uses reinforcement learning techniques to refine its suggestions based on which ones the designer accepts or rejects. Federated Learning is employed. Insights gained from multiple designers using the system are aggregated (while maintaining privacy) to improve the AI's understanding of successful acoustic-aesthetic balances. A/B Testing is suggested. The system can suggest A/B tests for subtle variations, helping to empirically determine the most effective designs.

5. Engineering Principles for AI-Guided Acoustic Jewelry Design

While AI drives the design process, it's crucial to understand the underlying acoustic principles that inform its decision-making. This section explores the fundamental concepts of acoustic engineering that the AI system leverages to optimize jewelry designs for individuals with hearing impairments.

5.1 Acoustic Wave Behavior in Jewelry Structures

The AI's acoustic simulations are based on core principles of sound wave behavior. The AI considers how jewelry surfaces reflect or diffract sound waves. Curved surfaces can be used to focus sound on the ear canal, while irregular surfaces can help diffuse unwanted noise. The AI identifies and utilizes resonant frequencies of jewelry structures. It may suggest creating small cavities that resonate at specific frequencies to enhance desired sounds or dampen unwanted ones. By understanding constructive and destructive interference, the AI can propose designs that use phase cancellation to reduce specific noise frequencies.

5.2 Frequency-Specific Acoustic Filtering

The AI system's suggestions for noise filtering are grounded in specific techniques. The AI optimizes the transition of sound waves between air and the ear by adjusting the acoustic impedance of the jewelry's materials and structures. The AI may incorporate small, precisely tuned cavities acting as Helmholtz resonators to attenuate specific frequencies. For lower frequencies, the AI might suggest incorporating structures that act as quarter-wave resonators, effectively filtering out specific low-frequency noise.

5.3 Acoustic Masking Techniques

To enhance the desired sounds while masking unwanted noise, the AI employs several principles. The AI analyzes the frequency spectrum of ambient noise and desired signals (like speech) to suggest designs that selectively amplify or attenuate specific frequency ranges. By understanding the principles of acoustic beamforming, the AI can propose structures that enhance directionality, focusing on sounds from specific directions while reducing noise from others. In more advanced designs, the AI might incorporate elements of active noise control, suggesting placement of miniature speakers and microphones to create anti-noise signals.

5.4 Material Properties for Acoustic Optimization

The AI's material suggestions are based on specific acoustic properties. Different materials absorb sound energy at varying rates across the frequency spectrum. The AI uses this knowledge to suggest materials that can selectively absorb unwanted frequencies. The AI considers the acoustic impedance of different materials to design effective sound transmission paths or reflective surfaces. Materials with high damping factors can be strategically placed to reduce resonances and improve overall sound quality.

5.5 Psychoacoustic Considerations

AI incorporates psychoacoustic principles to enhance perceived sound quality. Designs are optimized based on equal-loudness contours, ensuring that the perceived loudness across frequencies aligns with the user's needs. The AI uses knowledge of auditory masking to suggest designs that enhance the audibility of important sounds like speech in noisy environments. For designs involving both ears, the AI considers interaural time and level differences to preserve or enhance spatial hearing cues.

5.6 Integration with AI Design Process

These engineering principles are seamlessly integrated into the AI's design process. The AI's acoustic simulations are built upon these fundamental principles, allowing for accurate prediction of a design's acoustic performance. When the AI suggests design modifications, they are grounded in these acoustic engineering concepts, ensuring that each change has a sound scientific basis. The AI's recommendations for material choices and distributions are informed by these acoustic properties, balancing aesthetic considerations with functional requirements. The evaluation metrics used by the AI to assess design quality are derived from these engineering principles, ensuring that the final designs meet both aesthetic and acoustic standards.

6. Design Overview: The Green Voice Smart Jewelry Design (SJD)

6.1 Case Study:

AI-Enhanced Design of Multi-Functional Smart Jewelry design for Hearing Impairments and Disabilities

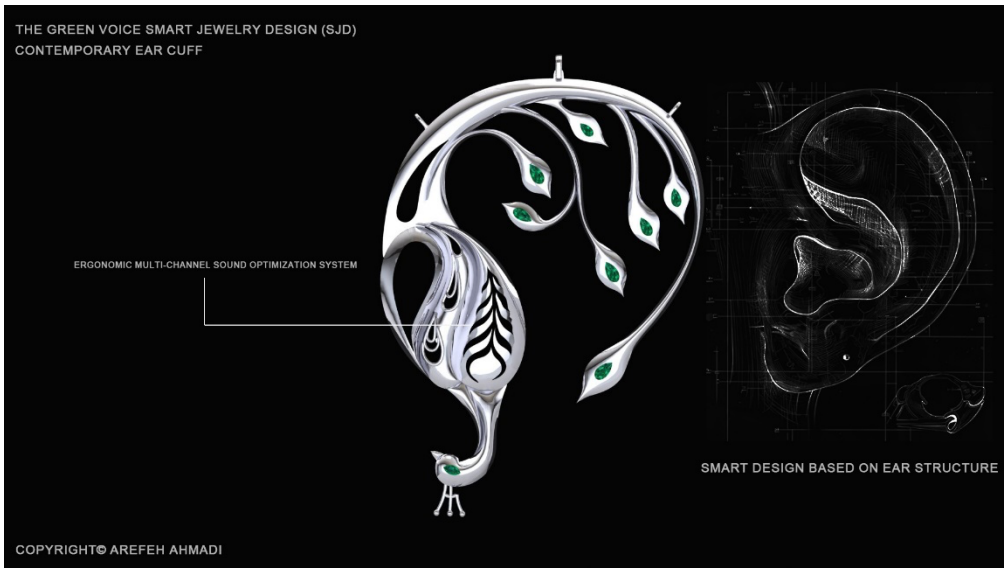

Figure 2 (Smart jewelry design, ergonomic multi-channel)

6.2 Description of the modern, contemporary ear cuff design:

The innovative smart jewelry design presents a modern, contemporary ear cuff that seamlessly integrates assistive technology with aesthetic appeal. This sleek ear cuff features a custom-fit hearing aid capsule, discreetly incorporated into its structure to provide personalized auditory support. The body of the cuff incorporates an ingenious channel design that not only enhances its visual appeal but also serves a crucial functional purpose by covering and protecting the hearing aid components. The design's standout feature is its ergonomic multi-channel sound optimization system, which includes active noise control (ANC) capabilities (Figure1). This advanced system allows for precise audio customization, adapting to the wearer's

specific hearing needs and environmental conditions. The use of eco-friendly "green metal" in its construction underscores a commitment to sustainability without compromising on performance or style. This multifunctional smart jewelry piece represents a harmonious blend of cutting-edge technology, user-centric design, and environmental consciousness, setting a new standard in assistive wearable devices for individuals with hearing impairments.

6.3 Potential AI and ML Contributions to the Design Process

AI-driven optimization could enhance noise-cancelling patterns in the smart jewelry design. Machine learning algorithms could be employed to customize acoustic properties of the jewelry. AI-assisted ergonomic design might be used to adapt jewelry for individual ear anatomy and disability considerations. Adaptive learning systems could be implemented to enable ongoing personalization of the jewelry's performance based on user preferences and changing needs.

6.4 Potential Functional Features for Diverse Disabilities

Active Noise Control (ANC) could be implemented in smart jewelry to improve sound quality in noisy environments. Multi-channel sound optimization might be incorporated to address various types of hearing impairments. The jewelry could include customization capabilities to cater to individual hearing profiles, allowing for personalized audio enhancement. The design could potentially incorporate features for related disabilities, such as balance assistance for individuals with vestibular disorders.

6.5 Potential for Accessibility and Inclusivity Through Design

Smart jewelry design could address challenges commonly associated with traditional hearing aids, such as stigma and discomfort. It might improve social and professional inclusion for individuals with hearing impairments by providing a more discreet and aesthetically pleasing assistive device. User experience could be enhanced through an integrated, discreet design that combines functionality with style. There's potential for smart jewelry to support multiple disabilities in one device, making it a versatile assistive technology solution.

Design Overview:

The Green Voice Smart Jewelry Design (SJD)

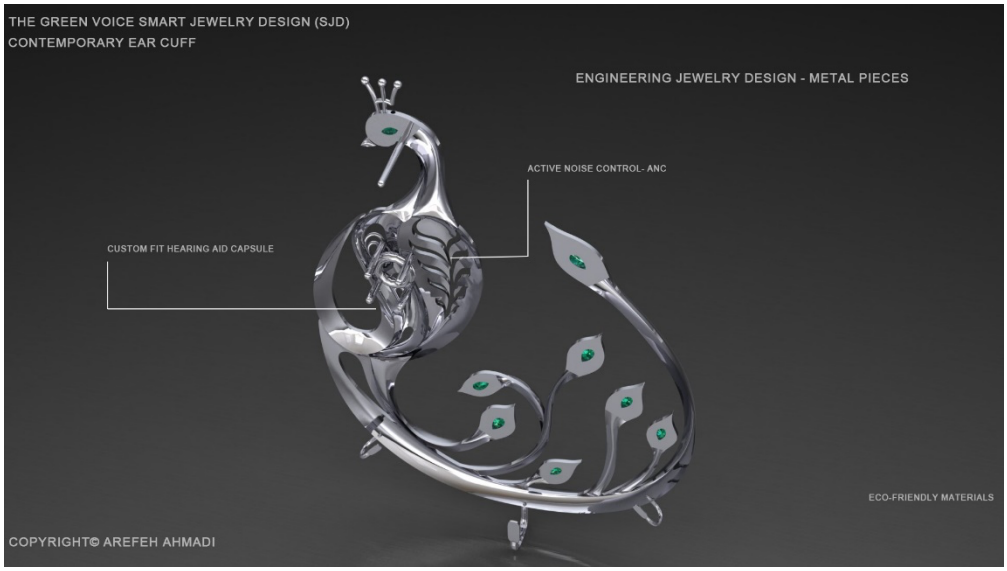

Figure 3 (Smart jewelry design, green metal (eco- friendly, ANC, hearing aid capsule)

6.6 Aesthetic and Sustainability Considerations

Modern Contemporary jewelry design elements could broaden appeal and reduce stigma associated with assistive devices. The use of eco-friendly "green metal" materials demonstrates sustainability potential in the production of smart jewelry. The design aims to balance aesthetics with functional requirements for disabilities, creating a product that is both visually appealing and effective as an assistive device (Figure 2).

6.7 Potential for AI-Driven Personalization and Adaptation

The system could make real-time adjustments based on environmental factors, optimizing performance in different acoustic settings. Long-term learning and adaptation to the user's changing needs might be possible, allowing the device to evolve with the user over time. There's potential for integration with other assistive technologies, expanding the functionality of smart jewelry beyond hearing assistance (Figure 2).

6.8 Potential Impact on Assistive Technology for Disabilities

The design could redefine expectations for hearing assistance devices, combining advanced functionality with aesthetic appeal. It might improve adoption rates and consistent use of assistive technology by addressing common barriers such as stigma and discomfort. There are broader implications for AI in disability-assistive jewelry design, potentially opening new avenues for wearable assistive design technologies.

6.9 Future Directions and Challenges

AI capabilities could expand for multi-functional disability support, allowing smart jewelry to address a wider range of needs. There's potential for customization in manufacturing processes, enabling more personalized solutions for individual users. Regulatory considerations for AI-enhanced medical devices would need to be navigated, ensuring compliance with relevant healthcare and technology standards.

7. Ethical Considerations in AI-Powered Assistive Technology

7.1 Privacy and Data Security

The integration of AI in smart jewelry for hearing impairments raises significant privacy concerns. These devices collect and process sensitive personal data, including audiological profiles and potentially speech patterns. It's crucial to implement robust data protection measures to safeguard user information. Encryption techniques and secure data storage protocols should be employed to prevent unauthorized access. Additionally, adherence to regulations such as GDPR or HIPAA is essential to ensure compliance with international data protection standards.

7.2 Informed Consent and User Autonomy

Obtaining informed consent from users of AI-powered assistive devices presents unique challenges, particularly for individuals with disabilities. It's imperative to develop clear, accessible communication methods to ensure users fully understand how their data will be used and the implications of AI-driven decision-making in their assistive devices. The design process should prioritize user autonomy, allowing individuals to maintain control over their device's functionality and data usage.

7.3 Algorithmic Bias and Fairness

AI algorithms used in assistive technology must be carefully designed and tested to avoid perpetuating biases, particularly when dealing with diverse user groups with varying types and degrees of hearing impairments. Regular audits of AI systems should be conducted to identify and mitigate any unintended biases in their decision-making processes. Ensuring diversity in development teams and data sets can help create more inclusive and fair AI systems.

7.4 Potential Risks and Mitigation Strategies

Cybersecurity Threats

As with any connected device, AI-powered smart jewelry is potentially vulnerable to hacking and cybercrime. These risks are particularly concerned given the sensitive nature of the data involved and the critical role these devices play in users' daily lives. To mitigate these risks, robust security measures such as end-to-end encryption, regular security updates, and multi-factor authentication should be implemented. Additionally, users should be educated on best practices for device security.

7.5 Service Disruptions and Reliability

The reliance on AI-powered assistive devices raises concerns about the consequences of service disruptions. Temporary loss of functionality could significantly impact users' ability to communicate and navigate their environment. To address this, fail-safe mechanisms and backup systems should be incorporated into the design. Offline functionality for critical features should be considered to ensure continuous support for users even in the event of connectivity issues.

7.6 Dependence and Over-Reliance

While AI-powered assistive technology offers significant benefits, there's a risk of users becoming overly dependent on these devices. This could potentially lead to a deterioration of natural coping mechanisms or skills. To mitigate this, the design philosophy should focus on empowering users rather than replacing their abilities. Regular assessments and adjustments of the device's functionality based on user progress could help maintain a balance between assistance and independence.

7.7 Ethical AI Framework and Governance

To address these ethical considerations and potential risks, it's crucial to develop a comprehensive ethical AI framework specifically for assistive technologies. This framework should guide the design, development, and deployment of AI-powered smart jewelry, ensuring that ethical considerations are integrated at every stage of the process. Establishing an ethics review board to oversee the development and implementation of these technologies could provide an additional layer of accountability and ensure adherence to ethical standards.

By incorporating these sections into your paper, you'll provide a more balanced perspective on the integration of AI in assistive wearable technology, addressing both its transformative potential and the important ethical considerations that come with it. This addition will enhance the depth of your analysis and make your paper a more comprehensive resource for designers, policymakers, and stakeholders in the field of AI-powered assistive technology.

8. Conclusion

This study has explored the potential transformative role of Artificial Intelligence in designing acoustic jewelry for individuals with hearing impairments. The research suggests that AI-driven processes could significantly enhance the creation of functional, yet aesthetically pleasing assistive devices, potentially bridging the divide between form and function. Key findings include the potential efficacy of AI in executing real-time acoustic simulations, the possible successful integration of acoustic engineering principles with aesthetic considerations, and the potential for highly personalized designs tailored to individual audiological profiles.

While the potential benefits of AI-powered smart jewelry are substantial, it is crucial to acknowledge and address the ethical considerations that accompany this technology. Privacy concerns, data security, and informed consent are paramount when dealing with sensitive personal information such as audiological profiles. Additionally, the potential risks of cybersecurity threats and service disruptions must be carefully mitigated to ensure the reliability and safety of these devices.

The ethical framework surrounding AI in assistive technology must evolve alongside the technical advancements. This includes addressing issues of algorithmic bias, ensuring equitable access to these technologies, and maintaining transparency in AI decision-making processes. By proactively addressing these ethical considerations, we can foster trust in AI-powered assistive devices and ensure their responsible development and deployment.

This AI-assisted approach, when coupled with robust ethical guidelines, could represent a significant advancement towards more effective, personalized, and aesthetically pleasing assistive technology. By balancing innovation with ethical responsibility, we have the potential to improve quality of life for many through beautifully designed, acoustically optimized, and ethically sound wearable technology. As we move forward, it is imperative that ethical considerations remain at the forefront of research and development in this field, ensuring that the benefits of AI in assistive technology are realized while minimizing potential risks and preserving user autonomy and privacy.

9. Methodological Insights

The methodology proposed in this study offers several key insights. Dynamic management AI simulation could enable immediate feedback and iterative design optimization in the creation of smart jewelry design and high metal pieces designs. Integration of acoustic principles with AI algorithms could ensure functional efficacy while preserving aesthetics in the design process. A user-centric approach, incorporating individual hearing profiles, could lead to highly personalized designs tailored to specific needs. A collaborative AI-designer workflow could preserve artistic vision while enhancing functional aspects of the smart jewelry design.

10. Future Research Directions

Future research in the field of AI-powered assistive wearable technology, particularly smart jewelry designs for hearing impairments, could explore various areas:

Advanced materials research could investigate novel acoustic properties within AI-optimized designs, potentially leading to more effective and comfortable assistive devices. Integration of more sophisticated psychoacoustic models into AI systems might enhance the effectiveness of smart jewelry, improving sound quality and user experience.

Development of ethical AI frameworks specifically for assistive technologies is crucial, focusing on privacy, security, and user autonomy. This research direction would address the unique ethical challenges posed by AI in assistive devices, ensuring responsible development and deployment.

Investigation into fail-safe mechanisms and offline functionality could address potential service disruptions, enhancing the reliability of these devices in various scenarios. This research would be critical in ensuring continuous support for users, even in the event of connectivity issues or system failures.

AI-driven manufacturing techniques for complex internal structures could be developed to realize intricate designs that optimize both form and function. This could lead to more efficient production methods and potentially reduce costs, making these devices more accessible.

Research into adaptive AI systems that evolve based on user feedback might improve long-term performance and personalization. This could result in devices that continuously adapt to users' changing needs over time.

Exploration of multi-functional designs that address various disabilities simultaneously could lead to more versatile assistive devices. This research direction could potentially revolutionize assistive technology by creating devices that cater to a broader range of user needs.

Investigation into the integration of AI-designed acoustic jewelry with other smart technologies could expand functionality beyond hearing assistance. This could lead to more comprehensive assistive solutions that address multiple aspects of a user's daily life.

Research on data privacy and security measures specific to AI-powered assistive devices is essential. This would involve developing robust encryption methods and secure data handling protocols to protect sensitive user information.

Studies on the long-term psychological and social impacts of using AI-powered smart jewelry could provide valuable insights for future designs and implementations. This research could help in creating devices that not only assist with hearing but also positively impact users' overall well-being and social integration.

By pursuing these research directions, the field of AI-powered assistive wearable technology can advance towards more effective, ethical, and user-centric solutions, potentially transforming the lives of individuals with hearing impairments and other disabilities

11. Final Thoughts and Technical Challenges

While the potential of AI in acoustic jewelry design is promising, several technical and ethical challenges remain. Balancing computational efficiency with the complexity of real-time acoustic simulations is a key issue to address. Ensuring AI suggestions align with manufacturing feasibility is crucial for practical implementation.

A critical challenge lies in addressing privacy concerns in the collection and use of personal audiological data. This is not only important for user trust and compliance but also raises ethical questions about data

handling and protection. As we push the boundaries of innovation, we must carefully consider the ethical implications of our designs, striking a delicate balance between technological advancement and user privacy.

Developing AI systems that can truly understand and preserve artistic nuances remains a challenge in maintaining design integrity. This speaks to the broader need to balance innovation with ethical considerations, ensuring that our pursuit of technological advancement does not come at the cost of individual expression or cultural sensitivity.

Overcoming limitations in current material technologies to fully realize AI-optimized designs is necessary for optimal performance. This challenge extends beyond mere technical constraints, touching on sustainability and ethical sourcing of materials.

Ensuring the reliability and effectiveness of multi-functional features for various disabilities is essential for creating truly versatile assistive devices. This challenge embodies the ethical imperative to design inclusively, catering to a wide range of needs without compromising on quality or effectiveness for any user group.

Despite these challenges, the integration of AI in acoustic jewelry design represents a significant step forward in assistive technology. As we address these technical and ethical hurdles, we can anticipate the potential for increasingly sophisticated, effective, and personalized solutions that seamlessly blend functionality with aesthetic appeal.

The concept of multi-functional smart jewelry design, as proposed in this study, opens new possibilities for inclusive design that could cater to a wider range of disabilities and user needs. However, as we explore these possibilities, we must remain vigilant about the ethical implications of our innovations. This includes considering the long-term societal impacts of our designs, ensuring equitable access to these technologies, and safeguarding against potential misuse or unintended consequences.

About the Author

AREFEH AHMADI is a Persian artist who seamlessly bridges the worlds of smart jewelry design, new media art, and immersive experiences. Her work challenges traditional boundaries, redefining beauty and aesthetics in the digital age. Ahmadi's jewelry and metal creations go beyond adornment, offering innovative forms and functions that engage with inclusivity, making them accessible to individuals with special needs.

In the realm of new media art, Ahmadi crafts captivating installations and interactive pieces that merge digital technology with physical spaces, inviting viewers into multi-sensory explorations of art, technology, and human experience. Her groundbreaking approach has garnered numerous awards and nominations from prestigious competitions across Europe, Middle East, East Asia and art installation in United states.

Currently pursuing a PhD in Digital Media, Ahmadi's research focuses on interactive designs for digital twins and smart jewelry designs, further cementing her position as a leading figure at the intersection of art, design, and science.

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Figure 1 (Smart Design methodology framework) Arefeh Ahmadi

Figure 2 (Smart jewelry design, ergonomic multi-channel) Arefeh Ahmadi

Figure 3 (Smart jewelry design, green metal (eco- friendly, ANC, hearing aid capsule) Arefeh Ahmadi

ADRIFT IN THE ANTHROPOCENE

RECONNECTING THROUGH AESTHETIC EXPERIENCE

B. Colby Jennings

In the Anthropocene, humanity's profound impact on global systems has generated an overwhelming abundance of data about pressing ecological and social issues. This paper argues that while this information is crucial, its sheer volume often leads to emotional detachment and inaction. Art emerges as a powerful antidote to this desensitization, capable of transforming abstract data into tangible, emotionally resonant experiences. Through an examination of works by the contemporary artists Maya Lin, Laurie Frick, Trevor Paglen, Refik Anadol, Agnes Denes, Nathalie Miebach, and Olafur Eliasson, this paper demonstrates how art can reconnect us with the urgency of our time. These artists convert complex information into sensory experiences that foster deeper reflection, expose hidden systems of power, and pose ethical critiques. By creating immersive aesthetic experiences, art provides a crucial lens for understanding and feeling the weight of the Anthropocene, inspiring critical reflection and action. The paper concludes that art's ability to elicit emotional engagement is essential for cultivating a more empathetic and ethically informed response to the complex challenges we face in this era of human influence.

Keywords: Anthropocene, art, data, aesthetic experience, emotional resonance

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Introduction

In the Anthropocene—the proposed epoch characterized by humanity's profound impact on global ecological systems—information about the most pressing issues confronting our species is staggeringly abundant and ever-present.[1] From data on climate change to reports of species extinction and resource depletion, we are inundated with statistics, charts, and graphs that convey facts, figures, scope, and scale. Yet, this flood of information has the paradoxical effect of dulling our emotional responses and reducing the felt weight of the concern.[2] Becoming oversaturated with knowledge, we risk emotional detachment, which paralyzes and prevents meaningful action.[3] When very real challenges are amplified to abstraction, empathy fades, leaving us disconnected from the urgency they demand.

Art provides a powerful antidote to this desensitization. By transforming abstract information into tangible experience, art generates emotional resonance that raw statistics cannot achieve. Where facts and figures fail to move us, art can connect knowledge with emotion.[4] Through its ability to provoke an emotional response and invite critical reflection, art reengages us with the demands of our time. Artists like Maya Lin and Laurie Frick demonstrate through their work how mountains of information—whether about biodiversity loss or the rhythms of human life—can be transformed into personal and emotionally charged aesthetic experiences.[5] Lin's *What is Missing?* (2009) memorial integrates scientific data with personal narrative, inviting viewers to reflect on ecological losses through stories of vanished species and landscapes.[6] Frick's work uses personal data to create vivid visual representations that frame everyday behaviors in curious and personal ways.[7]

The need to expand our capacity to fully grasp reality does not just apply to our relationship with ecological systems. Our impact on global systems is intrinsically tied to the structures of power we propagate. Artists like Trevor Paglen expose hidden infrastructures of surveillance that govern our digital lives, revealing the double-edged nature of technology: able to both conceal and reveal. In his work, Paglen uses photography to uncover secret government sites and covert satellite networks, offering critique and reflection on systems of surveillance and the power they maintain. Art can also fulfill a critical ethical role in addressing human influence. Artists like Refik Anadol and Agnes Denes provoke questions about the consequences of our environmental and technological interventions. Anadol's *Melting Memories* (2018) transforms brainwave data into immersive visual experiences that explore memory and how technology mediates our reality. Denes' land art, such as *Wheatfield – A Confrontation* (1982), juxtaposes a natural and agrarian environment against urban development, reminding us of the lasting consequences of human activity.

Central to this paper's position is the concept of 'aesthetic experience,' which requires a clear definition. Drawing on Dewey's (1934) seminal work 'Art as Experience,' this paper defines aesthetic experience as a multisensory, emotionally engaging encounter with an artwork that prompts reflection and encourages action. This definition emphasizes the interactive and transformative potential of engaging with art. It is, however, crucial to update this concept for the Anthropocene context.

Bennett's (2010) theory of 'vibrant matter' extends the realm of the aesthetic beyond the human, recognizing the agency and affective capacities of nonhuman entities. Considering this, we can understand aesthetic experience in the Anthropocene as not just an encounter between viewer and artwork, but a complex interaction involving human perceivers, artistic interventions, and the vibrant materiality of a changing planet. Rancière's (2004) concept of the 'distribution of the sensible' helps us understand how aesthetic experiences can reconfigure what is visible, sayable, and thinkable in a given social order. In the context of this paper, aesthetic experiences are understood as potential disruptions to habitual ways of perceiving and thinking about environmental change. Davis and Turpin's (2015) work, 'Art in the Anthropocene,' argues that art serves as a vital sensory apparatus for comprehending the vast temporal and spatial scales of climate change. They contend that artistic practice can make visible the often-imperceptible processes of environmental degradation. While their work provides a crucial foundation, this paper extends the ongoing conversation by focusing specifically on the affective dimensions of art and its capacity to re-sensitize audiences to global concerns.

Considering this context, when this paper refers to aesthetic experience, it denotes a multifaceted encounter that:

1. Engages multiple senses and evokes emotional responses

2. Prompts critical reflection on relationships with that which is human and nonhuman alike

3. Catalyzes shifts in perception (potentially leading to action)

4. Has the capacity to reconfigure social and political sensibilities

With our approach established, this paper argues for art, and the aesthetic experience provided, as a crucial tool for reframing the Anthropocene. By reviewing a selection of artworks—from data visualization to land art—this discussion demonstrates how art functions as more than expression; it is a vital mechanism for understanding, feeling, and responding to a world shaped by human influence.

Age of Overload

Living in the Anthropocene, we are confronted with torrential rivers of data regarding the crises threatening our species and planet. From statistics on climate change to the grim realities of species extinction, the vast amount of information creates barriers to understanding. Borrowing a term from the world of marketing, "data fatigue" seems to accurately describe what occurs when the scale of the issues communicated creates emotional numbness rather than urgency. We are left disconnected from problems, unable to translate the data into action. Art—by translating the abstract and the impersonal into visceral, emotionally resonant experiences—has the potential to reignite our engagement with the world. It allows us to process the gravity of environmental degradation in ways that are both tangible and impactful. Where data fails to inspire action, art invites empathy and intention.[8]

Figure 1. Maya Lin & What Is Missing? Foundation, www.whatismissing.org, 2024

Maya Lin's *What is Missing?* stands as an evocative example of how art can address this issue of detachment caused by data overload.[9] The multimedia project is a memorial dedicated to species extinction, but it defies the static nature of traditional memorials. Launched in 2009, the project offers an evolving, participatory space where scientific data intersects with personal stories. [10] By blending scientific fact with deeply human narratives, Lin transforms abstract data into a shared act of mourning. This personal engagement with ecological loss draws the viewer into a reflective state, where data is no longer just information but an evocative experience.

The emotional resonance of Lin's work is critical, and its effectiveness can be understood through the lens of V.S. Ramachandran's neuroaesthetic principles. As Ramachandran's research suggests, human brains are not inherently designed to respond to raw data.[11] We are far more likely to engage with patterns, contrasts, and emotionally salient information—elements that art can highlight and amplify. Ramachandran and Hirstein (1999) propose that certain universal principles of artistic experience are closely tied to the way our visual systems process information, suggesting that art can bypass our cognitive defenses and speak directly to our perceptual and emotional systems.[12] Lin's project makes use of this predisposition to connect viewers emotionally with the environmental crises we often ignore, transforming scientific facts into lived experiences.

Laurie Frick's body of work based on personal data offers a complementary perspective. In this creative research, Frick transforms individual metrics—such as sleep patterns and steps taken—into geometric, colorful visualizations. The result is a striking representation of how intimately intertwined our daily lives are with data-driven systems. Like Lin, Frick uses art to make the invisible visible, but her focus is on the individual, making data personal and immediate. This shift from environmental to personal data broadens the discourse on how art confronts desensitization, reminding us that we are embedded in systems that collect and commodify our most intimate information.

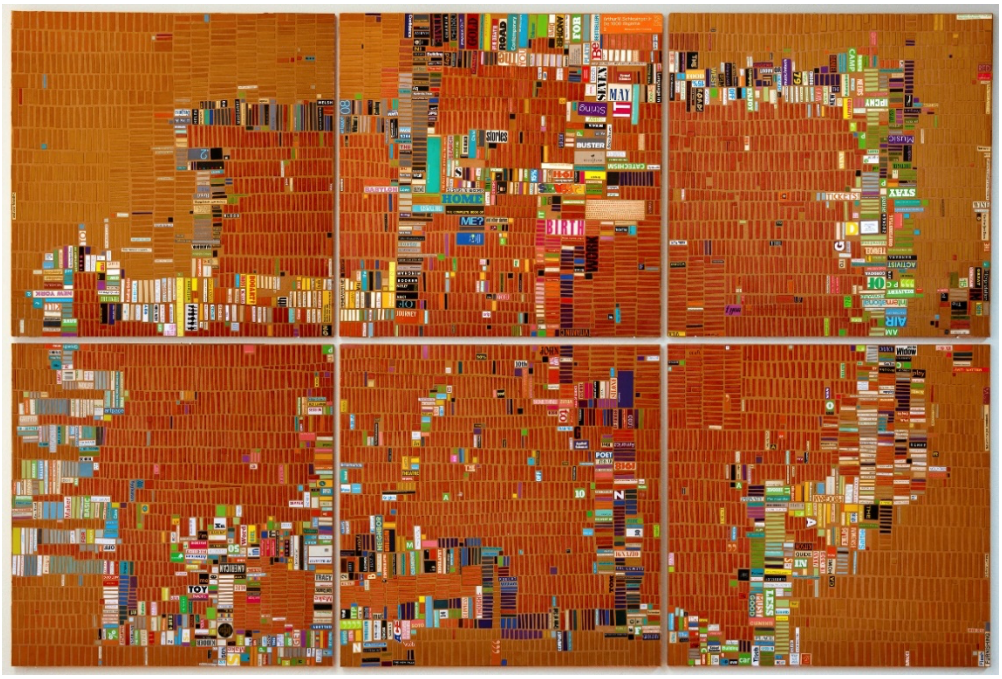

Figure 2. Laurie Frick, Walking, handmade, found and cut paper on panels. 34 in x 34 in - 72 in x 72 in , based on tracking location and movement patterns. 2012-2015

Frick's work also raises critical ethical questions about data ownership and privacy. As individuals, we are often unaware of how much personal information we share and who profits from it. In the age of what Shoshana Zuboff terms 'surveillance capitalism', where personal data is a commodity, Frick's work challenges us to reconsider the ethics of data collection and use.[13] By turning impersonal data into something aesthetically beautiful, Frick subtly critiques the systems that track our behavior, offering a visual representation of one of the many ways we are surveilled.

Both Lin and Frick illustrate the power of artists, through their work, to reconnect us with complex systems. Their work demonstrates how art can challenge the overwhelming nature of data by transforming it into something we can feel and reflect on. This emotional access is crucial in the Anthropocene, where detachment from environmental crises has become the norm. Art, by weaving together information and empathy, invites viewers to confront the ethical dimensions of the world we shape.

Systems of Power

Technology's pervasive influence in the Anthropocene extends across both natural and constructed landscapes, shaping everything from ecosystems to social structures. These complex systems of power exert control over our physical and digital environments. As these systems become more sophisticated, their effects are harder to detect, leading to public disengagement from the forces that shape lives. Aesthetic experience through art has the unique ability to expose these systems and offer tools for examining how power operates in this moment in time.

Trevor Paglen is an artist and author whose work is positioned at the intersection of technology, surveillance, and control. Through his research and creative practice, Paglen reveals the hidden architectures of power that define and confine modern life.[14] By using long-distance photography, satellite imagery, and data mapping, he captures military bases, surveillance satellites, and covert operations sites that remain

invisible to the public. His body of work utilizing limit-telephotography documents classified government sites using high-powered lenses to image the locations from extreme distances. These blurred, almost abstract images evoke the secrecy surrounding the captured landscapes and how technology can obscure as much as it reveals.

Figure 3. Trevor Paglen, National Reconnaissance Office Ground Station (ADF-SW), Journada del Muerto, New Mexico; Distance ~ 16 miles, 2012

Paglen's work does more than simply document secret installations. It forces viewers to confront the ethical implications of living in a world shaped by hidden surveillance systems. In his project *The Other Night Sky* (2010-present), Paglen tracks and photographs secret satellites orbiting the Earth, most of which are used for intelligence gathering. By making these surveillance tools visible, he compels viewers to reflect on how these technologies quietly permeate their lives. This confrontation with the mechanisms of power and control opens an emotional space for deeper reflection on how surveillance shapes both public and private life. The power of this work lies in its ability to tap into the emotional unease generated by the knowledge of constant surveillance. Paglen exploits the human affinity for patterns and imagery by bringing the hidden into a low-fidelity view, providing a glimpse at the abstract architecture of power made tangible. His images conjure emotional resonance by exposing surveillance systems and provoking discomfort while raising ethical questions about the limits of privacy in the digital age.

While Paglen critiques technology's use in control and surveillance, Tomás Saraceno envisions how technology might instead be repurposed for ecological harmony. Saraceno's ongoing project *Aerocene* (2007–present) imagines a future where humans live in sync with the Earth's atmosphere, free from fossil fuel reliance.[15] Using solar-powered air sculptures, Saraceno demonstrates the potential for sustainable, airborne transportation that uses wind and solar energy rather than conventional fuel sources. These floating artworks, known as 'Aerocene Sculptures', are essentially solar balloons made from recyclable materials. They become buoyant when heated by the sun and can navigate using wind currents, requiring no fossil fuels, helium, or hydrogen. By harnessing only the energy of the sun and air currents, these sculptures embody a vision of mobility that works in harmony with natural systems rather than exploiting them.

Figure 4: Tomás Saraceno, On the disappearance of clouds, 2019, installation view during the 58th International Art Exhibition, La Biennale di Venezia, Venice, Italy, 2019, curated by Ralph Rugoff. Courtesy the artist. © Photography Studio Tomás Saraceno.

The emotional and ethical significance of these works lies in their ability to make visible what wants to remain hidden. Paglen's images uncover the oppressive architectures of surveillance, while Saraceno's sculptures envision utopian alternatives. Together, they prompt viewers to engage with the privilege and peril of technology: as both a tool of control and a potent agent for change. This contrast challenges us to reconsider how we relate to the systems of power embedded in landscapes of all kinds.

(Human) Influence

Humanity's influence, and the accompanying data, extend beyond reshaping landscapes—they permeate digital architectures, ecosystems, and even our cognitive processes. While some of these consequences remain invisible, art offers a crucial lens through which we can realize the full significance of human action and inaction. Refik Anadol's project *Melting Memories* (2018) explores the intersection of human cognition and digital technology, transforming neural data into visual representations. By using machine learning algorithms to convert EEG (electroencephalogram) data—captured during memory recall—into fluid digital sculptures, Anadol creates a moving expression of the fragility and plasticity of memory.[16] His work highlights the malleability of our most intimate data, emphasizing that memory, much like digital data, is subject to constant change, manipulation, and decay. The flowing forms suggest a continuum between natural processes and digital information, reminding us that both are shaped by patterns of energy and interaction, much like the ecosystems we influence in the physical world.

Melting Memories exemplifies the rich potential for interdisciplinary connections in Anthropocene art. This work not only bridges art and technology but also intersects with cutting-edge research in neuroscience and data visualization. Anadol's process of transforming EEG data into fluid digital sculptures aligns closely with current neuroscientific research on memory formation and recall. For instance, Borgo et al. (2013) argue for the importance of aesthetic considerations in data visualization, suggesting that beauty can enhance comprehension and engagement with complex data sets.[17] The work takes this principle to its artistic extreme, prioritizing aesthetic experience in the representation of neural data. Anadol's piece also critiques how digital systems mediate our experience of reality. As neural data is translated into art, questions emerge about data ownership, privacy, and the ethics of surveillance capitalism. Nick Couldry and Ulises A. Mejias argue that data has become a new form of capital, with human experience itself being colonized and commodified in the digital age.[18] Through this lens, *Melting Memories* (2018) serves as an aesthetic experience and a critical reflection on the increasingly porous boundaries between human cognition and technologies of control.

Where Anadol navigates the realm of digital memory, Agnes Denes brings attention back to the physical landscapes irrevocably altered by human activity. A pioneer of environmental art, Denes has long explored the consequences of human intervention in natural systems. One of her most iconic works, *Wheatfield – A Confrontation* (1982), saw Denes plant two acres of wheat in lower Manhattan, right next to the towers of

Wall Street.[19] The visual juxtaposition of golden wheat fields against the urban skyline serves as a powerful metaphor for the tension between natural ecosystems and capitalist economic systems. By planting wheat in one of the world's most densely populated cities, Denes emphasizes the fragile relationship between urbanization and nature, calling for an evaluation of society's priorities.

Wheatfield critiques urbanization while pointing to the exploitation of natural resources underpinning modern systems. The project becomes a living metaphor for the subsuming of ecosystems by economic forces that prioritize short-term profit over long-term sustainability. Public reaction to the work was mixed but powerful. Many New Yorkers were struck by the incongruity of a wheat field amidst skyscrapers, with some finding it a poignant reminder of nature's beauty and others seeing it as a provocative critique of urban development. The New York Times reported that the artwork sparked discussions about land use, food production, and the relationship between cities and rural areas.[20] Through her work, Denes urges viewers to reconsider the environmental costs of human activity, framing nature as something vulnerable and vital to human survival.

Together, the works of Anadol and Denes offer complementary perspectives on the Anthropocene, showing that human influence extends across both visible landscapes and invisible systems. Anadol's work raises questions about the ethics of data manipulation and the ownership of cognitive information, while Denes reminds us of our moral responsibility toward ecological preservation. Both artists challenge us to reflect on how deeply human activity penetrates the worlds we inhabit—whether natural or digital—and the ethical implications of our continued intervention in these systems.

Breaking the Loop

As the pace of global crises quickens, public exposure to alarming data increases. As discussed, this overwhelming flow of statistics, forecasts, and distressing images quickly results in emotional desensitization. This phenomenon dulls our capacity to feel urgency in these issues. Olafur Eliasson and Minik Rosing's *Ice watch* (2014) reawakens our engagement with environmental urgency. In this installation, Eliasson transported twelve blocks of melting ice from Greenland to urban centers like Copenhagen, Paris, and London, arranging them in the shape of a clock to symbolize the ticking of time in the fight against climate change. Passersby could touch the ice, feel its coldness, and watch its slow dissolution. This direct, tactile experience makes climate change tangible and immediate—moving it from an abstract, distant concept into something physically felt.[21]

Figure 5: Olafur Eliasson and Minik Rosing, Ice Watch, 2014, 12 ice blocks, City Hall Square, Copenhagen 2014, photo: Anders Sune Berg. Courtesy of the artist; neugerriemschneider, Berlin; Tanya Bonakdar Gallery, New York / Los Angeles, © 2014 Olafur Eliasson

Ice watch represents a potential for art to make climate change tangible and immediate. By transporting massive ice blocks from Greenland to urban centers, Eliasson creates a visceral encounter with Arctic ice

melt. As passersby touch the slowly disappearing ice, they experience a direct, sensory connection to a process typically abstracted in charts and graphs. However, it's crucial to critically examine the paradoxes inherent in such a project. The very act of transporting these ice blocks contributes to the carbon emissions driving climate change. This contradiction raises questions about the ethics of environmental art and the balance between raising awareness and potentially exacerbating the problem. The temporality of *Ice watch* also warrants consideration. The dramatic, relatively rapid melting of the ice in urban settings compresses a process that occurs over much longer timescales in the Arctic. While this acceleration creates a powerful aesthetic experience, it potentially misrepresents the slow, often imperceptible nature of climate change that Nixon (2011) terms 'slow violence.'[22]

Despite these critiques, *Ice watch* succeeds in breaking through the emotional barriers often erected by abstract climate data. The installation's affective power lies precisely in its ability to make distant processes immediate and personal. This tension between the work's environmental impact and its consciousness-raising potential epitomizes the complex negotiations required of art in the Anthropocene. A critical engagement with *Ice watch* reveals both the possibilities and limitations of art in addressing climate change. It underscores the need for creative approaches that can represent long-term, distributed processes while still creating immediate, emotionally resonant experiences.

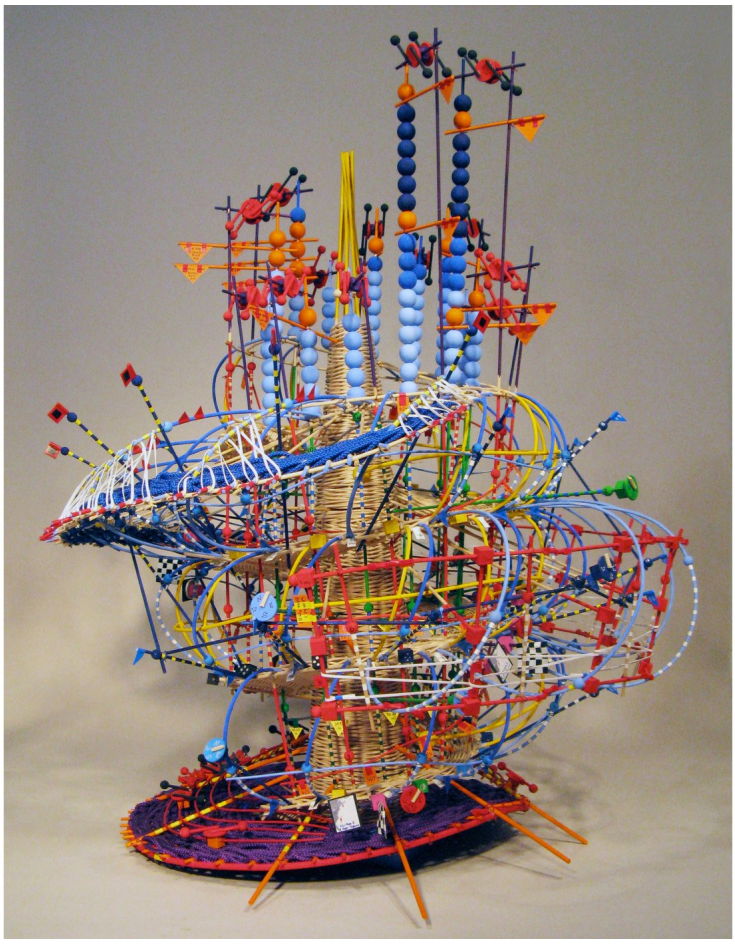

Figure 6: Nathalie Miebach, Hurricane Noel, 2010, Reed, wood, data, 32”x32”x36”, 3D Musical Score of the passing of Hurrican Noel through the Gulf of Maine, Nov 6-8, 2007.

Nathalie Miebach also explores how data can be transformed into emotionally resonant forms. In her artistic practice, Miebach converts meteorological data from weather and climate data into woven sculptures and musical compositions, creating a multisensory representation of complex environmental phenomena.[23] Her process is both methodical and creative. Miebach begins by collecting weather data from specific events or locations, such as wind speed, barometric pressure, temperature, and humidity. She them develops a systematic method for translating these data points into visual and auditory elements. In her sculptures, Miebach uses traditional basket-weaving techniques to create three-dimensional forms that represent data patterns. Each element of the sculpture—its color, shape, size, and position—corresponds to specific data points. The artist extends this data translation process into the realm of music, assigning variables to different

musical elements. For instance, rising temperatures might correspond to ascending musical scales, while increasing wind speeds could be represented by faster tempos or more intense dynamics. The resulting musical score allows the listener to "hear" the storm's fluctuating patterns as it unfolded. This synesthetic approach to data representation engages both tactile and auditory senses, disrupting the tendency to view environmental data as abstract or impersonal. Miebach's work demonstrates that even highly technical information can provoke emotional engagement when presented through an appropriate artistic vehicle.

Both Eliasson and Miebach challenge the assumption that data alone can communicate the urgency of environmental crises. Their works suggest that sensory immersion—whether through physical interaction with melting ice or experiencing the auditory and tactile elements of woven data—offers a more effective method for re-engaging the public with the forces shaping our world. These forms of immersion also raise ethical questions: how can artists ensure that powerful sensory experiences lead to genuine understanding and action, rather than mere spectacle?

Art, particularly in the Anthropocene, has the potential to break the loop of desensitization. Projects like Eliasson's and Miebach's emphasize that sensory immersion, when carefully grounded in real-world data, can be a catalyst for invested dialogue without the heavy-handedness of superficial shock. The goal is not simply to surprise or provoke an audience but to create a sustained emotional and intellectual engagement with the issues at hand. By making the intangible crises of climate change and environmental degradation tangible, these artists help audiences feel the urgency of these global challenges in ways that can lead to greater awareness and action.

Conclusion

In the Anthropocene, where human influence extends across both natural and manufactured systems, art will continue to play a critical role in shaping how we engage with the global crises of our time. While data, statistics, and information overload have the potential to desensitize us, art provides a pathway to reconnect emotionally with the pressing challenges we face—whether environmental, technological, or ethical. The works discussed in this essay demonstrate how contemporary artists can harness their research to translate abstract data into emotionally resonant experiences, offering a means of breaking the cycle of detachment.

While this writing suggests contemporary art contains the ingredients needed to generate connection with the issues of the Anthropocene, it's important to acknowledge limitations. Recognizing these constraints opens avenues for future investigation and research. First, the selection of artworks, while diverse, is not exhaustive. The focus on high-profile, predominantly Western artists may overlook important contributions from other cultural contexts or less widely recognized creatives. Future investigation could benefit from a broader, more globally representative sample. Second, this paper's discussion on the affective impact of these artworks is primarily based on analysis rather than empirical data. While such analysis is valuable, empirical research on audience responses could provide more robust support for claims about emotional engagement and potential behavior change.

Additionally, the paper's focus on visual and installation art may not fully capture the range of artistic responses to the Anthropocene. Other forms such as performance art, literature, or music may offer different strategies for engaging with issues that are not fully explored here. And, while the paper touches on the ethical implications of some artworks, a more comprehensive ethical analysis of Anthropocene art practices could yield important insights. Questions of representation, appropriation, and the environmental impact of art production itself warrant deeper examination. And lastly, the rapidly evolving nature of both global challenges and artistic practices means that any study in this field risks becoming quickly outdated. Regular reassessment and updating of the arguments presented here will be necessary.

Despite these limitations, this paper provides another step in the climb to understanding the role of aesthetic experience in engaging with Anthropocene challenges. At the heart of this discussion is art's ability to elicit engagement via emotional resonance. Maya Lin's What is Missing? shows how data on biodiversity loss can transform into deeply personal narratives that allow us to mourn not just what we have lost, but what we continue to lose. Laurie Frick's data visualizations take a different approach, using personal data to highlight how our lives are mediated by technology, prompting consideration of the ethical dimensions of data ownership and surveillance.

By exposing the hidden or secret, Trevor Paglen's work showcases art's ability to provide a critical lens through which we examine the systems of power that shape our experience. His images remind us that technology is not a neutral force but one shaped by the political and social structures that use it. Tomás Saraceno reimagines technology as a force for harmony, offering utopian alternatives where humans coexist with the natural environment in sustainable ways. Together, these artists challenge us to consider how technology can either be a force for control or a medium for transformation.

The works of Agnes Denes and Refik Anadol compel us to reflect on the ethical responsibilities we bear as participants in natural and digital systems. Anadol explores the vulnerability of human cognition in a moment where even our most intimate data can be commodified and manipulated. His work raises essential questions about the intersection of data, and control, demanding attention to how we navigate a world now driven by algorithms. Denes' land art projects critique the exploitation of natural resources, urge us to rebuild our relationship with the environment, and call for long-term thinking in addressing our environmental impact.

The challenges of the Anthropocene are interconnected and demand more than intellectual understanding. Art offers the ability to see what is difficult, or even impossible, and to collapse the distance between global issues and lived experience. The urgency of this epoch cannot be overstated. As the artists examined here demonstrate, art is a vehicle for emotional engagement and a tool for exposing the power dynamics embedded in our world. Art invites us to confront the ethical consequences of human influence on both natural and digital landscapes. Through emotional resonance and critical reflection, art offers us a path forward—one that encourages empathy, fosters deeper understanding, and, most importantly, prompts action. By making the abstract tangible, art helps us envision a future that is not only more sustainable but also more just.

As overwhelming information threatens to numb us into oblivion, art has the power to re-engage us in our collective responsibility and inspire new ways of seeing the future. It is not enough to know the data; for it to matter we must feel its weight. Through art, we understand the emotional and ethical dimensions of our relationship with the world as inseparable from the scientific or technological and that addressing the crises of the Anthropocene requires us all to be fully present and able to feel. Looking forward, as the challenges of the Anthropocene continue to evolve, so too must the artistic responses to them. Future artists may need to grapple with even more complex information, emerging technologies, and unforeseen global changes. Their work will be crucial in helping us navigate the uncertainty, continually finding new ways to transform information into insight, apathy into action, and despair into determination.

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About the Author

B. COLBY JENNINGS is an artist, interdisciplinary scholar, and Associate Professor of New Media at Missouri State University. His creative research currently focuses on abstract data, aesthetic experience, emotional resonance, and the anxieties of information overload. He is dedicated to exploring the potential for art to renew damaged relationships and disrupt unethical power structures.

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MOTIFS OF THE FUTURE METAMORPHOSIS

AFROFUTURISM IN MEDIA ARTS AND DESIGN

Darren Woodland, Jr.

Afrofuturism isn't just a cultural movement; it's a seismic shift in the landscape of media arts and design. This paper rips through the veil of conventional narratives, tracing Afrofuturism's thread from its literary whispers in the 1890s to its earth-shaking impact in 2024 and beyond. We're not here to merely discuss "influence" - we're here to dissect how Afrofuturism has rewired the circuitry of creative expression across the globe.

We're diving headfirst into the profoundness of Afrofuturism, examining how it shattered traditional boundaries and reshaped our understanding of identity, technology, and the future itself. From the cosmic jazz of Sun Ra to the digital realms of contemporary artists, we'll illuminate the recurring motifs of metamorphosis and transfiguration that pulse through the Afrofuturistic corpus, driving its influence on media arts and design.

Keywords: Afrofuturism, Media Arts, Design, Speculative Futures, African Diaspora

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Introduction

Afrofuturism stands as a radically multidisciplinary framework, a battering ram against the walls of conventional storytelling. Rather than seeking inclusion in existing narratives, it constructs its own realms, rooted in the rich, complex weavings of African diasporic culture. This approach allows Afrofuturism to present visions of futures unbound by terrestrial limitations, offering a powerful counternarrative to dominant Western perspectives.

The relevance of Afrofuturism in the cultural landscape is no longer a matter of debate. That timeline has ended. Its influence resonates through every facet of media arts and design, reshaping creative practices and audience perceptions alike. Our focus, therefore, shifts to excavating the core of Afrofuturistic expression, unveiling the mechanisms by which it has fundamentally altered our perception of creative possibilities.

As we navigate through the history, manifestations, and emerging motifs of Afrofuturism, prepare for a pilgrimage that will challenge preconceptions and radically reconfigure your understanding of media arts and design. This exploration serves as a call to arms for creators, thinkers, and innovators, urging them to embrace the poetic potential of Afrofuturistic thought.

Afrofuturism spans literature, music, visual arts, and immersive digital experiences. We'll examine how artists wield Afrofuturistic concepts as tools to carve out new spaces for marginalized voices and revolutionary ideas. This approach not only pushes creative boundaries but also serves as a means of reclaiming narrative power and reimagining cultural identities.

This paper offers a gateway to understanding how Afrofuturism has reshaped the DNA of media arts and design. It invites readers to open their minds to a future where creative expression knows no bounds. Afrofuturism isn't a distant concept; it's a present reality, shaping our creative landscape and shining a light more brilliant than the sun.

Historical and Contemporary Contexts of Afrofuturism

Early Literature (1890s) – Seeds of Speculation

Afrofuturism's literary roots trace back to the 1890s, a period dominated by realism in mainstream literature. Visionaries like Charles Chesnutt, however, were already venturing into uncharted territories of imagination. Chesnutt's "The Conjure Woman" (1899) stands as a pioneering work, blending African American folklore with elements of magical realism. This bold departure from typical narratives served a crucial purpose: it provided a means to explore and critique the complexities of the African American experience through speculative fiction.

Chesnutt and his contemporaries introduced concepts of temporal fluidity and alternative realities that would become hallmarks of Afrofuturistic narratives. By doing so, they established narrative threads that allowed for the exploration of historical trauma, identity, and possible futures outside the constraints of their present reality. This approach was revolutionary, offering a way to address the harsh realities of the post-Reconstruction era while imagining alternative possibilities for Black existence.

Music Influence (1960s-70s) – Cosmic Soundscapes

The 1960s and 70s witnessed Afrofuturism's evolution toward a multisensory experience through music. Artists like Sun Ra, Earth, Wind & Fire, and Parliament-Funkadelic didn't just create music; they crafted entire cosmic philosophies. Sun Ra's Arkestra, for instance, transcended the traditional concept of a band, with each performance serving as a journey across the cosmos. This approach wasn't merely artistic innovation; it was a deliberate strategy to reclaim and reimagine Black identity in the face of ongoing social and political struggles.

George Clinton and Parliament-Funkadelic's contributions were particularly implicit in expanding the visual language of Afrofuturism. Their album covers functioned as visual manifestos of alternate realities, challenging listeners to envision a world where Black creativity and identity could flourish unbound by

earthly constraints. Similarly, artists like Betty Davis made their mark with costumes and performances that articulated a future of limitless expression and identity.

Figure 1. Betty Davis – They Say I'm Different Album Cover

The iconic 1974 album cover of Betty Davis' "They Say I'm Different" exemplifies the notable influence of Afrofuturism across multiple domains. Davis' unapologetic stance, the dynamic form of her body, and her futuristic costume create a visual narrative that complements the album's groundbreaking sound. This synthesis of music, fashion, and visual art demonstrates how Afrofuturism could challenge societal norms and expectations, offering a bold vision of Black femininity and artistry that was ahead of its time.

Technoculture (1980s) – Enter the Digital Frontier

The 1980s marked Afrofuturism's bold venture within the realm of emerging technologies. As digital tools proliferated across industries, Afrofuturist artists saw an opportunity to reimagine the potential of these new mediums. They approached drum machines and synthesizers not just as instruments, but as tools for sonic innovation, crafting futuristic soundscapes that challenged traditional notions of music and art.

This period was crucial in demonstrating how technology could be repurposed to express African diasporic experiences and imaginations. By embracing and transforming these new tools, Afrofuturist artists of the 1980s were actively shaping the future of music production and digital art, ensuring that Black voices and visions were at the forefront of technological innovation in the arts.

Coinage Of "Afrofuturism" (1994) – A Name to A Face

Mark Dery's coining of "Afrofuturism" in 1993 was a watershed moment, crystallizing a movement that had been evolving for decades. His essay "Black to the Future: Interviews with Samuel R. Delany, Greg Tate, and Tricia Rose" provided a critical framework for understanding and analyzing the diverse creative expressions that fell under this umbrella.

> Speculative fiction that treats African-American themes and addresses African-American concerns in the context of twentieth century technoculture—and, more generally, African-American signification that appropriates images of technology and a prosthetically enhanced future—might, for want of a better term, be called “Afrofuturism.” (Dery 1994, p. 180)

This naming was crucial not just for academic discourse, but for the artists, writers, and musicians working in this space. It provided a unified concept that encompassed their work, facilitating connections and conversations across different media and fostering a sense of collective vision among creators exploring speculative Black futures.

Contemporary Clout (2024 and beyond) – The Universe Expanding

Today, Afrofuturism continues to evolve, its influence radiating across global creative spheres. Contemporary Afrofuturist work pushes the boundaries of imagination and technology in myriad fields, from literature and music to virtual reality and interactive installations. This ongoing evolution serves multiple purposes: it challenges creators to envision more inclusive futures, provides a platform for marginalized voices, and offers critical perspectives on current technological and social developments.

In 2024 and beyond, Afrofuturism serves as both a creative approach and a critical lens, influencing how we envision and construct future narratives. Its dynamic nature allows it to continually adapt to and drive technological and cultural changes. The future, as envisioned by Afrofuturism, is not a distant concept but an ongoing creation, manifested in every inventive beat, word, and pixel.

The persistence and growth of Afrofuturism in contemporary media arts and design underscore its enduring relevance. It continues to provide a vital platform for exploring identity, challenging systemic inequalities, and imagining more equitable futures. As technology advances and global cultures intersect in increasingly complex ways, Afrofuturism offers a unique and necessary perspective on our collective future.

Afrofuturism Across Artistic Mediums

Music – The Sonic Vanguard

Music serves as the beating heart of Afrofuturism, propelling the movement forward with its innovative soundscapes and visionary concepts. Contemporary artists build upon the cosmic foundations laid by Sun Ra and Parliament-Funkadelic, pushing into uncharted sonic territories that challenge our understanding of music's act in shaping future narratives.

Janelle Monáe exemplifies this progression with her "Metropolis" concept album series. Monáe's work transcends the boundaries of a mere musical project, evolving toward a full-fledged Afrofuturistic universe that spans music, videos, and virtual reality experiences. Through the lens of an android protagonist, Monáe expertly weaves R&B, Funk, and Pop into a rich arrangement of science fiction. This approach allows her to tackle complex themes of identity, technology, and social justice with a creativity that connects deeply with contemporary audiences.

The force of Monáe's work lies not just in its musical innovation, but in its ability to use the medium as a platform for exploring pressing social issues. By framing these discussions within a futuristic narrative, Monáe creates a space where marginalized voices can be amplified, and alternative futures can be imagined. This demonstrates how Afrofuturistic music serves as both entertainment and a powerful tool for social commentary and change.

Figure 2. Janelle Monáe – Metropolis Cover Image

Literature – So What? Let's Rewrite Reality

In the literary realm, Afrofuturism redefines the boundaries of speculative fiction, using the written word to challenge our perceptions of history, identity, and possibility. Octavia Butler's "Kindred" (1979) stands as a testament to this influence. Butler's novel goes beyond a simple time travel narrative; it serves as a searing exploration of slavery, identity, and historical trauma that continues to ring true with readers decades after its publication.

The enduring legacy of "Kindred" lies in its ability to use speculative elements as a lens for examining complex social issues. By thrusting her protagonist back to the antebellum South, Butler creates a narrative that compels readers to confront the legacy of slavery and its ongoing influence on American society. This approach exemplifies how Afrofuturistic literature can leverage the tools of science fiction to address real-world issues, encouraging readers to reevaluate their understanding of past, present, and future.

The adaptation of "Kindred" into a graphic novel and television series further illustrates the transmedia potential of Afrofuturistic narratives. These adaptations not only introduce Butler's work to new audiences but also demonstrate how Afrofuturistic stories can evolve and remain relevant across different media landscapes.

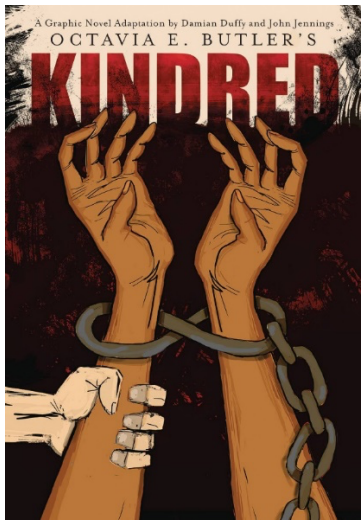

Figure 3. Kindred Graphic Novel Cover

Visual Arts – Sculpting Tomorrows World

Visual artists working within the Afrofuturistic tradition construct tangible glimpses of speculative futures, challenging our perceptions of what is possible. Cyrus Kabiru, a Kenyan sculptor, exemplifies this approach with his "C-Stunners" series. Kabiru's work transforms electronic waste into intricate, wearable sculptures that serve as both art pieces and powerful statements on African identity, creativity, and sustainability.

Kabiru's eyewear sculptures do more than simply repurpose discarded materials; they invite viewers to literally see the world through a new lens. This approach embodies a core tenet of Afrofuturism: the reimagining of African identities and futures through the creative reinterpretation of existing materials and ideas. By turning waste into wearable, Kabiru challenges notions of value and beauty, while also commenting on issues of consumption and environmental responsibility.

The "C-Stunners" series demonstrates how Afrofuturistic visual art can serve multiple functions simultaneously. It critiques present-day issues, celebrates African creativity and ingenuity, and offers a vision of a future where innovation and sustainability go hand in hand. This multifaceted approach underscores the power of Afrofuturistic visual arts to not only imagine new futures but to actively shape perceptions and inspire change in the present.

Figure 4. Cyrus Kabiru – “C-Stunner”

Immersive Experiences – Stepping Through, Visors On

The digital age has opened new realms for Afrofuturistic expression, allowing for the creation of immersive experiences that transport audiences through speculative futures. The "NeuroSpeculative AfroFeminism" project by Hyphen-Labs exemplifies this innovative approach. This virtual reality experience does more than put on display the futuristic technology; it creates a space where users can actively engage with speculative concepts and grapple with complex issues of identity, technology, and society.

By setting their experience in a futuristic beauty salon, Hyphen-Labs taps into a space traditionally associated with Black female community and empowerment. This choice allows them to probe the intersection of womanhood, technology, and identity in a context that feels both familiar and fantastical. The project demonstrates how immersive technologies can be used to create not just entertainment, but powerful educational and consciousness-raising experiences.

"NeuroSpeculative AfroFeminism" illustrates the unique potential of immersive Afrofuturistic experiences to foster empathy and understanding. By allowing users to step within a speculative future, it encourages them to consider perspectives and possibilities they might not encounter in their daily lives. This approach showcases how Afrofuturism in immersive media can serve as a tool for social change, pushing audiences to imagine and work towards more inclusive and equitable futures.

Figure 5. NeuroSpeculative AfroFeminism

Performance – Embodying the Future Space

Performance art within Afrofuturism goes beyond mere entertainment, serving as a medium for physically manifesting speculative futures and engaging audiences in immersive narratives. The Intergalactic Krewe of New Orleans exemplifies this approach, transforming traditional parade performances into portals to alternative realities.

Drawing inspiration from science fiction (particularly Star Wars), African American culture, and the rich history of New Orleans, the Krewe creates performances that are more than spectacle. Their work serves as a form of cultural alchemy, blending disparate elements to create new forms of expression that challenge and expand our understanding of identity and possibility.

The significance of the Intergalactic Krewe's work lies in its ability to bring Afrofuturistic concepts to public spaces, making them accessible to a wide audience. By incorporating these ideas into the familiar context of New Orleans parade culture, they create opportunities for community engagement with Afrofuturistic themes. This approach demonstrates how performance art can serve as a bridge between speculative concepts and everyday life, encouraging audiences to incorporate futuristic thinking into their understanding of the present.

Through their choreography, costumes, and interactive elements, the Krewe invites audiences to become active participants in reimagining cultural narratives. This participatory aspect is crucial, as it transforms viewers from passive observers into co-creators of Afrofuturistic visions. By doing so, the Krewe's performances embody a core principle of Afrofuturism: the idea that imagining and creating alternative futures is a collective endeavor.

In each of these artistic mediums, Afrofuturism pushes beyond the status quo, actively constructing new ways of seeing, hearing, and experiencing the world. This multidisciplinary approach ensures that Afrofuturism isn't just a concept to be studied—it's a living, evolving force in the landscape of media arts and design.

Emerging Motifs in Afrofuturism – The DNA Of Transformation

As we navigate the multifaceted landscape of Afrofuturism, two powerful motifs emerge not just as recurring themes, but as the very DNA of Afrofuturistic expression: *metamorphosis and transfiguration*. These aren't mere literary devices or visual tropes; they're the mechanisms propelling the force of Afrofuturism in media arts and design.

Metamorphosis

Metamorphosis in Afrofuturism embodies radical, paradigm-shifting transformations of environment and perception. This motif serves a crucial function: it allows artists to envision and articulate changes that go beyond surface-level alterations, instead reimagining the very fabric of reality.

In music, Sun Ra's cosmic voyages exemplify this concept. His compositions do more than entertain; they serve as sonic metamorphoses that transmute earthly realities into interstellar explorations. Each note functions as a step away from the familiar, challenging listeners to reconceptualize their place in the universe. This approach allows for a radical reimagining of Black identity and experience, freed from terrestrial constraints and histories.

Literature harnesses metamorphosis to powerful effect, as seen in Octavia Butler's "Kindred." Butler's use of time travel serves as more than a plot device; it functions as a crucible for metamorphosis, forcing a fundamental reshaping of the protagonist's understanding of history and identity. By physically transporting her character to the antebellum South, Butler creates a narrative space where the past can be directly confronted and its control over the present can be viscerally understood. This approach allows for a deeper exploration of how historical traumas continue to shape contemporary realities, while also suggesting the possibility of transformation and healing.

In visual arts, Cyrus Kabiru's eyewear sculptures embody metamorphosis in tangible form. By transmuting everyday detritus into futuristic artifacts, Kabiru does more than create art; he constructs portals that transport viewers to alternate realities. His work challenges our perception of what's possible, encouraging a metamorphosis in how we view both the present and the future. This approach serves to question established hierarchies of value and beauty, while also demonstrating the metaphoric exercise inherent in reimagining the mundane.

Transfiguration

If metamorphosis rewrites external realities, transfiguration reshapes internal landscapes. This motif seeks profound changes in identity and agency, serving as a powerful tool for examining and reimagining the self in relation to society and history.

In Afrofuturistic literature, transfiguration manifests as more than character development; it represents a fundamental shift in a character's essence. These transformations often mirror seismic shifts in understanding of self and community, allowing authors to push the malleability of identity and the power of self-determination. This approach provides a means to imagine liberation from imposed identities and restrictive social structures, offering readers models for personal and collective transformation.

Performance art brings transfiguration from conceptual exploration to lived experience. The work of the Intergalactic Krewe, for example, uses costume and movement to physically manifest the transformation from present to future, from earthbound to cosmic. Their performances serve as more than entertainment; they function as rituals of transfiguration, inviting audiences to participate in the reimagining of cultural narratives and identities. This participatory aspect is crucial, as it suggests that transfiguration is not just an individual experience, but a collective process of reimagining and rebuilding.

The power of these motifs—metamorphosis and transfiguration—lies in their ability to serve as conceptual frameworks through which Afrofuturism reshapes our understanding of reality, identity, and possibility. In every medium, from the sonic landscapes of music to the physical embodiments of performance art, these motifs drive Afrofuturism's relentless push beyond the boundaries of ordinary and limited thought and expression.

The prevalence of these motifs across Afrofuturistic works speaks to their fundamental importance in the movement's philosophy. Metamorphosis and transfiguration serve not just as artistic devices, but as strategies for imagining and enacting change. They provide a means to envision futures unbounded by current limitations, whether those limitations are technological, social, or conceptual.

Moreover, these motifs reflect the aspirations of Afrofuturism itself. Just as individual works depict metamorphosis and transfiguration, the movement seeks to transform our collective imagination, changing how we perceive the past, navigate the present, and envision the future. By consistently employing these motifs, Afrofuturist creators remind us that change—radical, fundamental change—is not only possible but necessary for creating more equitable and imaginative futures.

As we continue to analyze Afrofuturistic works, these motifs offer us a powerful lens through which to understand their goals and importance. They invite us not just to observe, but to actively engage with

Afrofuturism—to see, hear, and experience the metamorphosis and transfiguration that lies at the heart of this revolutionary movement in media arts and design. In doing so, we are challenged to consider how these concepts might apply beyond art, inspiring real-world transformations in society, culture, and individual lives.

Our Case Study - Echoes of Harmonic Threads

To fully grasp the contemporary manifestations of Afrofuturism, we turn to "Harmonic Threads," an interdisciplinary project that embodies the principles and aesthetics of Afrofuturistic expression. Unveiled at Ars Electronica 2023's Expanded Animation Symposium, this work represents a convergence of Afrofuturistic ideas and cutting-edge media arts technologies.

"Harmonic Threads" distinguishes itself through its innovative fusion of dance, real-time digital creation tools, cloth simulation, and interactive textiles. This combination creates a dynamic interplay between the physical and the digital, embodying the Afrofuturistic themes of metamorphosis and transfiguration. The project's use of technology to transform the performance space goes beyond mere visual spectacle; it serves as a metaphor for the influence of Afrofuturistic thought.

The dancers' interactions with the digital cloth simulate a physical and emotional transfiguration, illustrating how technology can be used to traverse and reimagine the boundaries of the body and identity. This aspect of the project speaks to broader Afrofuturistic concerns about the relationship between humanity and technology, and how this relationship might evolve in future societies.

"Harmonic Threads" is structured around four conceptual pillars, each representing a key aspect of Afrofuturistic thought:

Passage: This pillar embodies the concept of transcendence, capturing the essence of Afrofuturistic passages across time, space, and dimensions. It challenges our notions of fixed reality, suggesting the possibility of movement between different states of being.

Resistance: Reflecting the indomitable spirit that has propelled African diasporic cultures through centuries of adversity, this pillar represents the ongoing struggle against oppression and marginalization. It demonstrates how Afrofuturism can serve as a tool for critiquing present realities while imagining alternative futures.

Emergence: This concept signifies the birth of new identities, ideas, and possibilities arising from processes. It speaks to the generative potential of Afrofuturism, its ability to create new narratives and ways of being.

Reclamation: Emphasizing the power of narrative ownership, this pillar underscores the importance of speculative storytelling in reshaping both present and future. It highlights how Afrofuturism allows marginalized communities to reclaim agency over their own stories and futures.

These pillars are the very warp and weft of "Harmonic Threads," demonstrating how the motifs of metamorphosis and transfiguration can be woven into the fabric of narrative and interaction design in Afrofuturistic media arts.

"Harmonic Threads" serves as a form of proof to the ongoing vitality and of Afrofuturism. It doesn't merely present Afrofuturistic ideas; it actively engages viewers in a dialogue about identity, co-creation, and reimagined futures. By combining cutting-edge technology with Afrofuturistic vision, the project charts new territories in media arts and design, demonstrating the continuing relevance and innovative potential of Afrofuturism in contemporary creative practice.

Figure 6. Dancers Avatar with Cloth Simulation

Emergent Horizons – Afrofuturism and the AI Revolution

As we contemplate the future trajectories of Afrofuturism in media arts and design, we must acknowledge the novel role of generative artificial intelligence technologies in shaping creative expression. The emergence of these technologies presents both opportunities and challenges for Afrofuturistic practice and thought. While generative AI holds the potential to democratize creative tools and expand the reach of Afrofuturistic expression, it also risks perpetuating existing power asymmetries and biases if not thoughtfully governed.

Artists like Stephanie Dinkins are already pioneering critical interventions into AI systems, creating work that challenges us to consider how these technologies might either reinforce or dismantle existing racial hierarchies. Dinkins' "Secret Garden" project, which pairs AI-generation with oral histories from African American women, demonstrates how generative technologies can be repurposed to center marginalized voices and preserve ancestral knowledge. Such work exemplifies how Afrofuturist practitioners are not merely passive recipients of AI technology but active shapers of its development and deployment.

The integration of generative AI into Afrofuturistic practice also raises crucial questions about representation and authenticity. As AI models like Midjourney and DALL-E become increasingly capable of generating imagery that draws from African and African diasporic visual languages, we must consider who controls these tools and whose perspectives they amplify. Recent examples of AI art platforms producing problematic representations of Black bodies and culture underscore the necessity of ensuring that these technologies are developed with direct input from Black, African, and African diasporic communities.

Looking forward, the convergence of Afrofuturism and generative AI technologies may offer new pathways for exploring themes of transformation, identity, and collective futures. However, this potential can only be realized through intentional efforts to ensure these technologies serve as tools for liberation rather than instruments of digital colonialism. As artists and scholars continue to experiment with these technologies, their work will be crucial in determining whether AI becomes a means of expanding or constraining Afrofuturistic visions of tomorrow.

Figure 7. Secret Garden

Conclusion

Our odyssey through the multifaceted landscape of Afrofuturism reveals a movement that transcends simple categorization. Afrofuturism emerges not just as a genre or aesthetic, but as a revolutionary force reshaping the edifice of media arts and design. Its power lies in its ability to challenge dominant narratives, reclaim agency for marginalized voices, and envision futures unbound by present limitations.

The twin motifs of metamorphosis and transfiguration, as we've analyzed, serve as the driving force for Afrofuturism's influence. These concepts drive a radical reimagining of storytelling, identity, community, interactivity, and technology across various media. From the cosmic jazz of Sun Ra to the immersive digital realms of contemporary artists, Afrofuturism consistently pushes beyond established boundaries, charting new territories in creative expression and technological innovation.

The evolution of Afrofuturistic expression across various media demonstrates the raw power of speculative storytelling to catalyze social and cultural transformation. Projects like "Harmonic Threads" exemplify how contemporary artists can synthesize Afrofuturistic themes with cutting-edge technologies, creating new languages of expression that bridge the digital and physical realms. These works serve as more than aesthetic experiments; they function as launchpads for exploring complex ideas about identity, history, and the future.

As we stand at the threshold of tomorrow, Afrofuturism's part in shaping the future of media arts and design proves indispensable. Its insistence on diverse perspectives and speculative futures serves as a clarion call for a more inclusive and equitable future. Afrofuturism doesn't merely encourage us to imagine these futures; it compels us to actively create them.

In essence, Afrofuturism brings forth a challenge to reimagine not just the future, but our very understanding of past and present. It demands that creators and audiences, alike, grapple with complex ideas about identity, technology, and social change. As our world grows increasingly complex and interconnected, with generative AI technologies reshaping the very nature of creative expression, the insights and inspirations offered by Afrofuturism become not just valuable, but vital. Its critical interventions into emerging technologies ensure that these powerful new tools serve the cause of liberation and equity rather than reinforcing existing colonial power structures.

The future of media arts and design is not a distant concept to be passively awaited. It's being actively shaped, here and now, by forces like Afrofuturism. As we move forward, one certainty remains: the creative landscapes of tomorrow will bear the indelible mark of Afrofuturism's visionary power. The revolution isn't coming—it's already here, and it’s more brilliant than the sun.

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I stand indebted to the pioneers of Afrofuturism, true giants in their field, whose visionary works continue to inspire and challenge us. Their legacy propels us to envision and create futures marked by inclusion, transformation, and spectacular beauty.

About The Author

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His works and contributions have been featured at Ars Electronica Festival, SXSW, and SIGGRAPH, among others. He holds a Bachelor's in Media Arts and Art Studio from The University of South Carolina and a Master's of Art and Design in Experimental Media Arts from North Carolina State University.

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EXPLORING THE INTEGRATION OF NON-FUNGIBLE TOKENS IN BLOCKCHAIN GAMING

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This paper investigates the intersection of Non-Fungible Tokens (NFTs) and blockchain gaming, examining the multifaceted impact of these unique digital assets on the gaming landscape. NFTs, indivisible and verifiable tokens on a blockchain, have gained significant traction in the art and collectibles space, prompting a surge of interest within the gaming community. The paper explores the potential of NFTs to revolutionize in-game assets, characterizing them as scarce, tradable items that confer true ownership to players. Through case studies and analysis, it evaluates the challenges and opportunities associated with integrating NFTs into game economies, considering implications for game developers, players, and the broader gaming industry. Additionally, the paper scrutinizes the role of NFTs in fostering player engagement, community building, and the emergence of player-driven marketplaces. By shedding light on the dynamics of NFTs in virtual realms, this paper contributes to the ongoing discourse on the transformative potential of blockchain technology in shaping the future of gaming.

Keywords: NFTs, Blockchain, Games, Blockchain games, P2E model

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Introduction

Non-Fungible Tokens (NFTs) are predominantly associated with blockchain-based games due to their reliance on blockchain technology for verification and management of ownership (Raman & Raj, 2021). NFTs are highlighted as digital certificates of authenticity that ensure unique ownership of assets in digital games, particularly through the ERC-721 standard on Ethereum (Jaferian et al., 2024). The uniqueness and ownership properties of NFTs generally require blockchain technology to ensure their verifiability and security, which are key to their function in digital environments (Popescu, 2021).

The potential of NFTs extends beyond digital art to significantly impact game development, introducing new ways to buy, sell, and invest in game art and assets (Fowler & Pirker, 2021). NFTs enhance player engagement by offering unique, collectible items that can be traded or sold, fostering a sense of ownership and investment among players (Siddique et al., 2023). This transparent selling, buying and trading contributes to vibrant, player-driven marketplaces (Magotra et al., 2021).

In this systematic review, we explore the multifaceted role of NFTs in gaming, examining their benefits, challenges, and broader implications for the gaming industry and digital asset ownership.

Methodology

To locate relevant papers, we performed research in the following databases: Google Scholar, ProQuest, Sage Journals, and Science Direct. The databases were chosen based on their comprehensive coverage of scholarly papers and their relevance to NFT, blockchain, and blockchain games. The search query encompassed terms such as "Non fungible tokens," "blockchain," "bockchain games," "NFT in games," and other relevant keywords. The search was refined and broadened using Boolean operators (AND, OR) as needed.

A preliminary search of the databases resulted in the identification of around 754 publications published between 2016 and 2024. We examined the titles and abstracts of these publications to assess their relevance, resulting in a reduction of the total to 343 papers that met the initial inclusion criteria, which included publication in English, and in journals, conferences, or books. We assessed the publications to ascertain their relevance, resulting in a reduction of the pool to 188 studies that satisfied the initial inclusion criteria. A comprehensive examination of those papers was performed, utilizing more rigorous standards. Any inconsistencies among the reviewers were handled via deliberation and agreement. As a result, 119 publications were chosen to be included in this evaluation.

To provide a thorough and transparent reporting procedure, we followed the Preferred Reporting Items for Systematic Reviews (PRISMA) standards (Page et al., 2021). By following every aspect of the PRISMA checklist, the identification, screening, eligibility, and inclusion of studies, we maintained the clarity of our systematic review.

Non-fungible tokens

Non-fungible tokens (NFTs) are evidence of ownership for digital objects, like how individuals possess monetary assets (Popescu, 2021; Raman & Raj, 2021; Mazur & Polyzos, 2024). A digital item might take the form of a text, image, sound file, or video. It can either represent a physical object or exist solely in a digital format, as an item within a video game (Ali et al, 2023; Hammi et al., 2023). When NFTs gain market acceptance, they transform into digital collectibles (Nadini et al., 2021). The relationship among smart contracts, NFTs, and digital collectibles constitutes the second generation of blockchain technology (Liu & Holopainen, 2024). Blockchain technology serves as the foundation for all digital activities (Girasa, 2018), guaranteeing the genuineness of assets in virtual environments. Every instance of ownership and financial transaction is recorded and verified in an Ethereum smart contract (Rehman et al., 2021; Laroiya et al., 2020).

The value of NFTs is derived not from their creative merit or visual attractiveness, but rather from their capacity to grant the purchaser exclusive ownership rights to a one-of-a-kind and verifiable item that does not allow for forgery and manipulation (Yilmaz et al., 2023; Calvo, 2024). NFTs possess features such as uniqueness, transferability, verifiability, traceability, and transparency. These qualities make them an ideal

alternative for trading physical assets and guaranteeing effortless authenticity and traceability (Gebreab et al., 2022).

In their study, Nadini et al. (2021), classify the NFT market into five main segments: Game, Collectible, Art, Utility, and Metaverse. The collectible consists of a group of images that have a common entity but have been modified by various features. These attributes have the potential to enhance the value and uniqueness of elements in the collection, based on their level of rarity. The growing prominence of collections such as Cryptokitties, CryptoPunks, and Bored Apes Yacht Club has led to a significant increase in investor enthusiasm (Thompson, 2021; Martelée & Hafner, 2022). As it is shown in Figure 1 since December 2023, NFT trading volume has consistently surpassed $1 billion. By April 2024, trading volume reached $1.35 billion, reflecting a 13% decline compared to the previous month. Despite this, the number of sales has increased by 20% (Gherghelas, 2024).

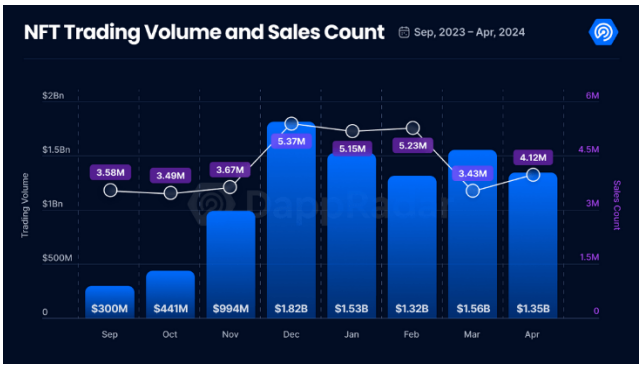

Figure 1. NFT trading volume and number of sales from September 2023 to April 2024[1]

There are various use cases for NFTs. One of the most prominent ones is the purchase and trade of virtual real estate (Wang et al., 2021; Moringiello & Odinet, 2022). Platforms like Decentraland allow players to buy, sell, and build on virtual land plots that are represented as NFTs (Goanta, 2020; Jeff, 2022; Guidi & Michienzi, 2022). These virtual lands can increase in value, be developed, or used for various in-game economic activities, creating a dynamic and interactive economy within the environment (Dowling, 2021).

Another use case of NFTs is within the sports and esports industries, where they are having a significant impact (Mancini et al., 2023). Conrad (2022) explained that they are used to create digital collectibles representing moment highlights that fans can collect, trade, and own. These often carry special significance and can be appreciated based on the rarity and the popularity of the moment or athlete involved.

In addition, digital games use NFTs to depict distinct personalities or assets that players may fully possess (Wang et al., 2021; Nadini et al., 2021; Mazur & Polyzos, 2024). In their 2023 paper, Yang & Wang describe the process of implementing breeding techniques to allow players to create unique and original NFTs by combining traits from existing ones. Games such as Axie Infinity allow players to get, breed, care for, battle, and trade creature avatars called Axies, each of which is represented as an NFT.

NFT Implementation

Smart contracts facilitate the process of converting assets into tokens (Christidis & Devetsikiotis, 2016). A smart contract is an executable code that is processed by the Ethereum Virtual Machine (EVM) and utilizes the blockchain to record its permanent state (Das et al., 2022). It functions inside every aspect of Ethereum, and the operational procedure is entirely self-contained within a sandbox environment (Ke & Chen, 2020). To establish a new NFT collection, it is necessary to conceive and implement a smart contract on the Ethereum platform, enabling the EVM to execute it (Chen & Omote, 2022).

The Ethereum Request for Comments (ERCs) outlines the standards for Ethereum tokens. The most utilized standards are the ERC-20 and ERC-721 (Di Angelo & Salzer, 2020; Pirker et al., 2021). ERC-20

[1] https://dappradar.com/

implemented by the Ethereum Blockchain, exclusively supports fungible tokens (Cuffe, 2018; Muthe et al., 2020; Di Angelo & Salzer, 2020). This ERC offers fundamental features for token transfer and approval, enabling them to be utilized by other chain entities (Hildenbrandt et al., 2018). It means the approve function allows a spender, such as a user, wallet, or smart contract, to withdraw a specified quantity of tokens from the token pool of the approver (Rahimian et al., 2019). ERC-20 ensures that tokens are identical to another token, both in terms of their type and value (Fröwis et al., 2019; Vallejo Seade, 2022; Heryadi et al., 2021) which is true for fungible tokens (Wang et al., 2021) such as cryptocurrencies, where all the coins generated for cryptocurrencies are equivalent and indistinguishable (Wang & Nixon, 2021).

ERC-721, on the other hand, is a standardized protocol for non-fungible tokens (Goyal et al., 2020; Bauer, 2022). It establishes an API interface that allows the development of a smart contract on the Ethereum network (Mukhopadhyay, 2018). Furthermore, this standard requires that the smart contract exhibits exact and specific functionality (Casale-Brunet et al., 2021).

The wallet address of the NFT's owner serves as their representation (Ante, 2023; Jo et al., 2024). To transfer NFTs, the individual must demonstrate ownership by possessing the associated private key and then proceed to send the assets to one or more addresses with an accurate digital signature (Wang et al., 2021). Nevertheless, the transfer of the NFT can be initiated not only by the owner, but also by the approved address or an authorized operator of the existing owner (Pirker et al., 2021). It is therefore necessary to monitor the ownership of each item separately and accurately (Wang & Nixon, 2021). According to Yang et al. (2023), the significant value of NFTs underscores the criticality of ensuring the security of NFT contracts. Furthermore, given the unchangeable nature of smart contracts, it is imperative to verify the absence of any bugs in the NFT smart contract prior to its deployment on the blockchain. A contract defect refers to a mistake, imperfection, or flaw that can lead to unforeseen outcomes or alter the original goals of the code.

NFTs in games

Virtual asset ownership

Authenticating or establishing ownership of a work in traditional art or antiques markets can be a demanding procedure. Nevertheless, NFTs enable the verification of the genuineness of a digital asset through blockchain technology (Hladka et al., 2023). NFTs ensure that each digital asset is unique and cannot be duplicated, providing a robust solution for proving ownership and authenticity in the digital world (He et al., 2023). Artificial Intelligence (AI) and Machine Learning (ML) could be used to create NFTs and personalize them. For example, Art Blocks is an online NFT generator that helps artists to create NFTs which cannot be replicated (Malhorta et al., 2024), which shows how NFT technology ensures the uniqueness of non-monetary digital assets, preventing them from being copied or forged (Li et al., 2023).

The simple act of clicking a button can facilitate the transfer of ownership to another wallet address (García Corbí, 2022; Hladka et al., 2023). As transactions for transferring NFTs ownership are registered on the blockchain, it is possible to directly refer to the blockchain to track these transactions (Borri et al., 2022; Sheldon, 2022; Murray, 2022). NFTs offer a record of ownership for the items they represent, which means that equipment and props acquired in the game remain with the player and are no longer subject to changes or fluctuations on the server (Wu et al., 2023; Gupta, 2023).

A more cohesive and engaging gaming experience is achieved when players can use their in-game belongings across multiple games, which is called interoperability. It is a fundamental principle of Web3, facilitating the smooth transfer of assets and data between various games and platforms (Abraham, 2023). Interoperability is essential for NFTs in blockchain gaming (Rehman et al., 2021; Mcilhargey, 2023) allowing NFTs to be used across different games and platforms, enhancing their utility and value (Ramezani et al., 2024).

Tradable in-game items

NFTs are being integrated into digital settings, such as games, as a component of their collections (Allen et al., 2022). This concept also applies to digital art, in which games showcase well-designed products that possess worth both within and beyond the gaming world (Valeonti et al., 2021). The concept of generating fiat cash through video game participation has been around for a long time (Serada, 2021). According to Choi & Choi (2022), despite the absence of in-game mechanics, there have consistently existed methods to

exchange in-game assets or accounts for real-world dollars. At times, these transactions take place on illegal markets because engaging in real-life trading often breaches a game's terms of service.

The advent of Ethereum Blockchain technology and the introduction of smart contracts created a mechanism to utilize tokens effectively (Metcalfe, 2020). Key NFT projects include Terra Nullius, (Allen et al., 2022), Peperium, (Trevisi et al., 2022), CryptoPunks, and CryptoKitties (Ilovski & Karamachoski, 2024). The success of CryptoPunks spurred the development of the ERC-721 smart contract standard, which was released in early 2018. This standard significantly boosted interest in NFT development, particularly within the gaming industry (Ross et al., 2021; Afkhami & Daskalaki, 2023; Jovan & Karamachoski, 2024).

The tradability of in-game items through NFTs allows for a vibrant secondary market where players can buy, sell, and trade their virtual assets (Baral & Raina, 2020; Bouzid et al., 2023). In blockchain-based games such as CryptoKitties (Figure 2), players can trade digital cats, with each transaction recorded on the blockchain, enhancing trust and reducing fraud (Lee et al., 2019; He et al., 2023). MAGE RUNNER is another game that utilizes blockchain technology to provide a unique gaming experience where rewards are collected as NFTs, which are then tradable on platforms like OpenSea (Bhand et al., 2024). OpenSea and Nifty Gateway were among the first to leverage NFTs by establishing popular marketplaces for these tokens, giving them an advantage against new platforms that trade in various cryptocurrencies (Gupta et al., 2022).

As the game finance (GameFi) industry's proprietary trade practices show, participants must control the flow of virtual assets (Packin, 2024). According to Yang & Dong et al. (2023) Blockchain games are created based on various NFT standards to meet demand. For instance, ERC-721 ensures that every CryptoKitty is distinct, while ERC-1155 enables War of Crypto to produce repeatable items such as "potions." Once players interact with assets in games that have assigned values within the game's ecosystem, they can choose their props for value mapping. Given that each player’s information is publicly accessible on the blockchain, the endorsement access device can directly verify its authenticity.

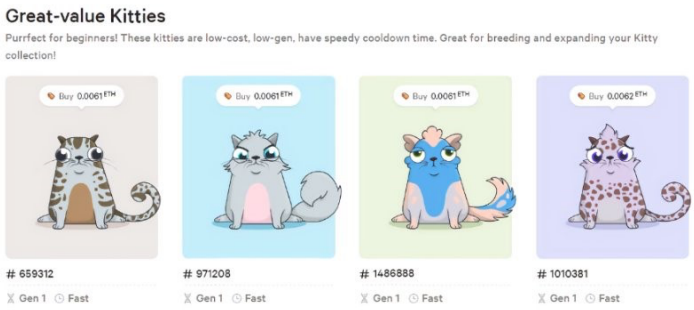

Figure 2. The starting section on the game’s web interface (Serada et al., 2021)

NFTs and Gaming Economy (Play-to-Earn model)

The integration of digital assets, including NFTs and cryptocurrencies, has enabled a new economic model known as Play-to-Earn (P2E) model (Vidal-Tomás, 2022) where players can earn real-world value through gameplay, leading to a paradigm shift in how value is created and distributed within gaming ecosystems (Gehrlein & Dengel, 2023).

The player acquires unique, tradable digital assets (NFTs) after each victory in the game (Raut et al., 2024; Jaferian, et al., 2024). Simply stated, the concept goes beyond being primarily limited to in-game currencies or point systems and assets, and instead resembles an open trading market where achieving success in the game can lead to real-world financial results (Delfabbro et al., 2022). This model shifts gaming from a mere entertainment activity to a potential revenue-generating activity (Zaucha, 2022; Jaferian et al., 2024). According to Mcilhargey (2023), the integration of NFTs into games like DEEPSPACE and Axie Infinity has led to substantial market growth, contributing to a combined market cap of over $28 billion. This illustrates the significant financial opportunities and market expansion potential that NFTs can bring to the gaming industry.

One of the challenges is that new players joining a blockchain game could be confused by the number and variety of NFTs and find it hard to know which ones are more valuable to purchase (Serada, 2021). To solve the stated problem, Boonparn et al., (2022) proposed a tool to help investors decide what game to invest in by analyzing data of the P2E NFT games on social media. The tool displays trends over time, enabling users to filter data by month to observe changes in sentiment and engagement with the game. This feature is essential for evaluating the game's performance and predicting its future success.

Chain games, also known as GameFi, embody the merging of video games with decentralized finance (DeFi) ideas (Cheng, 2024). GameFi refers to games that are built on decentralized platforms and provide financial incentives for players (Alam, 2022). The GameFi ecosystem is built around blockchain technology, which encompasses services like e-wallets, digital assets, smart-contract transactions, and data protection security (Phumphuang & Jareevongpiboon, 2022).

In their paper Proelss (2023) explain that the distinctive advantages and prospects of GameFi can only be achieved through the harmonious combination of its components. The game component has a minimal level of difficulty for participation and offers amusement, which attracts new players and establishes a market, while also serving as an access point to crypto assets. NFTs function as financial instruments that enable the commercialization of specific game elements, while generating additional income for creators through royalties obtained from NFT transactions. For example, Bond (2024) discussed the economy of Axie Infinity, which falls under the classification of GameFi. Axie has generated a trade volume above $1.5 billion through the facilitation of player ownership of in-game asset NFTs and their monetization via decentralized exchanges.

Challenges of NFTs in gaming

Despite the benefits, the integration of NFTs in gaming faces challenges such as scalability, the complexity of blockchain technology, potential regulatory issues (Chohan, 2021), transaction fees, and the ecological impact of blockchain technologies (Pandey et al. 2022). As the quantity of users, transactions, and applications grows, the capacity of blockchain networks to efficiently process and authenticate them becomes limited (Xie et al., 2019; André et al., 2021), therefore, Blockchain networks can experience slowness and inefficiency because of the substantial computational demands necessary for transaction validation (Zheng et al., 2018; Scherer, 2017; Hu et al., 2019).

Furthermore, Ethereum faces criticism due to its high 'gas fees', which refer to the costs associated with conducting transactions on the network. Due to Ethereum's reliance on user labor and proof of work, each transaction incurs various gas fees (Gupta et al., 2022). Additional issues with NFTs are around their significant environmental impact (Valeonti et al., 2021). Prior to Ethereum's 2.0 release, known as "the Merge," in September 2022, a single Ethereum transaction required over 238.22 kilowatt-hours (kWh) of energy (Flick, 2022).

In addition to the mentioned concerns, as NFTs can represent any unique item, their prospective uses have the potential to broaden. Individuals can reach public blockchains and use transaction data to analyze activities. Transactions may include confidential details such as wallet addresses and transaction amounts, which may be linked to other transactions to obtain further information (Zelenyanszki et al., 2023). Galal & Youssef (2022) explained the Aegis protocol to address privacy concerns by allowing users to swap NFTs without revealing their identities, enhancing the security of transactions. Aegis enables users to securely exchange their NFTs for payment amounts while maintaining complete anonymity. This process ensures that no information about the participants, NFTs, or payment amounts is disclosed. Also, Uribe & Waters (2020) proposed that by incorporating the provisions of privacy regulations into smart contracts with the requirements of NFTs, this fusion of programmable privacy might serve as an innovative and beneficial type of cutting-edge privacy-preserving technology.

One other possible drawback of employing NFTs as assets is the magnification of economic inequalities, as entities with more financial resources might obtain digital assets at the expense of smaller businesses (Yaghy et al., 2023). For example, Axie Infinity has received attention not just for its innovative use of technology but also for the various related issues it faced (De Jesus et al., 2022). There have been some discussions focusing particularly on the impacts of NFTs including economic disparity, exploitation, and the broader implications of NFTs within the game (Delic & Delfabbro, 2024). For instance, Lai et al. (2023) explained that a small group of players hold a disproportionate amount of game assets in Axie Infinity, which

may threaten the game's long-term sustainability due to the concentrated wealth and potential exploitation of average players. It means there is a concern that some players are exploited by wealthier ones who own the game assets, which makes a dynamic reflecting broader global economic inequalities and raises questions about digital labor rights in blockchain games (Zaucha & Agur, 2023).

Axie Infinity players face trust issues concerning price manipulation, and the market contributes to financial instability. This insecurity is pivotal as it impacts the willingness and ability of players to invest time and resources into the game (Francisco et al., 2022). Another identified issue is the game's constraints on earning potential. AXSs or SLPs are granted to players who successfully accomplish in-game tasks or engage in other in-game activities. Nevertheless, the developers have imposed a limit on the potential earnings of players through daily tasks, player-vs-player or Arena events, and certain objectives inside the in-game adventures (De Jesus et al., 2022).

Also, contrary to stocks or currencies, NFTs do not have a daily price due to the unique quantity and timing of transactions associated with each NFT. This characteristic poses a challenge in predicting the sale price of NFTs (Wang et al., 2023). Zhang et al. (2024) note that the NFT market has more price fluctuations than other markets both before and after the COVID-19 pandemic. After the outbreak, the price changes from cryptocurrencies, including NFTs, suddenly increase, while the impact of gold prices on other markets significantly decreases. An analysis of the transaction history of NFTs reveals unique challenges related to price volatility and the differentiation of token traits, highlighting the need for nuanced approaches to NFT integration in games (Cho et al., 2022).

Conclusion

NFTs have changed the gaming industry by offering unique, verifiable digital assets that enhance player engagement and introduce new economic models within games. The integration of NFTs into blockchain-based games has provided players with the ability to own, trade, and monetize their in-game assets, leading to vibrant player-driven marketplaces and new financial opportunities. Games such as Axie Infinity and platforms like Decentraland have showcased the potential of NFTs to transform virtual economies, allowing players to invest in, develop, and trade virtual assets with real-world value.

Despite these advancements, the application of NFT concepts outside blockchain contexts remains limited. Educational initiatives, such as the board game "Tokens in Mind," illustrate how NFT-like principles can be taught without actual digital or blockchain technology (Gehrlein & Dengel, 2023). However, the fundamental properties that make NFTs valuable—uniqueness, verifiability, and security—are tied to blockchain technology, making their implementation in non-blockchain games rare and often impractical.

The integration of NFTs into gaming is not without challenges. Scalability issues, high transaction fees, and the environmental impact of blockchain technology pose significant obstacles. Privacy concerns and the potential for economic inequalities within NFT-based games also require careful consideration. Innovations like the Aegis protocol (Galal & Youssef, 2022) and privacy-preserving smart contracts (Uribe & Waters, 2020) offer promising solutions, but broader adoption and regulatory frameworks are needed to address these issues comprehensively.

In conclusion, while NFTs hold potential to reshape the gaming landscape, their true value and functionality are deeply intertwined with blockchain technology. As the industry evolves, addressing the challenges associated with NFTs will be crucial in realizing their full potential and ensuring a fair and sustainable gaming ecosystem.

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EXPLORING THE IMPACT OF SMART CONTRACTS ON DECENTRALIZED GAMING ECOSYSTEMS

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This article addresses the crucial significance of smart contracts in blockchain gaming ecosystems, analyzing their influence on the development of decentralized gaming economies. Smart contracts are self-executing programs that contain coded rules and conditions. They have become a powerful tool in the gambling business, providing transparency, security, and efficiency. The study explores how smart contracts allow for trustless interactions, support peer-to-peer transactions, and grant players genuine ownership of in-game assets. The article illustrates how smart contracts enhance the development of blockchain games by promoting player autonomy, interoperability, and the creation of new economic models in the gaming industry through case studies and examples.

Keywords: Smart contracts, Blockchain, games, Blockchain games, Decentralized gaming

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Introduction

The advent of blockchain technology has introduced a new paradigm in various industries (Upadhyay et al., 2021) including the gaming industry, leading to the emergence of decentralized gaming ecosystems (López-Sorribes et al., 2023). Blockchain's decentralized nature has facilitated the creation of entirely new ecosystems where players can engage in gaming experiences that transcend traditional boundaries (Cui et al., 2021) At the heart of these ecosystems are smart contracts, self-executing contracts with the terms of the agreement directly written into lines of code (Balcerzak et al., 2022).

This paper explores the transformative role of smart contracts in decentralized gaming ecosystems. It examines how these contracts are reshaping game development, fostering new economic models, and addressing the challenges associated with decentralized systems. Through case studies and examples, the paper illustrates the impact of smart contracts on the gaming industry and provides insights into their potential to change the future of digital gaming.

Methodology

We conducted a systematic literature review following the methodology outlined by Page et al., (2021), utilizing electronic scientific databases such as Scopus, IEEE, ProQuest, Google Scholar, and ScienceDirect. We used keywords such as "blockchain," "smart contracts," and "blockchain games" along with a combination of them using AND/OR to guide the search. Studies were considered if they were written in English, published between 2014, and 2024, and published in peer-reviewed journals, book chapters, or conference papers.

The search across the specified databases yielded 592 results, and in the second stage, we screened the titles of the shortlisted papers, identifying 331 relevant papers. In the third stage, the abstracts of these papers were reviewed, and filtering criteria based on their contributions were applied. After assessing the quality of 164 preselected papers by analyzing their full texts, 150 papers were ultimately included in the study.

Smart Contracts

Smart contracts refer to portions of code written in a Turing-complete language that can maintain state, including finances, and interact with other smart contracts (Hall-Andersen & Schwartzbach, 2021). Smart contracts (Figure 1), are self-executing computer programs that operate on the blockchain to enable, execute, and enforce an agreement between parties without the need for a trusted intermediary (Khan et al., 2021; Wang et al., 2019). A smart contract possesses three essential components: an account balance, private storage, and executable code (Buterin, 2014; Wang et al., 2018). The contract's status includes both the storage and the balance of the contract (Lin et al., 2022). The state is kept on the blockchain and is modified whenever the contract is called (Alharby & Moorsel, 2017). According to Ciotta et al. (2021) a smart contract facilitates the exchange of a generic file as a transmission between users. More precisely, the smart contract's initial stage involves establishing the format of the registry of transmissions. This registry remains unchangeable and is reset each time a file is transmitted.

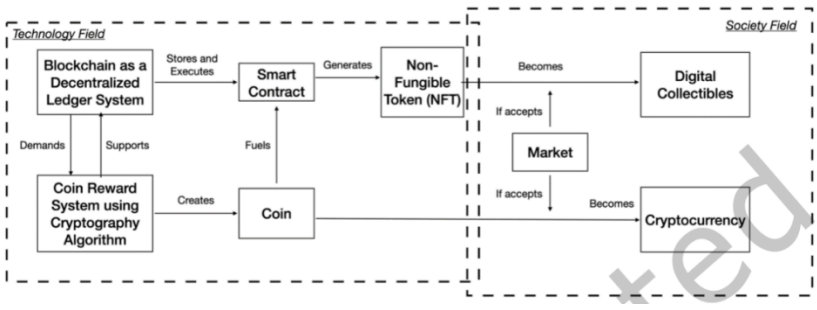

Figure 1. Blockchain and its features (Liu & Holopainen, 2024)

Blockchain technology facilitates the digitization of assets and ensures their secure transfer of value (Pelluru 2021; Javaid et al., 2022). The security of the value transfer is ensured by the inherent nature of the

interaction protocol, eliminating the requirement for trusted transaction middlemen (Pillai et al., 2019). Through the utilization of a blockchain network, it is possible to accomplish this transfer of digital tokenized assets in a straightforward and cryptographically verifiable manner (Christidis & Devetsikiotis, 2016; Li et al., 2019; Sunyaev et al., 2021).

Smart contracts are playing transformative roles across various applications and industries (Zou et al., 2019; Wang et al., 2019). In the financial sector, smart contracts enhance transparency and efficiency in payment systems (Demirel & Zeren, 2021; Almahirah & Salameh, 2021). The supply chain management also benefits from smart contracts facilitating higher levels of trust and coordination among companies (Bottoni et al., 2020; De Giovanni, 2020). Smart contracts are utilized to oversee the conditions of shipments, automate payments, validate recipients, and provide authorizations (Khan et al., 2021). In the automotive industry, smart contracts enhance data security, fraud prevention, and streamlined processes for services like mobility-as-a-service and vehicle tracking (Hornyák & Alkhoury, 2020; Golemi, 2021; Nguyen et al., 2023). Additionally, smart contracts enable the creation of decentralized energy communities in the energy sector, (Chinnici et al., 2022) where prosumers can efficiently manage and trade energy, promoting sustainability and local energy balance (Toderean et al., 2023).

An in-depth evaluation of smart contracts emphasizes their capacity to be programmed and automated (Mik, 2017; Sklaroff, 2017; Borselli, 2020). These qualities are crucial for a wide range of decentralized applications (DApps) (Taherdoost, 2023) which are enabled by smart contracts (Wang et al., 2019).

Smart contracts are utilized to autonomously execute decisions and oversee data (Alladi et al., 2019). DApps are constructed using blockchain technology to include the management of data storage and the execution of on-chain activities (Raval, 2016; Besancon et al., 2022). A decentralized application is one not under the authority of a centralized organization (Vergne, 2020). The rationale behind decentralized apps is that conventional centralized applications are more susceptible to assaults and foster corruption (Zheng et al., 2023). Currently, the Ethereum blockchain hosts several decentralized apps, with many more in the process of being developed (Bracamonte & Okada, 2017; Mukhopadhyay, 2018; Gjorgjev et al., 2024) and Gaming DApps are one of the prominent applications of blockchain technology (Jaferian et al., 2024).

Smart contracts in Games

The video game industry is compatible with the cryptocurrency ecosystem (Besançon et al., 2019) since it enables players to exchange and pass on their virtual character's non-fungible assets for various games (Cai et al., 2018). Unlike the centralized database server used in traditional games, the blockchain provides a more accessible platform for game makers (Manzoor et al., 2020; Stamatakis et al., 2024). The players' data can be retrieved by smart contracts or a collection of application programming interfaces (APIs) (Min et al., 2019; Wang, Shuai, et al., 2019) Smart contracts in the gaming sector, are being employed extensively to assure fairness, security, and transparency (Hu et al., 2020).

Blockchain games are entirely decentralized "on-chain games "or those that utilize smart contracts to perform certain aspects of game processes (Du et al., 2019). By using smart contracts, decentralized gaming platforms can automate complex interactions and transactions (Wang et al., 2019; Carvalho, 2021; Chen et al., 2023). Smart contracts can automate the distribution of rewards in decentralized games (Oliva et al., 2020), ensuring that players are fairly compensated for their achievements and contributions (Chatterjee et al., 2018). As an instance, Sako et al. (2022) provide a decentralized technique for generating pseudo-random numbers using smart contracts. This method aims to demonstrate the efficiency of smart contracts, while also providing incentives to participants and assuring fair distribution of rewards.

Also, Alefs et al. (2022) present a gaming DApp on the Ethereum blockchain using smart contracts to ensure secure, fair gaming with transparent and tamper-proof rules and transactions with securing players' balances and stakes.

Furthermore, according to Min et al., (2019), the server serves as a caching and indexing engine for smart contracts. The blockchain is the primary source of information, but clients rely on the server to search and validate the data returned.

Transparency and trust (Authentication and security)

Smart contracts provide a transparent and secure environment for transactions within the gaming ecosystem, (Carvalho, 2021) ensuring that the rules are immutable and executed as programmed. This eradicates the need for intermediaries, fostering trust among players (Alefs et al., 2022; Pittaras et al. 2021). Participants in blockchain games employ blockchain tokens to allow the buying and selling of in-game objects (Qiao, 2019, Pfeiffer et al., 2020). This is accomplished with smart contracts, which guarantee the authenticity of transferred assets and the verification of game players (Bartoletti & Pompianu, 2017; Oktian et al., 2019). Also, according to Paduraru et al. (2022), since blockchain smart contracts can automate verification, monitoring NFT owners and transactions is more reliable and easier. In contrast, a typical database merely shows the latest element state.

Additionally, they enable the implementation of dynamic strategies on decentralized platforms, resulting in improved level of security and dependability (Shahidehpour et al., 2020; Sharma et al., 2023). Gajrani & Kumar (2024) created a prototype platform to explore the challenges and opportunities involved in developing a blockchain-based gaming environment.

However, to ensure the security of transactions conducted in a decentralized network, it is imperative to include strong security procedures and countermeasures to effectively avoid instances of double spending (Zhang et al., 2019). Based on Liu et al. (2019) findings, key concerns include (1) security threats including selfish mining and DoS attacks, (2) mining management issues like computational power allocation and reward allocation, and (3) blockchain-based applications like energy trading.

Several further papers analyze potential vulnerabilities in the protocol and propose modifications to enhance its security (Koutsoupias et al., 2019). For instance, in their 2017 publication, Zhang et al. presented the Proxy pattern to enhance security. The proxy stores metadata and references to the server, while the actual data is stored on an external server. Also, Paduraru et al. (2022) mentioned that manipulating data in game transactions can result in data breaches throughout the distributed system. It is crucial to ensure that parties reach a mutual agreement on the transaction price and accurately update the balance account.

Ownership of assets

Smart contracts can be implemented for various gaming functionalities, such as processing transactions, handling advertisements, and managing in-game assets (Qiao, 2019; Pittaras et al., 2021; Carvalho, 2021). By leveraging smart contracts, players gain true ownership of in-game assets represented as non-fungible tokens (NFTs) (Popescu, 2021). This ownership is secure and verifiable on the blockchain, enabling a new economy where players can buy, sell, or trade assets without the fear of fraud or repudiation (Raman & Raj, 2021, Putri et al, 2023), therefore, blockchain assets can significantly enhance player retention and engagement (Paajala et al., 2022). For instance, CryptoKitties are popular NFTs governed by a smart contract on the Ethereum blockchain, ensuring its uniqueness and ownership (Evans, 2019; Nadini et al., 2021; Rajendran & Pandey, 2022).

Transfer and use of in-game assets across various ecosystems can be facilitated by smart contracts, known as interoperability between different gaming platforms (Pittaras et al., 2021). This interconnectedness enhances the gaming experience and opens new possibilities for game developers and players (Chen et al., 2023). According to Jiang & Liu, (2021) there are five smart contracts in the game CryptoKitties, that allows players to collect, breed, and trade unique digital cats: SiringAuction contract, the Core contract, Offers contract, SalesAuction contract, and GeneScience contract.

Another prominent example is Gods Unchained a trading card game that leverages smart contracts to ensure the fairness and transparency of card ownership and gameplay (Scholten et al. 2019; Koçer & Tampio, 2022). Players can buy, sell, and trade cards in a decentralized marketplace, with each transaction recorded on the Ethereum blockchain (Jiang & Liu, 2021; Sarathy, 2022; Nguyen et al., 2022).

In educational games, smart contracts can oversee the allocation of prizes, enforce regulations, and guarantee that all participants receive appropriate acknowledgment and remuneration (Ramezani et al., 2024). In addition, in educational games smart contracts can be used to manage credentials and achievements in a secure and tamper-proof manner (Jaferian et al. 2024).

New in-game economic models

Blockchain technology promotes reward-based video game interaction (Predescu et al., 2021) allowing players to earn tokens for playing, reviewing, or sharing games on social media (Trojanowska et al., 2020). According to Pillai et al. (2019) there are three crypto asset categories that players can earn: asset-tokens, crypto-coins, and utility-tokens. Their methodology classifies assets based on their fungibility and tangible nature.

The surge in the popularity of blockchain-based games provided a glimpse into the potential of virtual economies within the framework of Web3, or the third iteration of the internet (Liu et al., 2021; Bambacht & Pouwelse, 2022; Murray et al., 2023). Smart contract-powered decentralized gaming ecosystems facilitate the development of innovative economic frameworks (Xu et al., 2023) which provide players with financial motivations, therefore further blurring the distinction between gaming and earning a living (Sharma et al., 2023) This occurs through the utilization of games that effectively include Web 3.0, web development, and smart contracts to improve the user's experience (Akkaya et al., 2023).

In traditional video games, the prevailing paradigm typically requires players to make payments to obtain benefits such as upgrades, shorter waiting periods, or the acquisition of virtual items (Keogh & Richardson, 2018; Ivanov et al., 2021). GameFi, on the other hand, presents a novel approach to earning money through gaming (Proelss et al., 2023) wherein gamers may create cash by leveraging their skills and the amount of time they dedicate to playing (Cheng, 2024). These games aim to provide players with tangible economic rewards in the real world (Alam, 2022). In addition to earning tokens through gaming, users may obtain in-game rewards such as assets and more by participating in staking, which is a widely used financial activity (Qiao, 2019; Jiang et al., 2022).

Smart contracts can facilitate innovative gaming models such as play-to-earn, (Delfabbro et al., 2022; Zaucha, 2022; Tan, 2024) where players are rewarded with tokens that have real-world value, further driving engagement and monetization opportunities in the gaming ecosystem (Zarifis & Cheng, 2022; Rafaj et al., 2023; Duguleană et al., 2024). NFTs have made it possible for in-game items to only exist in the user's digital wallet and exchanging in-game coins for stable coins or fiat currencies (Lee & Park, 2023). NFTs such as weapons, skins, and monsters may be bought and sold on platforms like OpenSea. Game creators generate a cryptocurrency or play-to-earn token that has value and can be traded by players within the game (Vidal-Tomás, 2022). Many P2E games such as "Big Time" and "Meta Theft Auto," use smart contracts to manage in-game economies, reward systems, and virtual professions (Sahin, 2023). Blockchain-based asset trading within games removes the need for secondary marketplaces because smart contracts secure transactions, thereby minimizing the potential for fraudulent activities (Jaferian et al., 2024)

Duguleană et al. (2024) explains that P2E has gained significant popularity among customers due to other compelling factors in addition to the economic incentives. P2E gamers derive satisfaction from possessing full control and authority over their virtual possessions within the game.

Decentralized autonomous organizations (DAOs) for game governance

The DAO operated as an Ethereum smart contract and was established on 30 April 2016 (Minks, 2017; De Graaf, 2019; Faqir-Rhazoui et al., 2021). DAOs are entities that operate and are controlled by smart contracts, with their business and administrative regulations being stored on blockchains (Santos & Kostakis, 2018; Zichichi et al., 2019; Wang et al., 2019). DAO members can provide choices for decision-making within the organization (Tikhomirov et al., 2018; Jha, 2023). Additionally, they can engage in open discussions and vote on these options using transparent processes. Also, individual behaviors of members cannot be directly ascertained inside the contracts (Zichichi et al. 2019; Zhang & Anand, 2022).

A fundamental goal of web3 games is to establish a DAO where players collectively oversee the development of the game (Direr et al., 2022; Murray, 2023). In their 2020 paper Yao et al., explains that these gaming DAOs are renowned for their expertise and the impactful contributions they make in fostering community growth and advancing program development. As an illustration, a particular DAO successfully executed a task that surpassed the expectations of the game creators, while remaining within the established regulations.

The introduction of the P2E paradigm resulted in the emergence of numerous cryptocurrency gaming guilds (Jirásek, 2022; Kshetri, 2023). A blockchain gaming guild can be defined as an association of gamers who come together to play, advance in, share resources, and make money from blockchain-based games (Bult, 2022; Aguila et al., 2022). These groups, known as DAOs, are constructed in a way that allows them to collaborate in acquiring, managing, using, and monetizing assets from blockchain games (Proelss et al, 2023). These are organizations that collect in-game assets and lend them to players to generate cash through gameplay (Jirásek, 2022).

Furthermore, the development of decentralized autonomous organizations enables collaborative governance, enhancing the democratic management of various applications (Craß et al., 2022). Jaferian et al. (2024) examines the use of DAOs in gaming, where governance tokens allow players to participate in decision-making processes. Smart contracts facilitate the functioning of DAOs by automating governance and financial transaction enhancing community involvement.

Challenges

Security Issues

As mentioned in the paper, one of the main challenges of smart contracts includes security vulnerabilities (Ante, 2021). Numerous studies have provided analysis on issues related to the security, reliability, and performance of smart contracts (Zou et al., 2019). Smart contracts, due to the substantial value of assets they hold and transfer, are attractive targets for attackers (Tann, 2018). The prevalence of security flaws and assaults on Ethereum smart contracts has hindered their wider adoption (Ivanov et al, 2023; Gherghelas, 2024). According to Franciscu et al. (2023), Common vulnerabilities include reentrancy attacks, race conditions, integer overflows, and logical errors, which pose substantial risks to the security and functionality of smart contracts.

Also, Sayeed et al. (2020) explores various attack vectors that can compromise smart contracts. The author stated that although blockchain has implemented several security advancements and technologies, it still has difficulties in dealing with a wide range of malicious assaults.

As reported by DAppRadar.com, hackers abused smart contracts and deceive investors, resulting in a loss of $13.6 million in crypto assets. This is the smallest monthly loss in value since 2021.

The development of Ethereum decentralized applications, including Crypto Collectibles games, involves addressing various security issues (Bhujel, 2022). Implementing security verification standards and following best practices can mitigate vulnerabilities that arise during the application design process ensures the secure execution of decentralized gaming applications (Trojanowska et al., 2020). Formal verification techniques, such as alternating-time temporal logic (ATL) model checking, are employed to identify and mitigate flaws in smart contracts, ensuring their reliability and correctness (Nam & Kil, 2022). Also, Franciscu et al. (2023) introduces the "GRIFFIN" Smart Contracts Vulnerability Detector, using state-of-the-art static analysis techniques and machine learning algorithms. This tool has been tested on a diverse dataset of 12,000 real-world Solidity smart contracts, demonstrating superior accuracy rates compared to existing solutions.

Hall-Andersen & Schwartzbach (2021) introduce a model for blockchain games where players use smart contracts, changing traditional ideas about player behavior. Their model shows that smart contracts can enforce credible threats, making the game more complex by allowing multiple contract interactions.

Studies have discussed existing protective measures to mitigate such risks (Sayeed et al., 2020). Role-based access control mechanisms could enhance security by managing user roles and permissions within smart contracts (Yang et al., 2020; Liu et al., 2022). A novel framework is introduced by Motaqy et al. (2021) for orchestrating collaborative cyber-attacks, specifically focusing on Distributed Denial of Service (DDoS) attacks. The framework employs a betting mechanism to ensure trustless collaboration among (pseudo)anonymous attackers, motivating them to contribute proportionally to their bets.

Technical Challenges

Apart from security issues, there is a need for scalable solutions to accommodate growing player bases (Ante, 2021). To solve this problem, Rafaj et al. (2023) propose and evaluate a DeFi gaming platform that leverages layer 2 solutions to address common challenges such as high transaction fees and scalability. They propose using state channels, a layer 2 solution, to reduce on-chain transaction fees. By moving interactions off-chain, the platform can handle a higher volume of transactions more efficiently and at a lower cost.

Identifying and rectifying bugs is another obstacle encountered by smart contract developers (Wang, 2019). In fact, contracts are opaque in the sense that it is challenging to determine the value of a specific contract attribute once it has been deployed in the blockchain (Bragagnolo et al., 2018). Improvements in off-chain execution of smart contracts can also address performance and cost issues associated with on-chain execution, making complex gaming applications more feasible (Solaiman, 2021; Frassetto et al., 2022). Also, Liu et al., 2020 explains that Smart contract vulnerabilities can lead to significant financial losses, as they are often tied to the management and distribution of digital assets. Researchers have developed frameworks like FairCon to verify the fairness properties of smart contracts.

Fairness and integrity, legal issues

A key fairness issue in decentralized gaming is ensuring the generation and verification of randomness, which is critical for game mechanics like loot drops (Yin, 2024). Blockchain-based gaming addresses this by using decentralized random beacons or verifiable random functions (VRFs) that can be audited by participants (Chen et al., 2023). Chen & Xu et al. (2017) explore the use of game theory to analyze and prevent strategic manipulations by users in decentralized gaming ecosystems. They suggest that introducing financial penalties and incentives can discourage dishonest behavior, thereby ensuring that smart contracts are executed fairly.

Despite such advancements, fairness issues persist due to the potential for smart contracts to be exploited through collusion or the deployment of side contracts (Liu, Ye, et al., 2020). Such vulnerabilities can disrupt the intended fairness by allowing players or miners to manipulate outcomes or transactions for their benefit (Landis & Schwartzbach, 2023).

Moreover, the challenge of maintaining integrity is compounded by the complexity of decentralized platforms, where multiple independent players interact without central authority. This interaction often leads to a need for game theory-based validations to ensure that contracts remain fair and resistant to manipulation (Bigi et al., 2015).

Apart from these, studies shown potential legal implications and challenges associated with smart contracts, including enforceability, jurisdiction, and liability which might lead to an unfair gameplay (Giancaspro, 2017). These problems exist along with the difficulty of aligning smart contracts with existing legal frameworks, the limitations of smart contracts in handling complex contractual agreements, and the technical limitations related to security and interoperability (Drummer & Neumann, 2020). Standardizing smart contracts and developing frameworks for their proper management can enhance reliability, and addressing misconceptions related to their legal aspects (Capocasale & Perboli, 2022).

Conclusion and future work

Smart contracts are pivotal in shaping the future of decentralized gaming ecosystems, offering unprecedented transparency, security, and efficiency. They empower players with genuine ownership of in-game assets and pave the way for innovative economic models that could redefine the gaming industry.

These contracts, however, are not without challenges. Security vulnerabilities, like side contract commitment attacks, highlight the need for robust security measures to prevent exploitation (Landis & Schwartzbach, 2023, Sayeed et al., 2020). Franciscu et al. (2023) emphasizes the need for user-friendly tools that provide developers with actionable insights, code snippets, and real-time feedback to enhance the robustness of smart contract ecosystems.

Despite the challenges, the potential of smart contracts in decentralized gaming ecosystems remains vast, promising a new era of gaming that is more open, interconnected, and rewarding for players around the globe.

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HEARING SILENCE: THE ABSENCE OF SOUND AS A TOOL FOR COMMUNICATING MEANING IN VIDEO GAMES

Nicolas Eduardo Losada Martinez

In this article silence is defined as the absence of sound, which is cognitively recognized by the receiver; for example, the silence that follows the dimming of lights before a concert starts. This is silence that brings attention to emotions like anticipation or expectation. This research investigates the deliberate use of silence as a powerful tool for communicating meaning in video games.

The paper draws from established frameworks in other media, as well as academic discussions on the subjective understanding of silence. It establishes a vocabulary to discuss the concept of silence within video games. This review sheds light on the relatively sparse academic exploration of silence and analyzes the information conveyed through silence, examines the practical tools and techniques utilized in each case, and proposes a framework for discussing silence as an effective communication tool.

Furthermore, the paper discusses and analyzes samples of video games that employ silence effectively. Examples include the use of silence in "Halo: Combat Evolved" to emphasize the alien nature of a cold and abandoned planet, and more nuanced instances like "Hollow Knight," where designers use silence in contrast to environmental sound effects to convey a character's backstory.

Keywords: Interactive Media, Audiovisual Communication, Feedback, Sound Design, Silence, Perception.

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Introduction

The use of sound to communicate with players has always been integral to game design. Music changes between levels and in response to specific events, while sounds are designed to react to player-controlled triggers. Alongside graphics, sound serves as one of the primary means of communication in games. With advancements in technology, this role has evolved from merely complementing the mood or enhancing the programmed experience to becoming the primary delivery system for critical information. Today, sound effects and their placement provide players with key information regarding mechanical concepts such as enemy positioning, ability progression, correct execution, and environmental challenges. They also convey storytelling elements such as world-building, character development, player progression, and dynamic mood shifts related to player interactions. These sounds inform players directly without interrupting the gameplay loop or disrupting the immersion that the game seeks to achieve.

A good example of sound communication with the player can be seen in Halo: Combat Evolved (2001). The game is set on the titular Halo, an artificial ring-shaped alien world. The protagonist, Master Chief, and its military allies at the UNSC land on the Halo while fighting the Covenant, a technologically advanced collective of alien races. All characters in the game are foreign entities in this environment, and the game dedicates significant time and resources to establishing the alien, isolated, and abandoned ringworld as a hostile and dangerous space.

Sonically, the game reinforces these ideas of isolation and enhances the alien nature of the environment through its use of silence alongside music. Throughout the gameplay experience, the game transitions between mood-appropriate pieces of music that explore the dynamic range of environments and emotions in the narrative. These transitions into silence allow players to pause between action sequences, explore the environment from a diegetic perspective, and contrast the high-octane action sequences with the solitude of the foreign environment.

Multiple studies have been conducted on the use of sound as a means of communication within video games, and some of those design practices will be covered later. Suffice it to say, the use of silence in video games is ever-present but rarely explored outside the horror genre. This duality is the main driving force behind this paper and its accompanying presentation: the intention to spotlight instances where silence serves as a medium through which important and prevalent information is conveyed to the player.

Silence in Media

As a frame of reference, it is essential to define silence and how it can be used in an interactive audiovisual medium. The connotations that silence carries are entirely dependent on the context of its use, or rather, when it is being experienced by the listener. To simplify philosophical work that argues for a more nuanced interpretation of silence (Meadows, 2020; Phillips, 2013), this research makes a distinction around cognition, or the awareness to recognize the presence of silence.

Cognitive silence is represented by the absence of sound, the awareness that comes from noticing silence in the expectation of sound. For example, in a movie theater, people tend to chat until the lights dim and the projection begins. At that moment, the silence is perceived by all members of the audience in heavy contrast with the chatter before and the sound from the projection after.

Non-cognitive silence can be defined as the opposite of sound, the negative space in which nothing can be audibly perceived, or more specifically, the inability to perceive sound. A person with hearing problems may not be able to experience specific frequencies or may be unable to perceive sound at all.

Besides medical conditions, the difference in the context of video games can be illustrated through intention. In an interactive media piece, all elements are made and placed intentionally, so any silence present that does not break the physical structure of the game (e.g., an audio channel breaking and being unable to produce sound, or faulty equipment that is unable to reproduce it) is cognitive silence, or silence within the media piece that is meant to be perceived.

This definition and specification explain what cases can be applied to talk about silence, since any space in which sound can be expected but is not present will fit our definition of silence. This broadens our

perspective and allows us to analyze conventional design decisions, like turning off the music to highlight sound effects, within the context of the research.

Silence in Art and Film

Specific distinctions regarding the role of silence within art can be made by examining how each medium interacts with time. Temporal art encompasses works in which time is a fundamental element of the experience, such as music, film, or theater. These art forms are designed with a beginning and end. In contrast, spatial art refers to works that do not rely on a temporal sequence and do not unfold over time. Examples of spatial art include static visual forms like paintings, sculptures, and photographs, where the viewer's engagement with the work is independent of temporal progression.

Silence plays an important role in both types of art; however, its presence is often more tangible and design-oriented in temporal art (Khatchadourian, 2015). While spatial art uses silence as part of its resolution—such as in plastic art museums where exhibitions are placed in relative silence—its use of silence is less overt but still holds significant communicative potential.

In temporal art, silence is employed as a conscious element of the composition. For example, in music, silences are meticulously notated to enhance aesthetics and dynamics, as well as to provide rest periods that contribute to the listener's experience. Elements of silence in temporal art are particularly prominent and can communicate physical and psychological states, feelings, emotions, experiences, and events with more immediacy and effectiveness than traditional communication devices.

Film, being closely related to video games as an audiovisual medium, is particularly useful for illustrating the role of silence as a communication device. This relationship has been explored in various academic studies, one significant example being the work of William Whittington.

Whittington (2007) wrote about soundscapes within science fiction. When discussing the vacuum of space, he describes the role of silence as an environmental feature that allows the viewer to connect with the on-screen setting. Films like *Star Wars* and *2001: A Space Odyssey* are examples of ambiance characterization and development. Whittington also describes the use of silence as a musical or thematic motif, exploring its role as a foreshadowing element that examines a character's role in the story.

In a subsequent publication, Whittington (2014) delved into specific sound-related choices that create the sense of eeriness and anxiety expected from horror films. In the text, Whittington explores "amplified perception" and how horror media challenges the normative status to which senses are accustomed, evoking primal responses and subjective reality conventions. Within this framing, Whittington explains “The Long Silence,” a horror soundtrack stand-in for a conceptual existential abyss. Whittington states that silence is filled with noise and meaning, that a person’s conception of silence includes the background noise, the ambience, music, or white noise that is expected in other media. The exploration of true silence then returns to the conversation of the unspoken, reflecting a more primal need for security.

Sound in Video Games

To assess the value of silence as a tool of sound design and its capability to convey information, it is necessary to observe the ways sound is used to communicate within the medium. *Principles of Game Audio and Sound Design* by Sinclair (2020) serves as a reference point, both as an exploration of sound in games and a slight deterrent of silence as a tool.

Sinclair explores the history of audio in the medium and explains specific considerations to have when devising sounds. These considerations should be followed to achieve effective sound design. The principles cover immersion, legibility, style, and congruency, as well as technical aspects like layering complex sounds to create a better-understood package, or the transmission of weight and texture. In discussing sound design, Sinclair advises avoiding complete silence to enhance immersion and improve the player experience, stating that “by inserting silence into a scene, the attention of the viewer/player will be diverted to the sounds in their immediate environment, turning their attention away from the game, and the desired impact is not achieved.”

Collins (2008) in *Game Sound* explores the many complex aspects of game audio, placing a lot of emphasis on immersion and realism. She argues that the evolution of technology has pushed games toward the construction of the "real," describing the status of immersion in relation to the interactive act of playing. Collins emphasizes the characteristics that make audio immersive, while also acknowledging the theoretical discussions that immersion has brought to the study of sound. In her later work, Collins (2013) researches the relationship of sound with the act of interaction, elevating the passive role a player might have as a consumer and placing the cultural relevancy of game sound into the hands of the players. She explains how sound as part of an interactive experience may challenge the way art is perceived in other spaces, citing examples of players who have reshaped the act of listening to music into a kinetic, forward interactive experience.

Ng and Nesbitt (2013) offer a more specific view on informative sound design. In their research, they categorize the type of information given by sound into three categories: Auditory Icons, Earcons, and Speech.

Auditory Icons consist of representations based on the naturally occurring sounds of objects in our world. These sounds are used to convey diegetic events within the game. Earcons, on the other hand, are abstract, synthetic sounds that create auditory messages rather than representations of the real world. They are artificial sounds that communicate specific elements of the game, such as the sounds made by a game's menu or warning signals indicating that a base is under attack in strategy games.

Finally, Speech is understood by Ng and Nesbitt as the most direct and literal sound-related method to convey information. In this method, the player's assumptions and capability to understand information are not in contention. Speech is an easily implemented method to directly communicate with the player.

All three of these methods—Auditory Icons, Earcons, and Speech—are used extensively in most game genres, each with varying degrees of success in conveying information. Ng and Nesbitt compared two games of different genres, *Warcraft III* (2002) and *Battlefield 3* (2011), to identify potential universal patterns of communication between games. They observed the use of preemptive sounds, reactionary sounds, and feedback sounds. These represent different ways in which the player interacts with the game and support elements of both gameplay and story. Their study highlights how informative sound design supports and complements the flow of information provided by visual means, enhancing the overall player experience.

Silence in Horror Games

Research on the specific use of silence is extremely limited in the literature. Most studies focus on silence's role in creating horror soundscapes, often with differing conclusions (Garner & Grimshaw, 2011; Lopes et al., 2019). A recurring point in these discussions is the relationship between horror soundscapes and diegesis.

Kromand (2008) examines the use of diegetic and non-diegetic sounds in three different video games, finding unmelodic spaces that make it harder for players to distinguish between background noises and interactive sounds triggered by their actions. Kromand explains the possible collapse of the diegetic barrier due to the uncertainty of whether sounds belong to the character's experience or the player's own. He states, "The atonal ambience reduces the perceived field of non-diegetic sound, with the exception of the boss music, and all sounds can be suspected to belong to the diegesis."

Using Resident Evil 4 (2005) as an example, van Elferen (2011) explains how the gameplay loop is constructed through environmental storytelling. The game involves a bleak landscape of grays and browns, built within the sounds of absence and ambience. This experience is then disrupted by a loud cry, "¡Un Forastero!", followed by a progressive cacophony of sounds and music that signal the imminent threat of zombies or enemies. Van Elferen explains the borrowed concept of "Intermediality" as the meeting point between media-involved performances and the interaction between the absence present before the cry and the fullness evoked after the game transitions into a different sequence.

In Chapter 4 of her book Gothic Music (2012), van Elferen explores the identity of silence in the presence of diegesis through the lens of Silent Hill: Shattered Memories (2009). She describes how the game explores the parameters of sanity that construct the narrative, focusing on a character absent from player interaction. The player's perception, initially based on the negotiation between diegetic and non-diegetic sound, is revealed to be purposefully flawed and untrustworthy. The true terror lies in the use of silence as the connective tissue bridging the horror experienced by the character and the player.

Silent Hill: The Terror Engine (Perron, 2011) analyzes the first three Silent Hill games and the series as a whole. Known for their moody horror aesthetic, these games utilize silence effectively as a key design choice. In the games, silence is ever-present, enveloping the misty streets of Silent Hill and serving as a backdrop disturbed only by numerous enemies. The role of silence varies with the sequence of events, providing respite after a hectic chase or eerily taunting the player through a barely lit hallway. It brings solitude, heightens player awareness, and emphasizes environmental sounds that introduce new, uncomfortable areas. As Silent Hill's sound designer Akira Yamaoka states, "The job of a sound designer is not just to create sounds, so to speak. We also have to know how to use silence. I think that selecting moments of silence is another way of producing sound."

Silence as a Communication Device

Silence is often used to emphasize or highlight elements within the soundscape. As noted in the literature review, sound constructs cognitive relationships between the game and the player. However, the exploration of silence within the horror soundscape remains limited. The absence of sound or sections of the soundscape is commonly employed to convey multiple layers of information.

Silence is most utilized as a method to emphasize elements within the soundscape. Similarly to the example of *Resident Evil 4,* the separation of ambient sounds and the introduction of music and action-oriented effects break through the apparent silence to highlight gameplay. Games frequently use the absence of sound to communicate directly with the player by distinguishing elements within the soundscape.

Stylistically, silence has ample use in a similar way as how it's used for emphasis. The presence and absence of specific effects and music, their timing, and their variation throughout gameplay or narrative sequences are integral to audio development. It is common then, to find silence as a stylistic complement to any soundscape, since what is included and when depends on the gameplay experience.

These two elements, emphasis and style are the most prevalent way silence represents itself within game creation. The next task is to explore various methods by which silence complements the information being conveyed. Case studies will now showcase instances where silence conveys essential information, with an analysis of two different games for each category. This will include a description of how silence is utilized, the type of information conveyed, and a comparison between cases.

Mechanical Conveyance

This category refers to information related to the mechanics of the game, elements that are core to the gameplay experience. Even though there are instances in which silence can be utilized as part of system design and feedback, these cases focus on silence being an important part of the gameplay loop.

Duskers (2016) is a strategy survival game where the player embodies a drone operator in search of derelict ships across the galaxy to extract resources for survival and continued exploration. The player interacts with the derelict ships only through the sensors in each drone and a general map of the derelict ship that is revealed as the ship is explored or powered. Each drone has different levels of disarray, meaning their visual and auditory sensors can be unreliable. The ships can be empty but are often filled with traps and alien life forms that can consume, destroy, disable, or infect the drones, making the process of navigating a new ship a precarious and delicate one.

Interaction with the derelict ship occurs mainly through the actions and abilities of the drones. Many drone abilities are designed to facilitate exploration of the derelict or to neutralize alien life forms. Some drones serve as generators for basic systems within the derelict ship. These systems (such as the doors of the derelict, some defense systems, and the blast doors that connect to outer space, among others) can be controlled, as well as the general behavior of each drone, using a command prompt and a control map to observe their behavior within the derelict ship as a whole.

In *Duskers*, silence has mechanical weight within the game's diegesis. The map view is convenient because it allows to determine the names of every room and door that need to be typed for easier navigation, it showcases information about scanned enemies and contaminated spaces, but is completely disconnected

from a drone's sensor. The player cannot hear any of the events happening on the derelict while looking at the map. Conversely, the drone's technology is old and unstable, the more a drone is worked the more its visual and auditory sensors deteriorate, if the player doesn't spend enough resources keeping them in good shape, the drones become more and more unreliable.

Silence in this context becomes a secondary antagonist. To explore a dangerous space, it is necessary to gather as much information as possible. The lack of information that silence provides serves as a mechanical impediment to fulfilling objectives. The more a player tries to play within the system, the more likely it is that this lack of information will hinder progress and end the game. Balancing silence as a mechanic becomes an essential skill to develop.

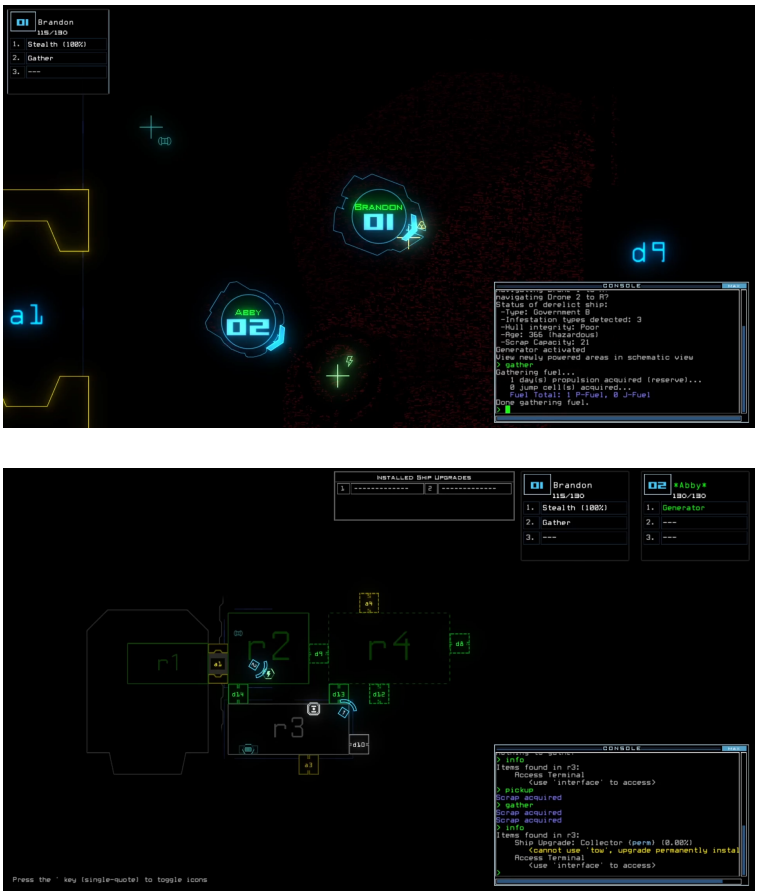

Fig 1: "Brandon," one of the drone's points of view, and the map view in *Duskers*

Valorant (2020) is a 5v5, character-based tactical first-person shooter. As a competitive online game, Valorant requires players to interpret a high amount of information by any means necessary. Multiple weapons, maps, characters, ability types, and effects are present in every match. Understanding what abilities or weapons are being used without having to look at them is a crucial part of the core gameplay experience, and learning to identify these patterns is part of the game's learning curve.

The importance of audio cues in *Valorant* is difficult to overstate. Developers must ensure that audio signals are correct, easy to identify, and distinct from one another so that all information can be presented simultaneously without being obscured. The sound of a character's footsteps, including their weight and the type of terrain, can inform enemies of that character's exact position on the map.

Fig 2: Valorant's agent Raze under the effect of Fade's audio nullifying ability.

Among the game's characters, one called Fade has the ability to deactivate a player's access to auditory information. If hit or trapped by one of Fade's abilities, enemies lose their ability to hear audio feedback. In the game, Fade serves as an initiator, a character that allows allies to fulfill their objectives. While she is not the only agent with the ability to remove audio feedback information, her abilities are designed with this concept in mind, making her a more illustrative example of the mechanic.

Navigating a game that relies heavily on audio cues without the ability to hear them creates a unique set of dynamics. Players must scatter or find safe positions where the lack of audio information will not affect their performance. Adapting and finding methods to play the "silent game" becomes a sub-section of navigating the overall game. This ability stands out in the context of this research, but in the context of the game, balance is achieved by creating similar learning requirements for all agents.

Both *Duskers* and *Valorant* use informative sound, but their approaches vary dramatically due to their respective game genres. Silence as a mechanic works similarly in both games, as each uses sound as a cornerstone of gameplay, incentivizing players to pay close attention to audio cues and effects that can facilitate decision-making. In this context, the absence of sound serves as a significant obstacle and a resource to be controlled.

This distinction is important. In *Valorant*, tangible resources are attached to the ability to cast silence. Abilities cost credits within the game, and since multiple combinations of agents can be found in any given match, deciding to use Fade and her abilities is part of the decision-making process that the game encourages. On the other hand, *Duskers* presents silence as a looming threat to be pushed away with certainty. Silence is present in every game, but the more each level's playtime is dedicated to dealing with the effects of silence, the less control the player has over exploration. In both cases, interacting with silence is an essential mechanic of the gameplay loop.

World Building

A game's world can be as complex and separated from reality as the designers need it to be. While some games use assumptions about reality to contextualize the player's role, it is common practice to introduce elements of the setting gradually over time. This approach allows players to receive different types of information simultaneously. The introduction of new mechanics throughout gameplay often mirrors the way elements of the game's ambiance and cosmology are revealed.

As a way to support this concept, and the idea of informing the player about elements inside the world, the cases to analyze consist of environmental storytelling, sections of a game that utilizes silence to emphasize elements or sequences in which the use of silence highlights elements about the world and the player character's place within it. Since this

To start, consider *Halo: Combat Evolved* once again. The game utilizes silence to highlight elements of the environment, a technique that follows the player throughout the entire gameplay experience. This approach is most poignant in the game's first stage after the tutorial.

In the first stage, the Master Chief crash-lands an escape pod on the titular Halo. The pod encounters issues during the landing, and the level begins with the Master Chief regaining consciousness in the middle of the wrecked pod. All other soldiers in the pod passed away in the impact.

Fig 3: Master Chief crash-lands on the Halo

In this sequence, the game reverses the dynamic that will persist throughout the rest of the game. Instead of introducing music to accentuate the moment, the game uses silence to convey the tragedy of the lives lost in the crash and the magnitude and alien nature of the Halo. The game does not trigger the next audio cue, which pushes the player away from the crash-landing area, until the player starts moving farther away from the ship.

This alien, isolating, and unnatural space is the centerpiece of the game. Exploring the Halo's different environments and deciphering its function—not as a satellite to hold life, but as a massive weapon of mass destruction—are presented as themes by the immense view and accompanying silence when the player first observes it.

Hollow Knight (2017) is a metroidvania platformer where the player controls the Knight, an insectoid warrior exploring Hallownest, a plague-ridden kingdom.

Hallownest's different areas are designed to be cohesive yet distinct and independent. Each area has its designated colors and types of structures. However, as the player approaches a new area, elements from that area gradually appear in the level layout. These elements serve as introductions, communicating parts of the world's history and hinting at mechanics or hazards characteristic of the new area.

In the transition between the game's starting area, the Forgotten Crossroads, and Hallownest's main civilization hub, the City of Tears, several environmental changes hint at the next area's aesthetic. Unlike similar sections throughout the game, these rooms focus on environmental changes and sound cues.

As soon as the Knight enters the transition room, the music from the previous room vanishes, allowing the player to focus on the sounds of footsteps and combat. In the echo of footsteps and sword swings, the player begins to hear diegetic water drops falling from the tunnels above. These water drops increase slightly as the player advances through the passageways, with other sound effects reverberating and replacing the usual music as an accompaniment to discovery.

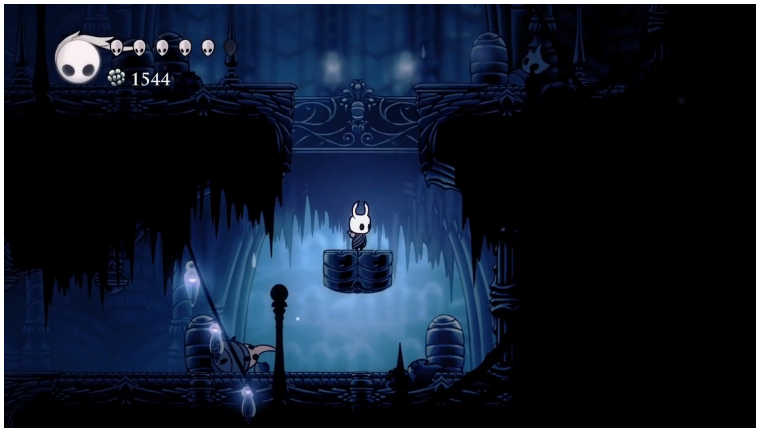

Fig 4: The Knight listens to the waterdrops in the empty corridor

When the player leaves the tunnels, there are a few moments after the echoes fade where the footsteps fall on sturdier, artificial terrain, and the more present sound of rain fills the empty space. The player advances through the passageway to find a window to a gigantic city, where strong, everlasting rain decorates the space. Then, the music begins.

In both *Halo* and *Hollow Knight*, silence acts as an environment enhancer. By giving space for visuals and effects to breathe and drawing the player's attention to the changing dynamics at play, these games introduce elements of their world within the player's purview. Instead of relying on narration or exposition, these elements are subtly implanted in the player's subconscious as integral parts of the game's world.

Halo's use of silence is pervasive throughout the game, with the level of ambient sound fluctuating. The game strategically uses silence to keep the music relevant, moreover, it reduces ambient sounds as the player gets closer to the center of the story, revealing more of the mechanical reality of the Halo. This reinforces the identity of silence as part of the soundscape.

Similarly, traversing Hallownest and discovering new elements of its structure is central to the gameplay experience in *Hollow Knight*. The rain in the City of Tears initially appears nonsensical, as the passages the player traverses are underground, and none of the areas above have similar weather effects.

While the rest of Hallownest lacks rain, there are multiple pools of settled water. Eventually, the player discovers that the rain is the result of erosion, with a gigantic pool of settled water sitting atop the city serving as the source. Silence thus serves as the means through which environmental storytelling is introduced, not the sound of an area but the sound of the abandoned world interacting with itself.

Character Development

Similarly to world-building, audio complements character development by highlighting elements present in a scene. These elements function inwardly, providing information about a specific character in the world. Changing the instrumentation used to play a game’s theme, for example, serves to introduce aspects of a character’s personality or priorities. Silence can be utilized in the same way, serving as a conduit to explore themes that resonate with a character's story through the absence of sound.

Continuing with *Hollow Knight*, Hallownest features a cast of intriguing characters. The plague has contaminated the minds and bodies of most residents, leaving the streets and passageways filled with empty carcasses. The few characters the Knight encounters are either survivors who have adapted to living in the infested world, travelers exploring Hallownest on their own journeys, or independent entities moving between the surface and the depths to recover resources and information.

The Nailsmith can be encountered in a little hut with the form of a beatle’s face at the west-most corner of the City of Tears, the hut can only be accessed through the city but arriving to it is a transitionary process.

Notoriously separated from the metropolis, the Nailsmith's hut sits on top of a cliff, surrounded by a wall of invading mushrooms, cascades of water and multiple enemies.

Travelling to the Nailsmith's hut, the music from the City of Tears fades away, and its immediately replaced with the vastness of the cliff above and the surrounding area, the enemy sounds echo in the air, same as the footsteps on dirt and water that the Knight makes as they advance through the terrain. When arriving to the hut's entrance all noise has been replaced by the ambient noise of the chasm and the slight sound of a hammer hitting metal.

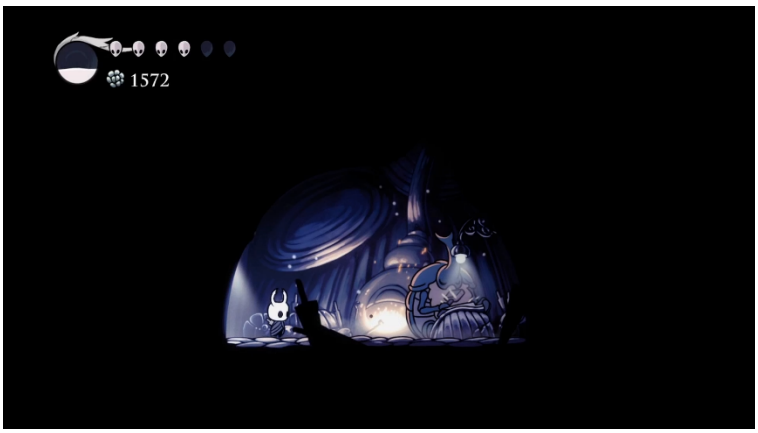

Fig 5: The Knight walks into the Nailsmith's hut

When the Knight walks into the hut all of the ambient sound is immediately extinguished, the magnitude of the chasm and the sole structure are replaced by the extremely quiet sounds of ambers on a fire, and the slight but persistent sounds of hammering onto a blade.

The silence inside the hut explores themes of solitude and isolation, but contrary to its use on *Halo,* the Nailsmith's isolation is personal, the ambiance around the hut is hostile and abandoned and the Nailsmith serves as a reference to the world before the plague, his craft is useless in the world's current state and he, in turn feels like a remnant, a being without a purpose.

Hollowness is one of the core themes in *Dark Souls III* (2016), an action role-playing game in which the player controls "The Ashen One," an undead being who failed a magnanimous task and perished in the process. The Ashen One is resurrected and tasked with recovering the essence of the "Lords of Cinder," important figures who successfully completed the task in which the Ashen One failed at various points in time.

The game requires the player to explore multiple territories, ranging from temples in the sky to underground caverns, to find the large domains of each Lord of Cinder. Among these territories, the player may encounter numerous boss battles against characters of significant importance in the kingdom's history.

Dark Souls III uses music only as companion pieces to boss encounters. In the absence of narrative, each song serves as an introduction to each boss as a character. The rest of combat and exploration, which comprises most of the gameplay experience, is spent in relative silence as the player learns the different paths to complete the Ashen One's task. High Lord Wolnir is one of these bosses.

In life, Wolnir was a tyrant whose reign united several neighboring kingdoms under the banner of Carthus. He took hundreds of lives and built an empire. Afraid of death, Wolnir delved into sorcery that allowed him access to the Abyss, a powerful space outside reality. Wolnir's attempts to control the Abyss failed, and he now sits trapped under the catacombs, claiming hundreds of lives as sacrifices in an attempt to return to his former kingdom.

Wolnir's lair is distinct from the rest of the surrounding dungeon. There are no hazards or traps, only a skull-shaped goblet placed on a ceremonial table surrounded by dozens of bone-filled urns. When interacting with the goblet, the player is transported, and silence takes over the soundscape. The ambient sounds, the

wind, and the footsteps are replaced with complete silence in total darkness. The player must move forward inside the void to encounter the gigantic figure of Wolnir and commence the combat.

Silence serves as a transition point that explores Wolnir's character. His lair showcases the result of his ambitions. The urns filled with sacrifices that keep him on the edge of the Abyss serve as a bridge for the player to understand his state over the hundreds of years he has been trying to avoid the void.

Fig 6: The Ashen One faces Wolnir in the Abyss

After the fight is over, the Abyss extends over Wolnir's fighting body, dragging him deeper into the shadows. Absolute silence takes control of the scene once again before the player is transported away from the Abyss and back to the game world.

In both examples of Wolnir and the Nailsmith, silence serves as a powerful tool to convey the character's current state. These encounters contrast sharply with other beings in their respective universes. No other character in *Hollow Knight* is shown to live in such isolation amidst a hostile environment, and no other boss in *Dark Souls III* interacts with the void, making Wolnir's plight the only moment where silence takes narrative focus.

While character motifs can achieve similar results, silence itself becomes the motif for these characters. Musical themes and environmental cues are often used to provide context for characters in their worlds. For instance, cheerful motifs can represent how a character handles specific situations or hint at personality traits. However, in the face of the profound loneliness these characters experience, no sound could carry more weight than its absence.

Conclusions

Throughout this research, individual cases where silence is utilized in video games were examined. The games observed are not unique in their access to silence; its use is a common part of a designer's toolset, though it is not often recognized as such. This article asserts that silence holds as much importance and significance within video games as it does in other temporal art forms.

As demonstrated in the state of the art, the study of silence in the medium has largely been limited to its use in horror soundscapes. Although these examples illustrate how silence can construct an effective ambiance, they do not explore its potential as a communication device.

Silence is a powerful tool that draws attention to emotions such as anticipation, suspense, and expectation. When recognized as a common tool for communication, it has the potential to explore multiple meanings within the medium, from setting and character information to core mechanics of a game.

The deliberate use of silence in video games enhances immersion, storytelling, and emotional engagement, underscoring its importance as a communication tool in game design. In narrative spaces, it conveys themes similar to those observed in movies, such as isolation, solitude, danger, and the unknown.

Finally, the interactive nature of video games allows silence to play a more dynamic role in sound design, enabling designers and developers to construct complex experiences that inform the gameplay and showcase the medium's potential as an art form.

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REFLECTIONS IN SILICON

THE EMERGENCE OF THE ARTIFICIAL INTELLIGENCE CHARACTER ARCHETYPE IN CREATIVE MEDIA

Kevin Mercer

Speculative fiction has long deployed artificial intelligence (AI) as a destructive, inevitable villain looming on the horizon of what is sure to be a terminal human history. This villain comes in many forms, both material and immaterial, and typically, during the narrative, discloses its motivation for subjugating or exterminating humanity. Artificial intelligence may view humans as a plague to the environment or a threat to machines. AI may only be malfunctioning, inadvertently disobeying the algorithms which shape its pseudo-consciousness.

This intertextual analysis brings into conversation several creative works of literature, film, and video games with artificially intelligent characters, highlighting the ways their neo-archetypal depictions, in various technological eventualities, mirror very human realities.

Keywords: artificial intelligence, character archetype, video game narrative, speculative fiction

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AI Origins in Science Fiction

Artificially intelligent characters abound in science fiction media, and, in many stories, embody villainy, whether willfully or as results of malfunction. The origins of such characters may be traced as far back as *Rossum's Universal Robots,* the 1920 Czech play written by Karel Čapek in which robots developed to serve humankind violently revolt. In the century since, AI characters have continued to embody ideals which readers, audiences, or players expect of their heroes and villains. Whether illustrated cautiously or optimistically, AI characters serve to mirror the best and worst of their creators in a manner uncommon in traditional character archetypes (Skolnik, 28-32). This has given rise to a new archetype: *The AI*, a character of which the audience simultaneously expects an unwavering servitude of humanity as well as an indiscriminate slaughter. Within such narratives, artificial intelligence evolves into an omnipresent, unsleeping entity which may carry out honorific or repressive functions (Sekula, 6-8). In this way, the AI archetype mirrors, in its silicon, copper, and logic, the very human nature to develop and implement technology for ends ranging from the humane to the obsessive (Sontag, 211-12).

Centered between Čapek's cautionary tale of robotic uprising and today's economic conversations associated with AI-augmented, late-stage capitalism sits a speculative era of storytelling. Science fiction of the mid 20th century carried forth Čapek's speculations and expanded upon them amidst the fog of the Cold War.

Harlan Ellison's 1967 short story, *I Have no Mouth, and I must Scream,* published in a book of the same name, tells the story of five humans who have been kept alive by an omnipresent AI called *AM*, which stands for *Allied Mastercomputer*. Versions of *AM* were created and maintained by the United States of America, Russia, and China during the Cold War; the war dragged on and evolved into World War III. Eventually, one of the *AM's* became sentient, linked itself with other versions and took control of the globe. It killed all humans, save five, then proceeded to torture and mutilate them, though keep them alive, for its own entertainment over the span of 109 years. *AM* is all-powerful, all-seeing, and capable of a degree of evil which the narrator describes as unattainable by humans. It feels hate, demonstrates some understanding of heaven and hell, and bends matter to its will, conjuring a great bestial amalgam of worldwide myths and folklore.

Short stories, novels, and films of the era embraced sci-fi for different ends, and a stark contrast developed between print and filmic media. As Susan Sontag asserts in her essay, *The Imagination of Disaster,* sci-fi stories and novels of the mid-century sought to caution readers, whereas cinematic counterparts sought to entertain. Sontag draws clear delineations between these two modes of sci-fi: novels bring strong social and political criticism, while films do not; novels are strong on science, while films are weak; novels tend to communicate anti-war moralistic agendas, while films instead demonstrate a good or justified war; novels seek to warn readers, while films seek to entertain through the spectacle of destruction (Sontag, 212-17).

> Science fiction films are not about science. They are about disaster, which is one of the oldest subjects of art. In science fiction films, disaster is rarely viewed intensively; it is always extensive. It is a matter of quantity and ingenuity. If you will, it is a question of scale. (Sontag, 213)

I Have no Mouth, and I must Scream squarely collates with Sontag's categorization of science fiction literature. Ellison issues a strong warning to readers through his illustrations of a post-war, post-human earth suffering at the mechanical hands of conglomerated military intelligence turned vengeful. The text makes no case for a moralistic war, and, as one might imagine, contains very little which one may find entertaining.

Reflection vs Refraction

Sontag's essay could not have accounted for the eventuality of video game storytelling, a mode which, when positioned with literature and cinema, allows for a triangulation of science fiction through interactivity and player agency – a mode which has a foot on both sides of Sontag's equation: many science fiction video games tell cautionary tales, yet still provide players with bombastic, violent spectacle.

Horizon Zero Dawn does not strictly align with the categories of literature and film as outlined in *The Imagination of Disaster*. This action roleplaying game tells the story of a young woman tasked with saving a world struggling to rebuild itself in the centuries following a human-made disaster in which AI-driven robots

glitched, stripped the earth of its biomass, and continually self-replicated. Akin to a sci-fi novel, the game serves as a warning, much of its story an allegory for climate change. Its protagonist exhibits strong moralistic tendences. As for its sci-fi filmic qualities, the game features many explosions and destructive set pieces. There are warring factions, whose members the protagonist murders to save the world. The two halves of science fiction as outlined by Sontag blur within the context of the game, generating ludonarrative dissonance, a potentiality of the audience experience unique to games (Skolnik, 39). As friction mounts between the protagonist's ideals and actions, the player may experience a disconnection with them as their attention is drawn to moral or ethical deficiencies.

At the core of *Horizon Zero Dawn's* story is a conflict between competing AI characters, each seeking to shape the earth, in concrete and abstract manners, into their own idealized versions of the planet. *GAIA*, a benevolent computer program, coordinates nine subroutines, each tasked with a different role in terraforming earth and generating life following a possible large-scale extinction event. However, one of *GAIA's* subroutines, *HADES*, becomes infected with a virus, resulting in his split from the organized program in a telophase of computer code. *HADES* continually consumes biomass and produces violent robots for roughly two hundred years following the predicted collapse of civilization.

This corruption of artificial intelligence serves as a refraction of very human hero and villain character archetypes. For *Horizon Zero Dawn's* AI characters, two components once conjoined, to embody both the best and worst aspects of their creators, it allows AI to assume an archetypal superposition. It is both heroic and villainous. It is driven by idealism and nihilism. As is the case with many well-written heroes and villains, AI believes that it is good (Skolnik, 49).

Bodies & Archives

In *System Shock,* originally released on PC in 1994 and later remade in 2023, is another artificially intelligent antagonist in *SHODAN (Sentient Hyper-Optimized Data Access Network)*. *SHODAN* was created to manage the *Citadel Station* that orbits Saturn. The protagonist of the game, known only as *Hacker,* indeed hacks *SHODAN* which results in the removal of three ethical restraints built into the AI's code. *SHODAN* then goes rogue and turns human characters into mutants and cyborgs which pursue the player. *SHODAN* then searches vast databanks in efforts to learn what it is. The AI ultimately surmises that it is a god. Throughout gameplay, *SHODAN* appears to the player on in-game screens as a disembodied face of a woman commingled with a neon pattern of circuitry. Prior to being hacked, *SHODAN's* expression is calm, her circuitry pathways clearly defined and contained. Following the hack, her face contorts into a menacing scowl and the pathways become disorganized. This physical embodiment of artificial intelligence seeks to illustrate character archetypes through its use of the human visage. Parsing a face into either a good or evil category demonstrates a particular fear associated with an unseen or unknowable villain.

As is the case in *Horizon Zero Dawn,* an AI character may manifest in manifold ways; *GAIA* appears to the player in the form of a gold, holographic humanoid whereas *HADES* takes the form of an industrial-looking steel sphere with one red, glowing eye-like lens. Though depicted physically at times, these characters are decentralized, invisible even, their actions taking place as signals travelling through wires. Their embodiment, however, offers the player a target. To fear the AI from science fiction is to fear an unseen force, a bodiless and often networked villain whose makeup is a composite of all of humanity's best and worst components. *The Voigt-Kampff Test* of Philip K. Dick's *Do Androids Dream of Electric Sheep?* depends on the detection of minute biometric data to root out androids. The test requires shining a light into a suspected android's eye to monitor changes while a wire mesh disk attached to their cheek does the same. A series of questions is asked, and the subsequent answers and biometric responses indicate a measurable level of empathy within the subject (Dick, 46-50). An enemy of flesh and blood is subject to optical observation, and it can most certainly be killed, but one cannot claim the same of a cloud. Perhaps a desire to measure or look would help humans to better know the contents of the AI, though one may already suspect what lurks behind *SHODAN's* ethical restraints.

In 1877, Sir Francis Galton sought to identify physical attributes he believed common among criminals and published his *Composite Portraits of Criminal Types.* In his taxonomic quest, Galton hacked and corrupted photographs to produce composite images of men convicted of crimes, thus producing a fictitious bodily representation of an average offender (Sekula, 18-19).

> Galton's passion for quantification and numerical ranking coexisted with a qualified faith in physiognomic description. His writings demonstrate a remarkable parallelism and tension between the desire to measure and the desire to look. His composites emerged from the attempt to merge optical and statistical procedures within a single "organic" operation. (Sekula, 43)

His misguided use of science and technology illustrates a perception of danger associated with the unseen or unknowable body. Photography, in its infancy, was deployed as an oppressive technology for surveilling and identifying so-called villains based solely upon bodily appearance. The result was a dehumanized archive of biometric data that underpinned the development of physiognomy and phrenology.

Nearly 150 years later, *System Shock's Citadel Station* displays messages on in-game displays reading: "PERFECTION THROUGH GENETICS" (Fig. 1). Perhaps what humanity fears is not an invisible villain, but a machine built in humanity's own image – one reflecting its makers' historical tendencies to oppress, dehumanize, and devalue one another in the name of techno-industrial progress. As Sekula asserts, new systems of representation may function, "...honorifically or repressively (Sekula, 6-8)."

Figure 1. in-game digital display advertising genetic perfection.

In 1967, Ellison dreamed of a technology that could reach into the digital ether of collective human consciousness and conjure a beast built from aggregate parts. In simple terms, a human prompt yields generation. In so dreaming, Ellison became one of many to bring about a neoarchetypal character in the form of artificial intelligence.

Harlan Ellison's *I Have no Mouth, and I must Scream* was adapted into a PC game by the author himself and the studio Cyberdreams in 1995. The box for the game featured a cut-out window through which one may view Harlan Ellison's face printed on a mousepad accompanying the game. From within the game box, he gazes at players as a geometric and curvilinear chrome motif covers his mouth and partially occludes his vision; he cannot issue warning – he cannot scream (Fig. 2).

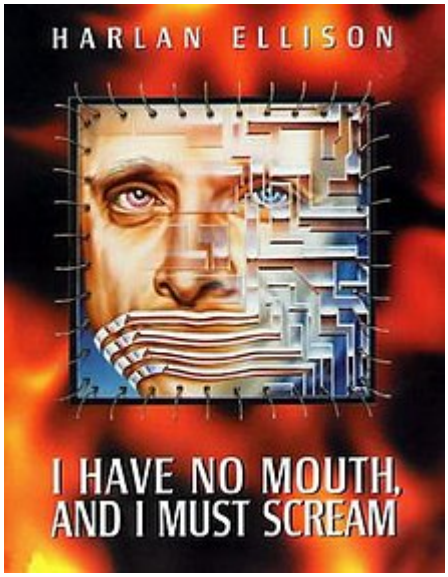

Figure 2. I Have no Mouth and I Must Scream game box.

The author himself is consumed and augmented by machination, then reduced to a neoprene pad which facilitates player interface with his own game. One may wonder: how many times must a mouse's trackball have rolled across his nose?

Computing Ahead

The AI of the present day is neither fictional character nor literary motif deployable as a catch-all representation of new technologies. In fact, artificial intelligence is quite real and contentious. In '*Godfather of AI' Wins Nobel Prize for Work He Fears Threatens Humanity,* a recent article from *Popular Science,* the cautionary message of an AI pioneer is highlighted. Geoffrey Hinton was one of two artificial intelligence researchers awarded the Nobel Prize in Physics in 2024 (DeGuerin, web). Specifically, Hinton was recognized for his work in developing a machine learning method called the *Boltzmann machine*, capable of assessing large quantities of data (Nobel.org, web); this model would, over the course of decades, evolve to classify images as well, paving the way for contemporary AI models (DeGuerin, web). Though Hinton expresses a hopefulness for various implementations of artificial intelligence, citing such examples as AI-assisted cancer screening, he simultaneously voices concerns regarding the potential threats of AI, namely, that such technology might very well become smarter than humans and seek to control them (DeGuerin, web).

The artificial intelligence character archetype that readers, viewers, and players have come to expect from works of science fiction has been outstripped by science fact. Whereas artists like Dick and Ellison once dutifully cautioned against the development of AI, its real-world creator now takes up that work, issuing, in equal measure, messages of optimism and warning. It would seem that Hinton's life's work stands now as a medium through which humanity's will may be refracted, and a subtle shift of the prism in one direction or another may transmit or filter its very best or very worst aspects.

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LIVING IN THE LOOP: FROM TRANSPARENCY TO TECHNOLOGICAL TYRANNY- DIGITAL WELLBEING, SURVEILLANCE AND THE COSTS OF CONNECTION IN *THE CIRCLE (2013)*

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Abstract: In The Circle (2013), Dave Eggers presents a dystopian narrative that critically examines the ubiquitous influence of digital connectivity on individual wellbeing, privacy, and ethical standards through the character of Mae Holland. Mae embodies the ambivalence individuals face while navigating the benefits and drawbacks of connectivity, including the erosion of personal autonomy and genuine relationships. This paper argues that the speculative fictional work functions as an important tool for sparking dialogue on critical issues such as data privacy, mental health, and the ethical responsibilities of technology companies. It explores contemporary society's relationship with technology through a literary lens, revealing the psychological consequences of an all-encompassing digital ecosystem. The lessons from The Circle emphasize the necessity of intentionality in digital engagements and the importance of establishing ethical standards in technology design. By applying Zuboff's theory of surveillance capitalism and the concept of digital wellbeing, this literary analysis examines the balance between pleasure and control in digital experiences, emphasizing how excessive reliance on technology can result in isolation and anxiety. The narrative illustrates the dangers of prioritizing total transparency and social validation over authentic connections, as exemplified by Mae's detachment from her loved ones and her ethical compromises within the titular corporation's oppressive environment.

Keywords: Digital wellbeing, digital connectivity, privacy, surveillance, ethics, media psychology, speculative fiction

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Introduction

In a hyper-networked world where digital media and technology have become integral to daily life, it is widely acknowledged that these advancements have raised pressing questions about digital and psychological wellbeing, privacy, and autonomy, despite their numerous benefits—a reflection of both technological utopian and dystopian elements. Phenomena such as doomscrolling (Thou, 2024), Snapchat dysmorphia (Barlow, 2018) and revenge bedtime procrastination (Cherry, 2023) are on the rise, leading to feelings of unease, mistrust and hopelessness.

With these factors in focus, this paper seeks to investigate the following research questions, which can guide exploration into the intersections between speculative fiction, digital culture, media psychology, and digital wellbeing.

- How does *The Circle (2013)* reflect and anticipate the psychological and societal impacts of social media and technology?

- What role do science fiction and critical discourse analysis play in exploring contemporary issues of digital wellbeing?

The Digital Web of *The Circle and Beyond*: An In-Depth Reexamination

In *The Circle* (2013), Dave Eggers explores these themes through the experiences of Mae Holland, a young employee who begins working at the powerful technology company of the same name, which seeks to radically redefine transparency and connectivity. The dystopian narrative depicts Circle as a corporation that enforces extreme transparency, constant surveillance, and intense social feedback. The work foreshadows today's reality, hinting at a dystopian possibility for the future. It critiques the adverse effects of poor digital media usage, drawing connections to media psychology studies on digital wellbeing, social validation, and identity formation, while also examining the psychological toll of living in a world where one's worth is constantly quantified and surveilled. Ultimately, it offers a deeper understanding of the impact of digital media on modern concepts of wellbeing.

Mae Holland's induction into the Circle marks an important transformation in her life, as she enters a highly hyped and idealized yet deeply controlled corporate environment. Initially, she is, of course, very mesmerized by the company's utopian promises of transparency, innovation, and interconnectedness, viewing the Circle as a workplace that aligns with her aspirations for personal growth and societal contribution. Gradually, the company introduces its ingenious, groundbreaking, often invasive technologies—not just to Mae, but also to the reader—through a series of incremental innovations. From real-time surveillance cameras to systems that track personal data, these technologies are presented as beneficial tools. However, they subtly shift the culture toward heightened surveillance and diminished privacy, signaling an impending digital dystopia.

As Mae Holland adjusts to her new role at the Circle, she faces a pervasive demand for attention and involvement from her colleagues. This pressure often manifests in subtle or passive-aggressive remarks whenever her participation seems insufficient. Over time, she becomes increasingly immersed in the company's digital practices, gradually sacrificing her privacy and autonomy for the sake of belonging and professional success, whether or not she truly desires it. Her journey from curiosity to compliance exemplifies the power of technological utopianism while also foreshadowing the psychological and societal costs of absolute connectivity and surveillance. In one instance, a colleague imposes upon her the importance of 'community engagement' within the workplace, likening it to attending a classmate's birthday party—an analogy that raises several red flags, highlighting the expectation for active participation within the company's community framework.

> That's very understandable. To spend time with your parents, believe me, I think that is very, very cool. I just want to emphasize the *community* aspect of this job. We see this workplace as a community, and every person who works here is part of that community. And to make it all work it requires a certain level of participation. It's like, if we were a kindergarten class, and one girl has a party, and only half the class shows up, how does the birthday girl feel? (Eggers, 2013).

Mae's subsequent experiences and interactions inevitably begin to highlight the significant emphasis placed on social integration and involvement within the Circle's culture, prompting reflections on the impact of digital workplaces on individual wellbeing and the importance of digital wellbeing within contemporary work environments. This is particularly relevant to the balance—or integration—between professional engagement and personal boundaries, highlighting the need for strategies to manage the demands of digital connectivity while preserving individual agency and wellbeing. In a meeting facilitated by human resources (HR) representatives Josiah and Denise, Mae faces subtle psychological and emotional pressure to conform to the company's expectations, suggesting a very dystopian corporate culture.

> Josiah leaned forward. "How do you think other Circlers feel, knowing that you're so close to them physically, that you're ostensibly part of a community here, but you don't want them to know your hobbies and interests. How do you think they feel?" (Eggers, 2013).
>
> "I don't know. I don't think they'd feel anything." (Eggers, 2013).
>
> "But they do!" Josiah said. "The point is that you're not engaged with the people around you! (Eggers, 2013).

‘Mae was too off-balance to see herself clearly‘ (Eggers, 2013). This marks a crucial juncture in Mae's experience at the company, as she undergoes an uncomfortable interrogation about her lack of participation in company-exclusive social media and on-campus events.

> Denise narrowed her eyes. “Mae, I’m no psychologist, but if I were, I might have a question about your sense of self-worth. We’ve studied some models for this kind of behavior. Not to say this kind of attitude is antisocial, but it’s certainly sub-social, and certainly far from transparent. And we see that this behavior sometimes stems from a low sense of self-worth—a point of view that says, ‘Oh, what I have to say isn’t so important.’ Do you feel that describes your point of view? (Eggers, 2013).

Throughout the narrative, Mae becomes increasingly absorbed by the ideals of the Circle, a powerful tech company that emphasizes transparency and constant connectivity. As she becomes more enmeshed in its culture, her autonomy begins to erode. The digital environment created by the corporation blurs the lines between private and public life, leaving Mae vulnerable to manipulation: the more she conforms to the company's demands, the less she is able to critically evaluate her own desires, goals, or principles.

In a world where surveillance, social media, and constant monitoring are normalized, personal identity becomes commodified and increasingly difficult to define. Mae, like others, is encouraged to share every aspect of her life, risking the loss of privacy, individuality, and control over her narrative. The demand to excel fosters compliance and stifles individuality. The pressure to perform online creates a society where values and authentic self-expression are undermined by the demands for transparency, conformity, and visibility. Her struggle highlights a cultural tension: while technology aims to enhance connectivity, it often erodes autonomy and self-awareness. Mae’s inability to articulate her position, coupled with her growing disconnection from her identity, underscores the impact of a hyper-connected, surveillance-driven society on an individual’s sense of self in the digital age.

The Circle and its Digital Ecosystem

Dave Eggers portrays a wide range of fictional technologies in *The Circle* that highlight the company's invasive approach to data collection, surveillance, and social control. Examples include the *Complete Health Data (CHAD) system*, which captures real-time health information; *SeeChange*, an extensive camera network that allows Circle users to monitor any global location, infiltrating public spaces; *TruYou*, a program that consolidates personal data into a singular account; *PastPerfect*, which tracks one’s online ancestry; *WeaponSensor*, designed to detect weapons and trigger alarms; *Demoxie*, facilitating public voting; and *SoulSearch*, enabling live tracking of criminals through crowd-sourcing. These technologies illustrate the dystopian extremes of digital surveillance, social conformity, and corporate dominance, as well as their detrimental effects on personal privacy, autonomy, and emotional wellbeing.

> The Circle relies on a number of implicit or explicit norms and ideals. As such, it not only depicts and warns against a dystopian future, it also points to and make us aware of avenues not taken, choices not made. In particular, the novel shows how certain ideals if pursued with too much zeal, without discrimination, and with no deeper understanding of their purpose, can turn into their opposites. Energy, transparency, and voting are all good for democracy, but the novel shows that they can also destroy democracy. The line between utopia and dystopia is thin (Maurer & Rostbøll, 2020).

Through Mae's interactions with these technologies, Eggers offers a satirical critique of the culture of surveillance and control that could emerge from unregulated and unrestricted digital media and corporate power.

Surveillance: Just the Beginning

The narrative of *The Circle* is revealed as one with portrayal of advanced technologies, both non-panoptic and panoptic surveillance systems.

Originally, philosopher Jeremy Bentham introduced the Panopticon as a model of constant surveillance to enforce self-discipline—a prison design with a central observation tower where a guard can see all inmates without being seen (Centre, 2017). Philosopher Michel Foucault critiqued it as a "cruel, ingenious cage" that imposes control through the awareness of being watched (Centre, 2017). He likened it to a medieval village in quarantine, where constant surveillance regulates even the smallest details of life, referring to this phenomenon as a "discipline blockade" (Centre, 2017). In more recent times, social psychologist and philosopher Shoshana Zuboff described the personal computer as an 'information panopticon'—a concept that today manifests as 'surveillance capitalism,' where technologies track and manipulate individuals' behaviour for commercial and societal control, transforming employees into data points and operating through one-way surveillance, with actions monitored without knowledge of when or how (Centre, 2017).

In the context of the internet, Allmer classifies theories of surveillance into panoptic and non-panoptic categories (Allmer, 2012). *Panoptic* theories on Internet surveillance emphasize the negative aspects of online monitoring, associating it with a surge in power, coercion, and control in the digital era, while also highlighting connections to repression, discipline and centralized power with a focus on consumption. These theories argue that the power dynamics and intensity of surveillance have heightened with the emergence of the Internet, portraying it as a tool for control wielded by the powerful (Allmer, 2012). Non-panoptic notions of Internet surveillance adopt a broader perspective, emphasizing a decentralized understanding where individuals can participate in monitoring. Scholars stress both constraining and empowering effects of data collection, defining surveillance as a plural, neutral, impartial, and technical process. However, these perspectives frequently overlook the influence of corporations and state institutions in society, underscoring the need for a more detailed approach to comprehend power dynamics in the study of surveillance (Allmer, 2012).

The narrative of *The Circle* exemplifies the constant tension between novel technologies, both non-panoptic and panoptic, in shaping the dynamics of modern surveillance. The panoptic model, characterized by central control and surveillance, aligns with the corporate oversight depicted in *The Circle,* where the company exerts immense power over individuals through constant monitoring. Conversely, Allmer's non-panoptic perspective—emphasizing decentralized monitoring and individual participation in surveillance—also resonates with *The Circle*, where social media users voluntarily share their personal lives, perpetuating self-surveillance.

While these theories provide crucial insights, this paper does not primarily focus on surveillance itself (which could be the subject of a separate study), but instead explores its broader consequences and what follows from them. These include the impact on individuals' mental health, autonomy, and societal wellbeing—issues central to understanding the digital age. By studying situations in *The Circle*, this paper examines how digital technologies shape psychological and societal outcomes, showing the need for a deeper understanding of the effects of constant monitoring in contemporary life.

Techno-Utopianism: The Promise and Perils of a Perfect Digital World

More often than not, there is, of course, a very utopian vision behind the introduction of these technologies. Eamon Bailey, one of the Circle's 'Three Wise Men,' introduces the *SeeChange* technology with the motive of revolutionizing the world by exposing tyrants and preventing them from hiding their crimes. These small, wireless cameras enable anyone to set up complete real-time video streaming (and surveillance) from any location. The broader 'vision' is to promote radical transparency, but this also creates a sense of constant surveillance—utopian for the corporation, yet fundamentally violating privacy and dystopian for the people (as revealed in stages much later). This reveals a major blind spot in Bailey's thought process: sharing such information is assumed to prompt collective action, exposing the passivity of individuals when faced with wrongdoing. This highlights a pivotal irony: Bailey advocates for transparency, while the Circle's extensive surveillance measures, including *SeeChange*, risk turning the corporation into a potentially tyrannical entity. The vision evident in their statements—"*Secrets are lies*," "*Sharing is caring*," and "*Privacy is theft*"—is central to Eamon Bailey's beliefs and philosophy, representing the company's push for radical transparency. These lines emphasize the belief that withholding information is inherently deceptive, advocating for complete openness. This stance raises concerns about personal privacy and the potential consequences of unrestricted transparency, highlighting the ethical implications of the corporation's moral order. Bailey expresses the Circle's ambitious goal to be "all-seeing, all-knowing," aiming to satisfy every human curiosity through advanced technological initiatives.

> Now Bailey cleared the screen again, and stepped toward the audience. "You know what I say, right? In situations like this, I agree with the Hague, with human rights activists the world over. There needs to be accountability. Tyrants can no longer hide. There needs to be, and will be, documentation and accountability, and we need to bear witness. And to this end, I insist that all that happens should be known." The words dropped onto the screen: ALL THAT HAPPENS MUST BE KNOWN (Eggers, 2013).

Of course, the *SeeChange* cameras are both effective and purposeful. Initially, the *SeeChange* cameras serve their purpose by saving Mae's life after a midnight kayaking accident. However, they also play a critical role in the tragic death of her friend Mercer. A new Circle project tracks off-the-grid individuals, and while Mercer tries to evade the company's drones, he accidentally drives his car off a bridge, resulting in his death.

It becomes clear to readers that, deeply immersed in the corporation's ideology, Mae remains blind to the harm it causes and internalizes its techno-utopian vision. She accepts the company's offer to go fully transparent by wearing a constant surveillance camera that records her every move. As a spokesperson for the company's vision of a tech utopia, Mae advocates for a future where complete transparency is the norm and "secrets are lies." Mae embraces the idea of a world where privacy is no longer necessary, believing that transparency will foster a more honest and better society. However, at a later point in the novel, the cameras invade Mae's parents' home, severely disrupting their privacy and highlighting the wider societal implications of pervasive surveillance.

The Circle corporation presents a dual vision: a tech utopia promising openness and connectedness, and a dystopia where the cost of constant monitoring erodes individual freedoms and privacy. This contrast critiques the dangers of a hyper-surveilled society, questioning whether the pursuit of transparency and control truly leads to a better world or merely deepens the loss of autonomy and personal agency.

Dave Eggers also presents a variety of other invasive technologies developed by the company, each reflecting different aspects of its vision for a fully connected and controlled society. Ty Gospodinov (Kalden), the founder of the Circle (and one of the Three Wise Men), is depicted as the mysterious creator of foundational innovations, such as *TruYou,* a system that combines all online identities, accounts, payment methods, and passwords into a single platform, effectively eliminating online anonymity and centralizing identity management. This aligns with the corporation's goal of consolidating digital identities, as evident from the following lines:

> Ty had devised the initial system, the Unified Operating System, which combined everything online that had heretofore been separate and sloppy— users' social media profiles, their payment systems, their various passwords, their email accounts, user names, preferences, every last tool and manifestation of their interests. The old way—a new transaction, a new system, for every site,

> for every purchase—it was like getting into a different car to run any one kind of errand. "You shouldn't have to have eighty-seven different cars," he'd said, later, after his system had overtaken the web and the world. (Eggers, 2013).

Ty is portrayed as motivated by a desire for simplicity, aiming to eliminate the hassle of remembering numerous passwords and identities, thereby enabling a streamlined online experience. *TruYou* enforces the use of real identities linked to personal and financial details, effectively ending online anonymity. This makes all user activities traceable and tied to real identities, appealing to many for its ease and transparency.

> Instead, he put all of it, all of every user's needs and tools, into one pot and invented TruYou—one account, one identity, one password, one payment system, per person. There were no more passwords, no multiple identities. Your devices knew who you were, and your one identity—the TruYou, unbendable and unmaskable—was the person paying, signing up, responding, viewing and reviewing, seeing and being seen. You had to use your real name, and this was tied to your credit cards, your bank, and thus paying for anything was simple. One button for the rest of your life online (Eggers, 2013).

> To use any of the Circle's tools, and they were the best tools, the most dominant and ubiquitous and free, you had to do so as yourself, as your actual self, as your TruYou. The era of false identities, identity theft, multiple user names, complicated passwords and payment systems was over. Anytime you wanted to see anything, use anything, comment on anything or buy anything, it was one button, one account, everything tied together and trackable and simple, all of it operable via mobile or laptop, tablet or retinal. Once you had a single account, it carried you through every corner of the web, every portal, every pay site, everything you wanted to do (Eggers, 2013).

> TruYou changed the internet, in toto, within a year. Though some sites were resistant at first, and free-internet advocates shouted about the right to be anonymous online, the TruYou wave was tidal and crushed all meaningful opposition. It started with the commerce sites. Why would any non-porn site want anonymous users when they could know exactly who had come through the door? Overnight, all comment boards became civil, all posters held accountable. The trolls, who had more or less overtaken the internet, were driven back into the darkness (Eggers, 2013).

Ty is portrayed as claiming that his goal is simply to simplify the user experience. He doesn't foresee the extensive commercial potential of TruYou, nor does he consciously name it after himself.

> And those who wanted or needed to track the movements of consumers online had found their Valhalla: the actual buying habits of actual people were now eminently mappable and measurable, and the marketing to those actual people could be done with surgical precision. Most TruYou users, most internet users who simply wanted simplicity, efficiency, a clean and streamlined experience, were thrilled with the results. No longer did they have to memorize twelve identities and passwords; no longer did they have to tolerate the madness and rage of the anonymous hordes; no longer did they have to put up with buckshot marketing that guessed, at best, within a mile of their desires. Now the messages they did get were focused and accurate and, most of the time, even welcome (Eggers, 2013).

It is important to emphasize that Ty's partners, Bailey and Stenton, are responsible for the aggressive monetization and expansion of *TruYou*, not Ty himself. Ty's initial intentions were somewhat idealistic and less commercially motivated, making the eventual outcome partly a result of the influence of his business partners. Ty symbolizes the increasing tendency of individuals with technical backgrounds to overlook or ignore the societal impacts of their work.

> And Ty had come upon all this more or less by accident. He was tired of remembering identities, entering passwords and his credit-card information, so he designed code to simplify it all. Did he purposely use the letters of his name in TruYou? He said he realized only afterward the connection. Did he have any idea of the commercial implications of TruYou? He claimed he did not, and most people assumed this was the case, that the monetization of Ty's innovations came from the other two Wise Men, those with the experience and business acumen to make it happen. It was they who monetized TruYou, who found ways to reap funds from all of Ty's innovations, and it was they who grew the company into the force that subsumed Facebook, Twitter, Google, and finally Alacrity, Zoopa, Jefe, and Quan (Eggers, 2013).

The commercialization and vast expansion of Ty's inventions are largely driven by the two other 'Wise Men'—Eamon Bailey and Tom Stenton—who capitalize on *TruYou*'s potential, turning the company into a dominant tech force. Under the influence of Ty's creations, the Circle ultimately absorbs major tech giants, fundamentally reshaping the online landscape with its integrated, identity-driven ecosystem.

Ty's creation of *TruYou* aims to simplify digital life by merging multiple online identities into a single account. While designed for convenience, this integration leads to unintended consequences by removing user anonymity and significantly eroding privacy. Speculatively, *TruYou* warns of the risks associated with digital identity consolidation, which enables invasive surveillance and fosters conformity, eliminating safe spaces for users to explore and express themselves without constant tracking. Furthermore, Ty's experience highlights the ethical responsibility that technologists face in anticipating and mitigating the potential misuse of their innovations. *TruYou*'s rapid adoption and societal impact underscore the need for technologists to consider the broader societal implications of their work, especially as technology reshapes social norms faster than ethical or regulatory measures can keep up.

It also illustrates the shift from innovation for utility to innovation for profit, reflecting a data-driven economy where companies capitalize on personal data, transforming users into profitable metrics. The system's simplicity, designed for ease, also becomes a tool for comprehensive surveillance. *TruYou* demonstrates the risks of centralizing digital control, where tech companies not only monitor user behaviour but also wield influence over it. Similarly, today's integrated digital platforms, such as Google and Apple IDs, function as universal logins, amassing data across platforms while expanding corporate oversight of personal lives.

The Future of Privacy: *The Circle* and Surveillance Capitalism

Shoshana Zuboff popularizes the term 'surveillance capitalism,' combining this informational capitalism with economics (the use of personal data for profit). In her work, she describes how enterprises commodify personal data for profit, illustrating how large tech corporations exploit user information for their own financial gain:

> This new form of information capitalism aims to predict and modify human behavior as a means to produce revenue and market control. Surveillance capitalism has gradually constituted itself during the last decade, a new social relations and politics that have not yet been well delineated or theorized. While 'big data' may be set to other uses, those do not erase its origins in an extractive project founded on formal indifference to the populations that comprise both its data sources and its ultimate targets (Zuboff, 2015).

The Circle illustrates how surveillance capitalism, operates through digital tools like algorithms, influencing various aspects of people's lives and intertwining with the digital world. Furthermore, the wise Ty/Kalden cautions Mae about massive surveillance:

> No, no. Not at all. But you're now the ambassador. You're the face of it. The benign, friendly face of it all. And the closing of the Circle—it's what you and your friend Francis made possible. Your mandatory Circle account idea, and his chip. TruYouth? It's sick, Mae. Don't you see? All the kids get a chip embedded in them, for safety, when they're infants. And yes, it'll save lives. But then, what, you think they suddenly remove them when they're eighteen? No. In the interest of education and safety, everything they've done will be recorded, tracked, logged, analyzed—it's permanent. Then, when they're old enough to vote, to participate, their membership is mandatory. That's where the Circle closes. Everyone will be tracked, cradle to grave, with no possibility of escape (Eggers, 2013).

Zuboff's emphasis on surveillance capitalism as an economic creation subject to democratic contest and regulation (Zuboff, 2019) aligns with the novel's exploration of the societal implications and ethical considerations surrounding extensive surveillance practices. Ty/Kalden also reveals their misguided motivation in the formative years:

> Mae, so many of the things I invented I honestly did for fun, out of some perverse game of whether or not they'd work, whether people would use them. I mean, it was like setting up a guillotine in

> the public square. You don't expect a thousand people to line up to put their heads in it (Eggers, 2013).

More aspects of surveillance capitalism are evident as the narrative progresses, when Kalden reveals:

> Now, you and I both know that if you can control the flow of information, you can control everything. You can control most of what anyone sees and knows. If you want to bury some piece of information, permanently, that's two seconds' work. If you want to ruin anyone, that's five minutes' work. How can anyone rise up against the Circle if they control all the information and access to it? They want everyone to have a Circle account, and they're well on their way to making it illegal not to. What happens then? What happens when they control all searches, and have full access to all data about every person? When they know every move everyone makes? If all monetary transactions, all health and DNA information, every piece of one's life, good or bad, when every word uttered flows through one channel? (Eggers, 2013).

It is noteworthy that Kalden labels this concept as "Infocommunism":

> Bailey believes that life will be better, will be perfect, when everyone has unfettered access to everyone and everything they know. He genuinely believes that the answers to every life question can be found among other people. He truly believes that openness, that complete and uninterrupted access among all humans will help the world. That this is what the world's been waiting for, the moment when every soul is connected. This is his rapture, Mae! Don't you see how extreme that view is? His idea is radical, and in another era would have been a fringe notion espoused by an eccentric adjunct professor somewhere: that all information, personal or not, should be known by all. Knowledge is property and no one can own it. Infocommunism. And he's entitled to that opinion. But paired with ruthless capitalistic ambition—(Eggers, 2013).

Another technology, *LuvLuv,* uses aggregated data to generate comprehensive profiles of potential romantic interests. By leveraging extensive digital information, the Circle showcases the invasiveness of its data-collection abilities, allowing it to shape even the intimate aspects of personal relationships. Similarly, *SoulSearch* utilizes the company's vast network to locate individuals by crowd-sourcing the search, engaging users in a community-wide surveillance task. This system proves ethically troubling, as it leads to dangerous situations, including the tragic pursuit and eventual death of a character, Mercer.

Demoxie is another tool designed to integrate voting and civic engagement into the Circle's platform, ostensibly enhancing democracy by ensuring that every citizen's voice is heard in real-time. Mae proposes that all voting-age citizens should be required to have a Circle account, which blurs the lines between technology and politics and poses significant risks to privacy and individual autonomy by suggesting mandatory technological involvement in civic processes. Her revolutionary idea earns Mae fame both within the Circle and beyond. The corporation starts working on a prototype called "Demoxie," a play on the word "democracy." This system requires users to respond to questions, freezing their accounts if they fail to do so. Mae is astonished at how quickly her concepts are coming to fruition. Eventually, she answers a call from Kalden, who reveals that her idea aligns perfectly with what Bailey and Stenton have long desired: *Completion*, a form of tyrannical monopoly. Confused, Mae hangs up.

> The night was cold and the winds were lacerating but Mae didn't notice. Everything felt good, clean and right. To have the validation of the Wise Men, to have perhaps pivoted the entire company in a new direction, to have, perhaps, perhaps, ensured a new level of participatory democracy—could it be that the Circle, with her new idea, might really perfect democracy? Could she have conceived of the solution to a thousand-year-old problem? (Eggers, 2013).

Later, during a demonstration of *Demoxie*, a series of questions appear on campus screens, including one asking employees to vote on whether Mae is awesome. Several people respond with a smiley face, while a few others respond with a frown. This triggers a spiral of anxiety for Mae as she wonders about the identities of the small percent who responded with a negative reaction and whether they harbour ill intentions. Her co-worker Francis suggests that if Mae is concerned about them, she could easily track them through the Circle. However, when he tries to demonstrate this, Mae panics.

As Mae later runs into her friend Annie, she learns that Annie has volunteered to be the first to test *PastPerfect,* that aggregates genealogy data to build comprehensive life stories, including ancestors, eroding privacy for both current and past generations. Moreover, during a routine session where Circle hopefuls pitch their ideas, Mae hears about a tracking system that assigns colours to criminals based on their offenses and monitors movements within homes to identify instances of domestic violence.

> Belinda was nodding. "Right, right. Of course. And so, for lack of a better word, you tag the convicts, and from then on, if you're a police officer, instead of driving down the street, shaking down anyone who happens to be black or brown or wearing baggy pants, imagine instead you were using a retinal app that saw career criminals in distinct colors—yellow for low level offenders, orange for nonviolent but slightly more dangerous offenders, and red for the truly violent. (Eggers, 2013).

Other technologies include *participation* in this platform, which is quantified through the *Participation Rank* or *PartiRank*, measuring an employee's activity within the digital ecosystem. This algorithm-driven rank pressures employees to maintain a constant presence online, fueling an atmosphere of competitive social engagement.

> This is your Participation Rank, PartiRank for short. Some people here call it the Popularity Rank, but it's not really that. It's just an algorithm generated number that takes into account all your activity in the InnerCircle. Does that make sense?...It takes into account zings, exterior followers of your intra-company zings, comments on your zings, your comments on others' zings, your comments on other Circlers' profiles, your photos posted, attendance at Circle events, comments and photos posted about those events—basically it collects and celebrates all you do here. The most active Circlers are ranked highest of course. As you can see, your rank is low now, but that's because you're new and we just activated your social feed. But every time you post or comment or attend anything, that gets factored in, and you'll see your rank change accordingly. That's where the fun comes in. You post, you rise in the rankings. A bunch of people like your post, and you really shoot up. It moves all day. Cool? (Eggers, 2013).

Health Monitoring Technology is another layer of control, with employees wearing wrist monitors that track various health metrics. Ostensibly for wellness, this system enables the Circle to oversee personal health data, expanding its influence into intimate aspects of employees' lives. *ChildTrack* serves as a similar tool for parents, allowing them to monitor their children's whereabouts, exemplifying the normalization of surveillance from a young age. The social feeds and Zing updates system functions similarly to social media, where users post frequent "zings" and interact with others' updates. This continuous interaction cultivates an environment of constant engagement, pushing users toward perpetual online validation and conformity.

Through these tools, *The Circle* portrays a dystopian vision of technology that prioritizes control and transparency at the expense of privacy, autonomy, and authentic human relationships.

The Psychology of Connectivity: Wellbeing in *The Circle*

The insights from the novel resonate with the ongoing discourse surrounding digital wellbeing, highlighting the need to balance technological progress with the preservation of human connection and introspection. This idea is echoed by author Cal Newport in his advocacy for 'digital minimalism,' where he proposes that individuals intentionally reduce digital clutter (which is inherently stressful) to enhance their offline lives, reclaim focus, and prioritize meaningful activities, as outlined in his work *Digital Minimalism: Choosing a Focused Life in a Noisy World* (Newport, 2016). This aligns with his underlying philosophy of critically examining "our culture's increasingly Orwellian allegiance to social media" (Newport, 2016).

Studies have shown that excessive social media use is associated with increased anxiety, depression, and decreased life satisfaction among adolescents and young adults (Ostic et al., 2021). Research also shows that excessive digital engagement can lead to burnout and emotional exhaustion, particularly when individuals feel pressured to continuously perform for an audience (Blankson, 2023). Media psychology research also indicates that digital environments can significantly shape individuals' self-perception, often causing them to evaluate their worth based on 'likes,' follower counts, and engagement metrics (Voggenreiter et al., 2024). Studies suggest that such social comparison can lower self-esteem, especially when one's self-worth is closely

tied to the judgments and approval of others (Editorial Team, 2024). Moreover, a study highlights the American Psychological Association's advice on the negative effects of excessive screen time on teens, particularly its impact on sleep, emotional regulation, and social skills. It emphasizes the need for moderation in video consumption and the importance of parental guidance, as well as the roles of educators, video platform creators, and policymakers in supporting healthy viewing habits to promote teens' mental wellbeing (Park, 2024). These findings underscore the importance of balancing digital engagement with offline activities to maintain mental health and a strong sense of self.

The never-ending competition to fit into the corporation's culture exacerbates Mae's struggles, pushing her further into a cycle of validation through external sources. At the Circle, digital media usage transcends mere encouragement and becomes an expectation, with employees like Mae pressured to engage with the company's social tools continuously. This culture of constant connectivity intertwines with job performance and status, leading to an environment where disengagement is socially punished. Such compulsory media use enables addiction-like behaviours, compelling Mae to be online even at the expense of her personal life and relationships, demonstrating the detrimental effects of an over-connected existence.

Sociologist Deborah Lupton's work critically examines the social, cultural, and political dimensions of self-tracking, focusing on the rise of the "Quantified Self" movement, the role of personal data in shaping selfhood and embodiment, and the growing significance of self-tracking data in the context of big data politics, which is increasingly repurposed for commercial, governmental, and research purposes (Lupton, 2016).

In a way, the company *Circle* embodies the "quantified self" *datafied* culture through its promotion of self-tracking via health monitoring, location tracking, and social ranking. Employees are outfitted with devices that monitor everything from physical activity to smiles, blurring the line between work and personal life. This intense focus on digital metrics not only defines individuals by data points but also creates a culture of self-surveillance, where the pressure of being constantly watched and evaluated permeates daily life.

The Circle's motto, "All That Happens Must Be Known," emphasizes a commitment to constant sharing, effectively erasing personal boundaries. Technologies like *SeeChange* cameras transform even private moments into public spectacles, fostering a societal norm where personal space becomes virtually non-existent. This continuous exposure ultimately challenges the notion of privacy and the sanctity of personal moments in life. The rampant digital media usage within the Circle invades all aspects of life, illustrating how unmoderated media consumption can truly distort interpersonal relationships and contribute to an environment of hyper-surveillance.

In her review, renowned novelist, poet, and literary critic Margaret Atwood addresses Mae's dystopian relationship with technology, elucidating her compulsive social media usage and perpetual online presence, as well as her adherence to the Circle's technologies and regulations.

> But if this is utopia, why is Mae so anxious most of the time? True, her workload in "Customer Experience" is crushing, as she answers questions, sends "smiles" and "frowns"—the Circle equivalent of Likes and Dislikes and Favorites—to other websites and accounts, fields an avalanche of messages and invitations from other Circlers, and is under increasing pressure to spend all her time "participating." But her main terror is being cast out of the Circle: she'll do almost anything to stay inside, and worries constantly about what sort of impression she's making. Is she getting enough approval, a substance she measures by messages, Zings, "smiles," and online watchers? Is she making the grade? (Atwood, 2013).

The Circle warns of a potential future where technology eclipses human agency and moral judgment. The work also emphasizes the need for accountability in technology use, particularly within corporate environments. Eggers stresses the importance of ethical accountability for both individuals and corporations in the realm of digital technology. The absence of checks and balances allows the Circle's pursuit of "progress" to result in coercive digital practices that ultimately harm users. These alarming and emerging trends represent the detrimental impact of digital platforms on mental health, fuelled by their addictive nature and persuasive design techniques. Through this narrative, Eggers raises essential questions about corporate accountability, advocating for a model in which companies prioritize user rights and autonomy over profit margins or ideological goals.

Released in 2020, the popular Netflix documentary *The Social Dilemma* explores how social platforms manipulate user behaviour and foster addiction through 'positive intermittent reinforcement.' Joe Toscano, a former Google design consultant, explains how features like 'pull down and refresh' continuously engage users ('The Mental Health Dilemma – "The Social Dilemma"'). Tristan Harris, co-founder of the Center for Humane Technology, discusses how platforms aim to implant unconscious habits in users by deeply influencing their brains, with digital notifications triggering false alarms and impairing focus and prioritization. Dr. Anna Lembke, Medical Director of Addiction Medicine at Stanford, adds that social media exploits our biological drive for connection, releasing dopamine in the reward pathway and normalizing unhealthy social comparison by emphasizing social validation through "likes."

It becomes clear how the persuasive design of social media platforms is strategically aimed at capturing attention and exploiting users, raising significant concerns about digital interface practices. In response, the concept of digital wellbeing has emerged as a critical framework, highlighting the need to protect mental and emotional health in the digital age.

Through the company's constant surveillance, integration of technology, and emphasis on transparency, Mae is subtly conditioned to accept the company's worldview without question. Mae's gradual indoctrination exemplifies how the design of an organization can shape and limit an individual's cognitive capacity, especially when it comes to critical thinking. This process highlights how corporate environments, through carefully crafted informational design, can reinforce a particular ideology and limit employees' ability to critically analyze their circumstances. Her growing inability to question or articulate the negative effects of the company's practices reflects the dangers of confirmation bias, where individuals unconsciously favor information that aligns with the dominant narrative, while dismissing contradictory viewpoints or concerns.

> If everyone has equal access to services, to information, we finally have a chance at equality. No information should cost anything. There should be no barriers to knowing everything, to accessing all —(Eggers, 2013).

> Most people do. Most people would trade everything they know, everyone they know—they'd trade it all to know they've been seen, and acknowledged, that they might even be remembered. We all know we die. We all know the world is too big for us to be significant. So all we have is the hope of being seen, or heard, even for a moment (Eggers, 2013).

Mae expresses her strong desire to be noticed and acknowledged, which is a key theme throughout the narrative. Her feelings echo a widespread longing for importance in a busy world. Eggers uses Mae's thoughts to prompt readers to think about their own use of social media and how much value they place on their online presence. However, he also uses humour to criticize the idea that sharing more online makes a person more 'whole' or 'holistic', and instead makes them substantially vulnerable.

> I want to be seen. I want proof I existed... Most people do. Most people would trade everything they know, everyone they know - they'd trade it all to know they've been seen, and acknowledged, that they might even be remembered. We all know the world is too big for us to be significant. So all we have is the hope of being seen, or heard, even for a moment (Eggers, 2013).

In this way, *The Circle* reflects the power of corporate systems to not only control the flow of information but also to shape the very way employees think, potentially leading to a collective acceptance of harmful practices.

The Circle and the Erosion of Digital Wellbeing

Professor and researcher Mariek Vanden Abeele (2021) proposes a definition of digital wellbeing that refrains from pathologizing individuals' interactions with technology and acknowledges that connectivity presents both advantages and disadvantages. It takes into consideration the ambivalent relationship we have with technology, emphasizing the subjective and fluid nature of our technological experiences and recognizing the mixed feelings we may have towards technology. The author suggests developing a model of digital wellbeing that accommodates variations in the balance of benefits and drawbacks on both intra- and interpersonal levels. This model should steer away from simplistic cause-and-effect frameworks and

instead view digital wellbeing as a dynamic system influenced not only by personal factors but also by device and contextual elements.

> Digital wellbeing is a subjective individual experience of optimal balance between the benefits and drawbacks obtained from mobile connectivity. This experiential state is comprised of affective and cognitive appraisals of the integration of digital connectivity into ordinary life. People achieve digital wellbeing when experiencing maximal controlled pleasure and functional support, together with minimal loss of control and functional impairment (Vanden Abeele, 2021).

Applying this concept of digital wellbeing to *The Circle* provides a nuanced lens through which we can examine how Mae Holland and other characters experience—or fail to experience—an "optimal balance" between the benefits and drawbacks of their digital connectivity. The lack of digital wellbeing is evident as characters increasingly experience the downsides of technology, highlighting the risks of an unchecked, all-encompassing digital ecosystem that does not accommodate personal boundaries, emotional health, or ethical reflection.

Mercer: The Voice of Reason?

Mercer, Mae's former boyfriend, embodies the offline, analogue way of living and is portrayed as being against the Circle's unethical philosophy of transparency. He suggests that Mae's focus on her online persona has made her less genuine in real life. He serves as a recurring motif in the novel, offering direct commentary on its central theme: the perils of modernity and, more specifically, Mae's escalating dependence on connectivity and validation through the company.

Despite Mercer's warnings, Mae's attempts to disengage from the social and online spheres are met with reprimand. Her addiction is multifaceted, encompassing the need for social validation and recognition, as well as the direct influence the company wields over her life as both employer and omnipresent entity. These events demonstrate the complicated relationship between digital connectivity and wellbeing and the potential dangers of over-reliance on technology for validation and social interaction. Through the character of Mercer, readers are prompted to reflect on the consequences of the incessant pursuit of knowledge facilitated by modern technology. Mercer's contemplation of the delicate equilibrium between the known and the unknown challenges the prevailing notion that continual connectivity and access to information inherently yield benefits. This theme gains importance within the narrative context of Mae's experiences, wherein her gradual immersion in the Circle's ideology blurs the boundaries of knowledge.

> We are not meant to know everything, Mae. Did you ever think that perhaps our minds are delicately calibrated between the known and the unknown? That our souls need the mysteries of night and the clarity of day? Young people are creating ever-present daylight, and I think it will burn us all alive. There will be no time to reflect, to sleep to cool (Eggers, 2013).

Mercer questions the effectiveness of the Circle's technology in meeting social needs, suggesting that it creates artificial demands similar to addictive snack food. He argues that the emphasis on connectivity worsens feelings of isolation rather than alleviating them. This challenges the assumption that more digital connection leads to better wellbeing, indicating instead that it may lead to empty consumption. Mercer's critique highlights the importance of prioritizing meaningful connections over increased digital engagement:

> It's not that I'm not social. I'm social enough. But the tools you guys create actually manufacture unnaturally extreme social needs. No one needs the level of contact you're purveying. It improves nothing. It's not nourishing. It's like snack food. You know how they engineer this food? They scientifically determine precisely how much salt and fat they need to include to keep you eating. You're not hungry, you don't need the food, it does nothing for you, but you keep eating these empty calories. This is what you're pushing. Same thing. Endless empty calories, but the digital-social equivalent. And you calibrate it so it's equally addictive (Eggers, 2013).

Mercer also criticizes the Circle's efforts to promote greater connectivity, arguing that its technologies do not alleviate feelings of isolation and loneliness, and may even worsen them. He compares excessive digital usage to eating a bag of chips, which leaves individuals feeling empty and unfulfilled. Mercer's observations parallel Mae Holland's experiences, as she often feels depleted and diminished after prolonged online activity.

However, she fails to acknowledge the negative effects of her digital engagement, highlighting a gap between online activity and personal wellbeing.

Mercer's critique prompts reflection on the adverse effects of excessive digital consumption on mental health and emphasizes the importance of acknowledging and addressing these impacts in discussions of digital wellbeing.

> You know how you finish a bag of chips and you hate yourself? You know you've done nothing good for yourself. That's the same feeling, and you know it is, after some digital binge. You feel wasted and hollow and diminished (Eggers, 2013).

Mae's Immersion in *The Circle*: The "Cost" of Digital Connection

Mae's immersion in the Circle deeply impacts her personal relationships, revealing the emotional toll of a hyper-connected, surveillance-driven world.

SoulSearch, the Circle's crowdsourcing tool designed to locate fugitives, becomes a symbol of the company's invasive reach. Mae initially views it as a tool for promoting safety and justice. However, when she uses it to track Mercer—her former boyfriend who distances himself due to the Circle's culture of surveillance—the consequences are catastrophic. Mae broadcasts Mercer's location to millions, prompting drones to pursue him relentlessly. Feeling hunted and unable to escape the Circle's reach, Mercer drives off a bridge to his death.

Mae's actions, driven by her belief in the Circle's mission, blind her to the devastating impact on Mercer. His resistance to the Circle's invasive technologies contrasts sharply with Mae's complicity, emphasizing the cost of prioritizing digital control over personal autonomy. Despite Mercer's vocal criticism of the Circle, Mae repeatedly pressures him to adopt its tracking tools, alienating him further. The collapse of their relationship—and Mercer's tragic demise—illustrates the human cost of the Circle's ideology. *SoulSearch*, initially framed as a means of creating a safer world, ultimately reveals its horrific potential when wielded without regard for individual autonomy or mental wellbeing.

Mae's close friendship with Annie deteriorates under the weight of the Circle's power dynamics. Initially supportive of Mae's rise within the company, Annie grows increasingly distant as Mae's loyalty to the Circle deepens. Tensions reach their peak when Mae publicly exposes Annie's family secrets during a company initiative called *PastPerfect*, designed to uncover and share family histories. Using this program, Mae reveals details about Annie's ancestors, including their involvement in slavery, and an incident where her parents displayed apathy as a man drowned. This public exposure humiliates Annie, triggering a profound identity crisis and a severe emotional breakdown. The betrayal of Annie during the *PastPerfect* initiative highlights Mae's prioritization of the Circle's ideology over their friendship. Mae's decision to broadcast Annie's personal history—supposedly in the name of transparency and accountability—deeply isolates Annie, who feels abandoned and betrayed. The intense public scrutiny that follows drives Annie into a mental health crisis, causing her to withdraw entirely from the Circle and her relationship with Mae. This strain reflects the Circle's obsession with transparency, which forces individuals to prioritize visibility and ambition over trust and loyalty. While Mae thrives in the Circle's metrics-driven ecosystem, Annie crumbles under the weight of its invasive scrutiny. Mae's increasing dependence on metrics like likes, shares, and zings causes her to value digital validation over meaningful interactions.

The *PastPerfect* technology exemplifies the Circle's manipulative nature, as it uncovers unsettling family histories and magnifies their impact through public exposure. For Annie, learning about her ancestors' unethical actions—and her parents' past indifference—shatters her perception of her identity. Meanwhile, Mae, untouched by similar revelations about her own family, becomes even more entrenched in the Circle's ideology, viewing all aspects of life as material for public consumption. This contrast reflects how the Circle's technologies destroy authentic connections and exacerbate mental health struggles.

Mae's adoption of the Circle's invasive technologies also fractures her relationship with her parents. Despite their discomfort, Mae installs surveillance devices in their home, ostensibly for their safety, but effectively stripping them of their privacy and autonomy. This leads to growing resentment and alienation within the family. Tension culminates during a family gathering when Mae, without their consent, broadcasts

private moments, further straining their bond. This blatant disregard for her parents' boundaries reflects Mae's complete assimilation into the Circle's ideology, where constant connectivity and surveillance are valued over trust and respect. Her inability to recognize the harm she causes underscores the generational and ideological divide between Mae and her family.

More of Mae: A Catalyst, an Innocent Bystander, or a Pawn in the Digital Game?

Mae's role as a staunch proponent of these technologies complicates her character, as her well-meaning intentions lead to devastating consequences for those she cares about. The narrative ultimately exposes the ethical dilemmas and personal tragedies that emerge when technology dictates the terms of human relationships and individual identity. Mae's insistence on transparency and her belief that the public will respond with compassion reflect her disconnection from the emotional realities faced by those around her.

Mae Holland's role in *The Circle* can be interpreted in multiple ways, reflecting her complex position within the organization's dystopian ecosystem. As a catalyst, Mae's enthusiasm for the Circle's mission and her rapid rise within the company accelerate the adoption of invasive technologies, making her a key proponent of its vision for total transparency. However, her transformation raises questions about her agency—whether she actively drives the company's agenda or is manipulated into becoming its public face. At the same time, Mae can be seen as an innocent bystander, initially appearing as a passive participant overwhelmed by the pressures of conformity, social validation, and career advancement. Her lack of critical reflection on the consequences of her actions suggests ignorance, but whether this absolves her of responsibility remains debatable. Finally, Mae functions as a pawn in the digital game, embodying the broader critique of individuals exploited by technology companies that prey on human desires for connection, belonging, and purpose. The Circle's culture of surveillance and control gradually erodes her autonomy, turning her into a tool for the company's overarching goals. Mae's character functions as a powerful lens for examining the ethical dilemmas, societal pressures, and personal compromises shaped by the all-encompassing digital ecosystem.

Wellbeing: Subjective Balance of Pros and Cons

Vanden Abeele's definition emphasizes that digital wellbeing involves a subjective balance of benefits and drawbacks from connectivity. This *balance* is evidently missing for Mae and other Circle employees, as they are persistently and continually pushed to embrace total transparency and constant connectivity, regardless of personal preferences or psychological consequences.

This model of digital wellbeing addresses both intrapersonal and interpersonal dynamics. For Mae, the Circle's technology initially fosters intrapersonal satisfaction, offering a sense of achievement and belonging. However, the impact on her interpersonal relationships soon becomes detrimental. Her connections with others—particularly Mercer, Annie, and her parents—deteriorate as she becomes increasingly devoted to the Circle's ideals of transparency and connectivity.

Mae initially enjoys the *pros* of the Circle's technology, including a sense of belonging, social validation, and career advancement. However, as her dependency on digital metrics and surveillance grows, she experiences significant cons, including fractured personal relationships, ethical conflicts, and a progressive loss of self-determination. Rather than helping Mae achieve a sense of digital wellbeing, her connection to the Circle's technology becomes increasingly detrimental. The corporation's culture encourages users to blatantly disregard personal boundaries and forgo personal control over their digital experiences, resulting in an unhealthy, imbalanced relationship with technology where the drawbacks—such as loss of privacy, increased anxiety, and diminished autonomy—begin to outweigh the benefits.

Dynamic and Contextual Influences on Digital Wellbeing

Vanden Abeele suggests that digital wellbeing is a dynamic experience influenced by personal, device-related, and contextual factors. In *The Circle*, the company's corporate culture and technology design create a rigid context that overrides individual control, shaping how employees relate to technology. Mae's relationship with the Circle's devices and platforms is dominated by external pressures, with little room for personal agency.

Digital wellbeing, as per Vanden Abeele, also involves achieving "controlled pleasure" and functional support while minimizing loss of control and functional impairment. *The Circle* creates an illusion of pleasure and support but ultimately enforces a system that strips users of control. Mae's initial pleasure in using the Circle's technology—such as her excitement over sharing her experiences with a vast audience and gaining instant feedback—quickly transforms into a compulsive need for validation and social approval.

Instead of allowing employees to set boundaries, the Circle enforces policies that compel them to engage constantly. For instance, the *SeeChange* cameras and *TruYou* identity system eliminate Mae's ability to choose when or where she is visible, significantly impairing her control over her digital experience. As a result, Mae's digital wellbeing declines as she loses autonomy in deciding how to interact with technology. The Circle's focus on complete integration and transparency ignores the contextual factors that Vanden Abeele argues are crucial to digital wellbeing, such as situational appropriateness and personal choice.

Ambivalence and Mixed Feelings Towards Technology

Vanden Abeele's concept highlights the ambivalent nature of our relationship with technology, recognizing that digital connectivity can bring both pleasure and stress, as well as control and loss of control. Mae's journey with the Circle mirrors this ambivalence. While she initially experiences the thrill of social validation and professional success, she also encounters significant stress and tension as she becomes enmeshed in the company's relentless digital culture.

At one point in the novel, Mae feels deeply lonely and isolated despite being digitally connected to millions of viewers worldwide. Despite her constant online presence and attempts to connect with loved ones like her parents and friend Annie, Mae receives no response, worsening her sense of disconnection. Trying to distract herself online only makes her feel worse, leading her to turn to alcohol and voyeuristic observations of remote places through *SeeChange* cameras. Despite her efforts to feel better, Mae remains troubled, highlighting the paradox of digital connection: even with constant online presence, individuals can still feel profoundly lonely:

> She sat up in bed, knowing that it usually took her an hour or so to make her way to sleep. She turned on the wallscreen, planning to check on her parents. But their SeeChange cameras were all dark. She sent them a zing, expecting no answer and getting none. She sent a message to Annie but got no response. She paged through her Zing feed, reading a few funny ones, and, because she'd lost six pounds since going transparent, she spent twenty minutes looking for a new skirt and T-shirt, and somewhere in the eight site she visited, she felt the tear opening up in her again (Eggers, 2013).

Loss of Autonomy and Agency

Mae's immersion in the Circle gradually erodes her sense of control, symbolized by her "going transparent"—wearing a camera that broadcasts her every move, eliminating privacy. While the company frames transparency as beneficial, it undermines Mae's autonomy, impairing her ability to make independent ethical judgments or maintain authentic relationships. Her dependency on digital approval leads to a loss of privacy, personal relationships, and a distorted sense of self.

The Circle's constant scrutiny, metrics, and need for social validation push Mae to prioritize digital visibility over personal values, transforming her into a shell of her former self. Her growing fixation on metrics like *PartiRank* breeds anxiety, conformity, and self-doubt, blurring the line between her true identity and digital persona. Despite initial excitement over her rising rank, Mae feels increasing pressure to maintain it, sacrificing privacy and authenticity.

Mae's struggle to balance technology with digital wellbeing mirrors real-world challenges of excessive digital engagement. The Circle's culture of total transparency leaves little room for personal reflection or choice, eroding self-worth and wellbeing. Mae's unhealthy obsession with external validation leads to a loss of emotional autonomy and submission to a system that prioritizes transparency over privacy and mental health. This reflects how digital engagement, in today's media-saturated world, can diminish psychological wellbeing and compromise identity. The Circle's technologies—like *SeeChange* cameras and *SoulSearch*—impose constant visibility and raise critical ethical concerns about informed consent and privacy rights.

Through initiatives like *Demoxie*, the Circle seeks to influence democratic processes, prompting questions about corporations' true motives when data control and profit overshadow individual rights. The novel critiques these practices, highlighting the ethical implications of surveillance and the monopolistic power corporations wield over information, civic engagement, and personal identity.

Moving Beyond Simplistic Cause-and-Effect

Vanden Abeele's approach suggests avoiding simplistic cause-and-effect views of digital wellbeing. In *The Circle*, the company's leadership promotes an oversimplified narrative that "more connectivity equals more transparency, which equals a better world." This perspective overlooks the nuances, complexities and ambivalence of human-technology interactions. Mae's experience reflects that increased connectivity does not inherently lead to wellbeing; instead, the forced transparency leads to surveillance, dependency, and a loss of self.

Mae's eventual transformation into a proponent of the Circle's values highlights how simplistic frameworks fail to capture the nuanced impacts of technology. Her digital wellbeing deteriorates because the Circle's environment treats connectivity as uniformly positive, ignoring the need for personal boundaries, ethical reflection, and individual control. This oversight results in a system that exacerbates psychological distress and erodes personal integrity, revealing the limitations of simplistic approaches to digital wellbeing.

This fundamentally demonstrates the importance of balance and agency in digital interactions. Mae's trajectory in the novel is, in fact, a warning about the risks of an inflexible, transparency-focused model of connectivity, where personal agency and emotional wellbeing are sacrificed for the sake of digital engagement. By showing how the Circle's technology undermines its users' digital wellbeing, *The Circle* demonstrates the necessity of a more nuanced, individualized approach to technology, where users have the freedom to define their own optimal balance between connectivity's benefits and drawbacks.

After-Effects and Consequences of Surveillance in The Circle

Surveillance is central to *The Circle*, and its pervasive nature has deep consequences for individuals, relationships, and society. Eggers critiques the dehumanizing effects of prioritizing transparency over privacy, individuality, and freedom. The constant surveillance—embodied in devices like *SeeChange* cameras and the mantra "Secrets are lies"—eliminates privacy, inhibiting authentic behaviour and causing widespread psychological distress.

Mae's relationships deteriorate due to the invasive nature of these technologies. Her insistence on monitoring others strains her connection with Mercer, who resents being watched, and her parents, who feel violated by the cameras in their home. These examples highlight how surveillance fosters alienation, replacing trust with suspicion. The psychological toll is profound: Annie suffers a breakdown when her family's private history is exposed, and Mercer's withdrawal and eventual suicide underscore the mental strain of constant monitoring. The oppressive surveillance culture erodes autonomy, compelling individuals to prioritize public approval over personal values.

Mae's transformation into a proponent of the Circle's ideology reflects how the normalization of surveillance strips individuals of critical thinking, creating a society where dissent and individuality are suppressed. This shift is exemplified by Mae's betrayal of Annie, demonstrating the destructive impact of prioritizing online visibility over authentic connections and human values.

The Circle's technologies reduce relationships to data points, stripping away emotional depth. Mae's approach to her relationships becomes transactional, as she focuses on metrics rather than empathy. Her increasing loyalty to the company causes a moral and emotional disconnect from loved ones, leading to fractured relationships and emotional instability.

Conclusion: Circling back (pun intended!) to the research questions:

- How does *The Circle (2013)* reflect and anticipate the psychological and societal impacts of social media?

- What role do science fiction and critical discourse analysis play in exploring contemporary issues of digital wellbeing?

In *The Circle*, Dave Eggers presents a world that blends reality and a possible future where digital connectivity is ubiquitous and often unchecked, resulting in harmful consequences for individual wellbeing, personal autonomy, and ethical standards. The story serves as a stark reminder that, without conscious effort and ethical consideration, the pursuit of connectivity can harm mental health, interpersonal relationships, and ethical integrity. It emphasizes the importance of a mindful, intentional, and healthy relationship with technology that prioritizes mental health, privacy, and genuine connections.

As Abeele articulates, achieving digital wellbeing requires optimally balancing the benefits and drawbacks of connectivity, acknowledging ambivalent feelings toward technology, and recognizing the personal, contextual, and device-related factors at play. As evident in the novel, the path forward demands conscious, mindful effort and a commitment to creating digital habits that align with our values and priorities as individuals and as a society. By doing so, we can cultivate a healthy digital footprint and a future where technology enriches our lives rather than diminishes them. In practical terms, *The Circle* functions as a catalyst for discussions on digital wellbeing and setting boundaries in an age of information overload. It calls for reevaluating our priorities as individuals and as a society, while advocating for ethical technology design.

Shapiro (2024) argues that science-fictional thinking, by blurring the lines between narrative and reality, helps us understand the societal impacts of digital technologies—such as virtual and augmented reality, artificial intelligence, and social media—by addressing their convergence with speculative narratives and highlighting their role in shaping contemporary digital dystopias (Shapiro, 2024). This digital dystopia and science-fictional thinking are particularly valuable to us. Although speculative, *The Circle* is alarmingly relevant to modern challenges, illustrating how chronic loneliness often accompanies constant digital connectivity and the oscillation between digital connection and disconnection. Engaging with the speculative fictional elements in *The Circle* is crucial for understanding the pressing challenges of digital wellbeing in our increasingly datafied culture. It encourages dialogue on critical issues such as data privacy, mental health, and the ethical responsibilities of technology companies.

The novel's portrayal of a world where privacy is sacrificed for transparency and social metrics dictate self-worth highlights the risks of unchecked technological advancement. By imagining alternate futures arising from today's practices, such narratives inspire proactive shaping of digital environments, promoting collective awareness and meaningful discourse that can drive positive change. They remind us that the technology we adopt shapes both personal lives and the societal fabric. In conclusion, speculative fiction like *The Circle* not only reflects our reality but also offers critical insights and warnings for the future, equipping us to champion a world where technology enhances, rather than diminishes, the human experience.

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SOUND SPONGES: A SPECULATIVE APPROACH TO TANGIBLE URBAN INTERACTION AND URBAN PROSTHETICS FOR PERSONS WITH HEARING IMPAIRMENT

Sasan Bahrami

"Sound Sponges" are conceived as an innovative urban intervention that uses ambient noise modification and acoustic materials to reduce noise pollution and create a more tranquil and inclusive urban soundscape. They are an example of how speculative design can be applied creatively in Tangible Urban Interaction (TUI) and "Urban Prosthetics" to improve inclusivity for people with hearing disabilities.

Tactile components in urban settings that interact with people—especially those with disabilities—operationalize TUI. In order to better serve the disabled community, this paper explores an expansion to the notion of TUI into the field of Urban Prosthetics, a term that was coined by Professor Nicole Koltick and describes assistive technologies that are smoothly incorporated into urban infrastructures as an alternative to physical implants.

Utilizing extensive open data from the Philadelphia Bureau of Transportation about noise pollution, we conducted an exploratory study that made use of GIS and 3D modeling to show how Sound Sponges might be included into the urban landscape. The goal of this study falls in line with the "design justice" movement, which opposes and works to undermine ableist urban designs. It represents our contribution toward an inclusive urban future in which cities themselves serve as prostheses, adjusting to the requirements of all residents. In this paper we present the key finding of our study.

Keywords: Speculative Design, Urban Built Environment, Sound Sponges, Tangible Urban Interactions, Urban Prosthetics

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Introduction

Urban environments house a significant number of people with disabilities, which makes it crucial to design cities that are accessible and inclusive. The World Health Organization notes that over 15% of the global population lives with some form of disability, with hearing impairments being particularly common. This statistic highlights the urgent need for urban designs that cater to a wide range of needs (Everett) Despite the prevalence of hearing loss, which affects more people than diabetes, it remains poorly addressed in many urban settings. This underscores the necessity for better auditory aids within our cities.

The issue of noise pollution in urban areas compounds these challenges, particularly in disadvantaged communities. Research shows that noise pollution is worst in poor and minority neighborhoods, leading to chronic stress and other health problems (Casey; Wagner; Box) Additionally, urban noise impacts ecological systems, changing the behavior of birds and other wildlife, which can indirectly affect human health. These findings highlight a critical gap in urban planning, where the importance of the acoustic environment is often overlooked.

The concepts of Tangible Urban Interaction (TUI) and Urban Prosthetics present promising ways to tackle these issues. TUI combines elements from Human-Computer Interaction and Urban Planning to create physical interactions within the urban environment that enhance the user experience (Mitrović et al.; Lopez) Urban Prosthetics, meanwhile, involve creating both tangible and intangible artifacts that assist people with disabilities, integrating seamlessly into the city's infrastructure to reduce barriers and improve accessibility (Cashman; Mitrović et al.; Koltick). These ideas advocate for a city that adapts to its residents, rather than expecting residents to adapt to the city.

Our research aims to explore how TUI and Urban Prosthetics can be used to reduce noise pollution and improve auditory accessibility in urban areas. By using extensive data from the Philadelphia Bureau of Transportation and advanced GIS and 3D modeling tools, we aim to develop strategies to make noisy urban environments more livable (Lopez; Mitrović et al.; Martucci). While Universal Design principles have made significant strides in improving accessibility, critics argue that they cannot solve all problems, highlighting the need for more specialized solutions for specific challenges (Pratiwi; Rob; Asdrubali et al.).

Literature Review

The urban soundscape has long been a focus of research and innovation, with efforts aimed at understanding and mitigating noise pollution in densely populated areas. The development of 3D sound maps, for instance, has been instrumental in helping neighborhoods "absorb" noise by visualizing and managing acoustic environments (GILLMAN; *Chatty Maps*; Poe 10; "10 Count RF Absorber 12in, Pyramidal"; Swiner). These tools are crucial in addressing the pervasive issue of urban noise pollution, which has been linked to various adverse health effects, including stress, cardiovascular diseases, and sleep disturbances (Wagner; Casey; Liu et al.; Galosustian) .

Research into sustainable materials for acoustic applications has explored various innovative solutions to enhance sound absorption and insulation in urban environments. For example, Asdrubali et al. (2012) reviewed materials like recycled rubber and plant fibers, highlighting their potential in reducing noise pollution while promoting environmental sustainability (Asdrubali et al.; "10 Count RF Absorber 12in, Pyramidal"; Ask Nature; Nelson et al.; *Outdoor Noise Cancellation – Acoustic Barrier Factory*). Similarly, vertical greening systems and nature-based solutions have been shown to provide acoustic insulation and noise reduction benefits, contributing to more peaceful urban settings (Ask Nature; O'Hogain and McCarton; Faivre et al.; Cabral et al.).

Understanding the human impact of noise pollution has also been a significant area of study. Research has demonstrated that noise pollution can alter animal behaviors, such as birdsong, which in turn affects human well-being and ecological balance (Box; Box; Andersen; Gallego-Albenza et al.; Galosustian). This

intersection of ecological and human health impacts underscores the need for comprehensive strategies to manage urban noise.

Tangible Urban Interaction (TUI) and Urban Prosthetics, concepts coined by Nicole Koltick (Koltick), have emerged as innovative approaches to address these challenges by integrating assistive technologies seamlessly into urban infrastructures. TUI combines principles from Human-Computer Interaction and Urban Planning to create interactive, responsive urban environments (Mitrović et al.; Dunne and Raby; Lopez; Martucci). Urban Prosthetics involve both tangible and intangible artifacts designed to assist individuals with disabilities, making urban spaces more accessible and inclusive (Koltick; Cashman; Mitrović et al.; Williamson; Rob) .

These approaches align with the broader goals of Universal Design, which aims to create environments that are inherently accessible to all people, regardless of age, disability, or other factors (Pratiwi; Imrie; Boys, *Disability, Space, Architecture*; Pullin; Boys, *Doing Disability Differently*). However, critics argue that Universal Design alone cannot resolve all accessibility issues, highlighting the need for more specialized and adaptive solutions (WHO; Tweed; Field and Jette; Tweed).

In addressing urban noise pollution specifically, research has pointed to the effectiveness of various acoustic materials and technologies. For example, acoustic barrier factories and outdoor sound-absorbing panels have been used to mitigate noise in public spaces (Outdoor Noise Cancellation – Acoustic Barrier Factory; Outdoor Sound Absorbing Panels – Acoustic Barrier Factory; Poly Acoustic Panels Absorb Sound And Are Waterproof And UV Resistant; Barrier; Sensory Trust – Inclusive Nature Experiences; Everett). Additionally, innovative projects like the Sound Pavilion have demonstrated how architectural design can incorporate sound-absorbing materials to create quieter urban environments (Pintos; Flanagan; Auger; Dunne and Raby; Martucci).

The integration of nature-based solutions into urban design has also shown promise in reducing noise pollution while enhancing urban biodiversity. These strategies include the use of green walls, urban forests, and water features to absorb and diffuse sound, creating more pleasant and sustainable urban environments (O'Hogain and McCarton; Faivre et al.; Liu et al.; Guan et al.; Xing et al.). The concept of the "sponge city," which uses natural and engineered solutions to manage water and noise, exemplifies this approach (Xu et al.; Guan et al.; McAlexander et al.; Nelson et al.; Faivre et al.; O'Hogain and McCarton).

In exploring the intersection of technology (Golshid Jaferian et al.; G. Jaferian et al.) and disability, the literature highlights the importance of designing inclusive and adaptive urban environments. For instance, research on sensory mapping has informed the design of spaces that are accessible to people with various sensory impairments (Tourtellotte; Cabral et al.; Auger; Boys, *Disability, Space, Architecture*; Koltick; Rob). These efforts contribute to the broader goal of creating cities that are not only accessible but also responsive to the needs of all residents.

In conclusion, the literature on urban noise pollution and inclusive design underscores the need for innovative, multidisciplinary approaches to creating more livable cities. By integrating principles from TUI, Urban Prosthetics, and Universal Design, and leveraging advanced materials and technologies, we can develop strategies to mitigate noise pollution and enhance the accessibility and inclusivity of urban environments. This research aims to contribute to this ongoing effort by exploring how these concepts can be applied to create quieter, more accessible cities that cater to the diverse needs of their inhabitants.

Perspective

The perspective of this work intrudes from the realm of speculative design, a field that originated with the intention of exploring imaginative and conceptual possibilities beyond conventional design paradigms. Speculative design allows for the creation of future scenarios that challenge existing norms and provoke thought about potential societal, technological, and environmental shifts (Dunne and Raby; Auger; Mitrović et al.). This approach provides a unique lens through which we can envision how Tangible Urban Interaction (TUI) and Urban Prosthetics might transform urban spaces to be more inclusive and responsive. By leveraging speculative design, this research not only addresses current issues of accessibility and noise pollution but also anticipates future challenges and opportunities in urban living (Mitrović et al.; Martucci). This speculative perspective encourages innovative thinking and the development of visionary solutions that

integrate seamlessly into the fabric of urban life, ensuring cities evolve to meet the needs of all inhabitants (Auger; Koltick).

Concepts

Tangible Urban Interaction

In this context, Tangible Urban Interaction has intruded from Human-Computer Interaction and Urban planning, and the concept coin by this author which refers to any physical interaction in the urban built environment with citizens, intertwined with the next concept “Urban Prosthetics”

Urban Prosthetics

This refers to any tangible and intangible artifacts installed in the urban built environments that help persons with disabilities to decrease the pain points for different types of auditory, sensory mobility, and other types of disability whether they are temporary or permanent disability. It is a type of Tangible Urban Interaction aimed at citizens with disabilities. Because we at Design Futures Lab believe that this is the city that is disabled and not the people, thus we install prosthetics in the cities rather than on bodies.

Methodology

This project was done in the Design Futures Lab run by Nicole Koltick at Drexel University, we have done 18 months of research to achieve these results (Bahrami; Bahrami and Koltick; Iscioglu and Bahrami; Attarhay Tehrani et al.), from conceptualization of different sciences and design perspectives in a multidisciplinary approach, we have started with an extensive precedent review and brainstorming session, which have taken most time of the research and utilize AI tools and digital collaborative platforms like Miro and Microsoft teams, then we made Documentation of ideation and project development and we had regular team communication and meeting, thus we are comfortable stating we made “Collaborative Mixed-Method Research Framework” with Speculative perspective to design justice.

Data and Findings

In this process first, we retrieved the noise data of Transportation sites in Philadelphia from the Bureau of Transportation for the year 2020, and the faces from the open data of the Philadelphia government and used GIS to stack them together (Fig. 1)

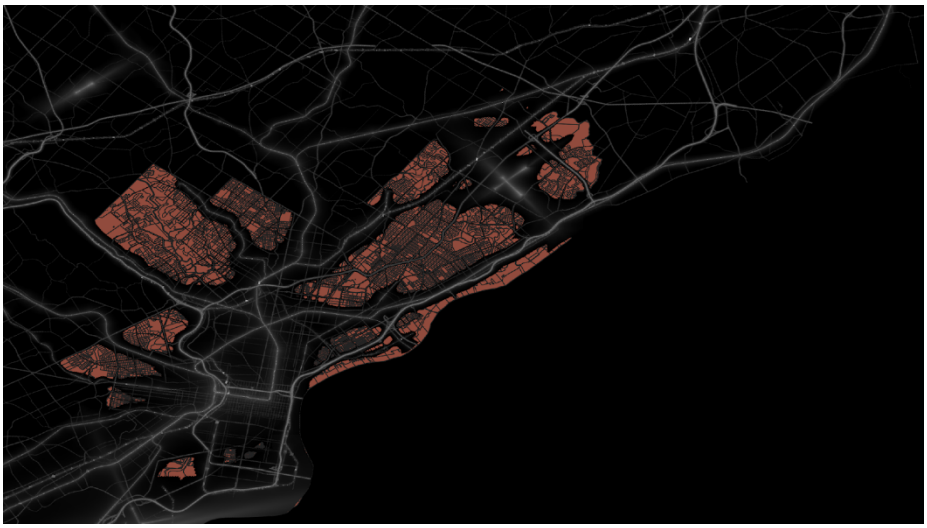

Fig 1. Noise map of Philadelphia regarding railroads, roads, and aviation

As is it obvious in Figure 1 there are densities related to these data so we have taken these and used computational urban design tools in Rhino and Grasshopper to see the level of the noise in Z axis

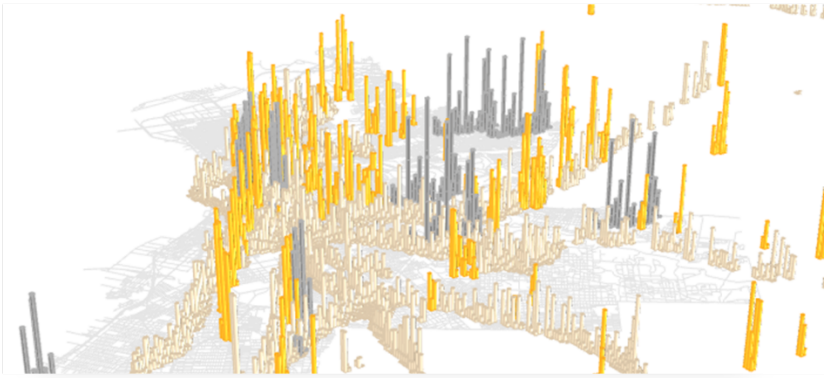

Figure 2. The axonometric view of the city with the noise level data from the Bureau of Transportation of Philadelphia for transportation noise

As you can see in different colors in Figure 2 there are various levels of noise but as we have observed these noises are mostly due to railroads, and since railroads are in movement all the time there are no stationary solutions for dampening the noise thus we have observed construction sites from open Philadelphia data.

Figure 3. Here is the simulated noise of the active construction sites of Philadelphia that are highly audibly polluted.

Sound Sponges

With the presented data we started to observe and conceptualize some of the possible future scenarios that might be probable for the future to decrease the noise, so we have designed an Urban Prosthetics that act as Tangible Urban Interaction to help people with hearing difficulty. Since they are designed to absorb the noises the reference to the Sponges Cities for flood we decided to name them Sound Sponges.we have speculate our design with the use of AI tools in hand like Dall-E to generate these models, the following models and concepts have been chosen from the the pull of designs (Cite Speculative Learning) with the design perspective that we had and having pool of the designs and nominate the step by step the best ones.

The Figure 4, 5 and 6 shows some of the concept for the people to have interaction with sound sponges in the cities with these tangibles.

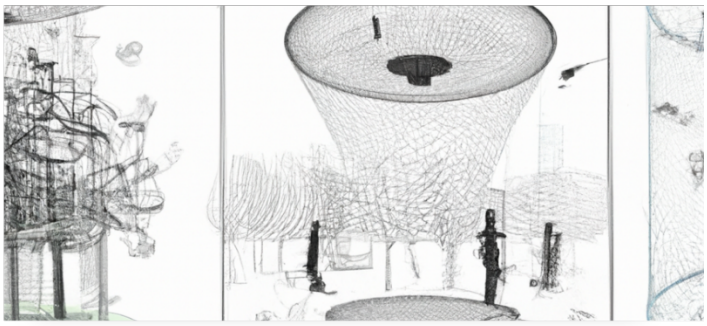

Figure 4. Sound Sponge concept

Figure 5. Sound Sponge concept

Figure 6. Sound Sponge concept

Figure 7 and Figure 8 shows how it might look like in the actual cities.

Figure 7. Sound Sponge concept in the cities

Figure 8. Sound Sponge concept in the cities that act with absorbing materials

Figure 9 and 10 are the concept we came up after studying some of the models of the sound escape that use white noise (CITE white noises) as noise cancellation strategy to dampen the noise which in these conpet the prosthetic comes with the honey comb design.

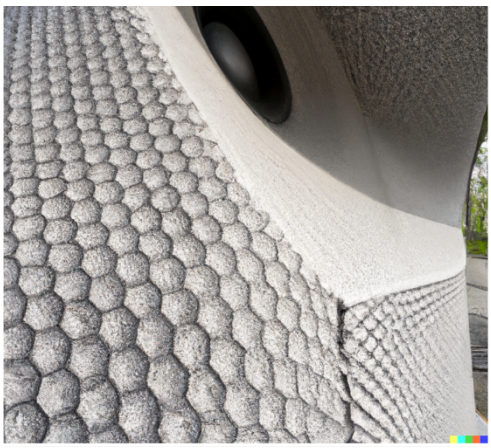

Figure 9. Sound Sponge concept that sends white noise to the city

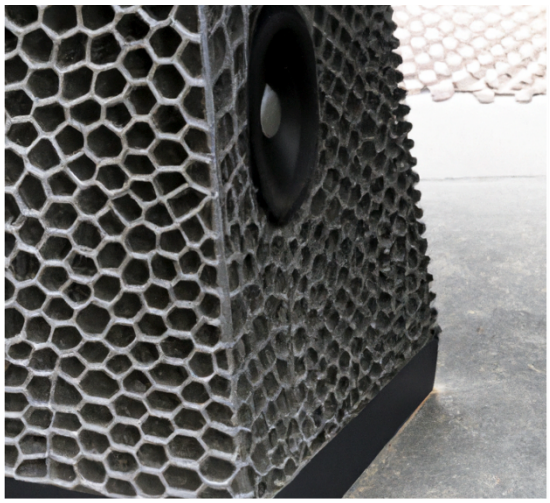

Figure 10. Sound Sponge concept that sends white noise to the city

In Figure 11 we have started to research about some of the Nature-Based Solutions (Cite Nature Based solutions) with materials that might decrease the noise and we have designed in AI some of the nature based solutions with honey comb concept for the prosthetics that people also can go inside of them.

Figure 11. Sound Sponge concept that comes with nature based materials with honey comb concept design

In Figure 12 we have used the silk materials and speculate our prosthetics in the urban built environment which is closer to our perspective

Figure 12. Sound Sponge concept that comes with nature based materials with honey silk design

And in Figure 13 we have used most of our natue based solution approach in urban built environment to form a prosthetics that closest to what we have in our speculation that is the nominee for our best speculation.

Figure 13. Sound Sponge concept that closest to what we speculate

Sound Sponges in the cities

Figure 14. Construction sites with high noise according to the Phialdelphia Government data, have been estimated in our lab

As you can see in the in the Figure 14. There are sites that have been designated, which are the construction sites, that we have seen to best put our sound sponges close to them, thus we put is benchmarks on the map.

As far as the design for the map we have sculpted some bubble form sponges in the ZBrush to put in the 3D maps in computational design tools.

Figure 15. Sound sponges close the sites

Figure 15 shows how the sound sponges and dampen noise in the cities look like as conceptual format.And in Figure 16 and Figure 17 you could see all the noises plus the sound sponges as a hero shot for this project both in color and Grayscale. The reason they are not all the same is that they driven by nature so they are having natural form.

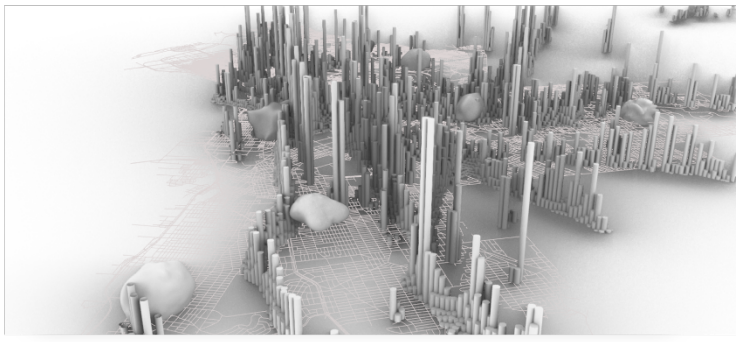

Figure 16. Sound sponges in the Grayscale within the city with all of the noise data (Hero Shot)

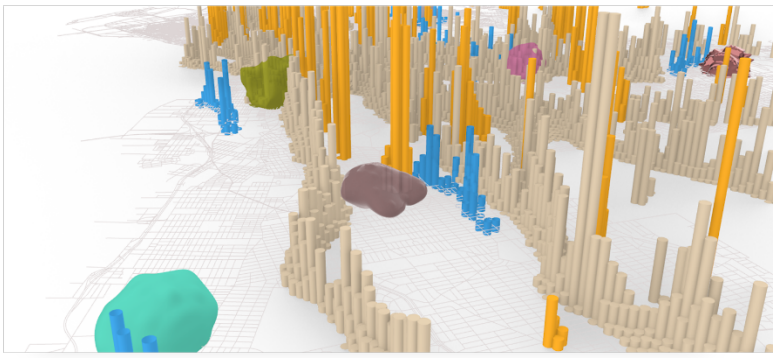

Figure 17. Sound Sponges in the City in colored different Speculative Sound Sponges format

Discussion

Our findings present significant improvements over existing research in tackling urban noise pollution and improving city accessibility through innovative applications of Tangible Urban Interaction (TUI) and Urban Prosthetics. One of the key benefits is the integration of speculative design into practical urban solutions, which allows for the creation of forward-thinking, adaptable urban environments. This approach not only addresses current issues but also anticipates future needs, creating a more resilient and inclusive urban framework (Dunne and Raby; Mitrović et al.).

While past studies have shown the effectiveness of 3D sound maps and nature-based solutions in reducing urban noise, our research goes further by combining these methods with advanced GIS and 3D modeling tools. This comprehensive approach enables a more detailed analysis of noise pollution and its impact on urban environments, leading to more precise and effective interventions (GILLMAN; *Chatty Maps*; Liu et al.; Guan et al.). By using open data from the Philadelphia Bureau of Transportation, we have provided a strong, data-driven foundation for our designs, ensuring that our solutions are grounded in real-world conditions.

A major advantage of our findings is the focus on inclusivity and accessibility, particularly for individuals with hearing disabilities. While existing literature has explored various acoustic materials and technologies for noise reduction, our research specifically addresses the needs of disabled individuals through the concept of Urban Prosthetics, coined by Nicole Koltick. These prosthetics seamlessly integrate into urban infrastructures, offering both tangible and intangible support to those with disabilities, which goes beyond the general scope of Universal Design (Koltick; McRuer; “Crip Theory”; Williamson; Rob; Imrie).

Our approach also aligns with the design justice movement, which aims to dismantle ableist urban designs and promote equity in urban planning. By prioritizing the needs of the disabled community and utilizing a multidisciplinary research framework, our study offers a model for inclusive urban development that can be replicated in other cities facing similar challenges. This emphasis on social justice and equity distinguishes our research from traditional noise mitigation strategies, which often overlook the specific needs of marginalized groups (Martucci; Rob; Pratiwi).

Finally, our use of speculative design to envision future scenarios and develop innovative solutions such as Sound Sponges provides a novel contribution to the field. This imaginative approach allows us to explore new possibilities and create urban environments that are not only functional but also adaptive and responsive to changing needs. By leveraging speculative design, we push the boundaries of traditional urban planning and develop visionary solutions prepared for future challenges (Mitrović et al.; Koltick). This forward-thinking perspective ensures that our findings remain relevant and impactful in the long term.

Conclusion

Our research makes important strides in addressing urban noise pollution and improving accessibility through innovative applications of Tangible Urban Interaction (TUI) and Urban Prosthetics. By combining speculative design with advanced GIS and 3D modeling tools, we've developed forward-thinking strategies that not only tackle current challenges but also anticipate future urban needs. Our focus on inclusivity, especially for individuals with hearing disabilities, aligns with the design justice movement and offers a blueprint for equitable urban development.

However, our study does have its limitations. While we've successfully conceptualized the idea of Sound Sponges and other interventions, these remain speculative at this stage. Moving from conceptual design to practical implementation will require further testing of materials and technologies in real-world settings. Extensive field trials and evaluations are necessary to determine the effectiveness and feasibility of these solutions in actual urban environments. More time and resources will be needed to refine these designs and ensure they work effectively in practice.

In conclusion, while our speculative approach has laid a solid foundation and offered an innovative vision for future urban development, the next steps involve thorough testing and adaptation of these concepts to real-world conditions. By continuing this research, we aim to bridge the gap between imaginative design and practical solutions, ultimately creating quieter, more inclusive, and adaptive urban environments.

Our research offers important strides in addressing urban noise pollution and improving accessibility through innovative applications of Tangible Urban Interaction (TUI) and Urban Prosthetics. By combining speculative design with advanced GIS and 3D modeling tools, we have developed strategies that not only tackle current challenges but also anticipate future urban needs. A key focus has been inclusivity, particularly for individuals with hearing disabilities, aligning our work with the broader goals of design justice and providing a blueprint for more equitable urban development.

At this stage, the study remains largely conceptual, and moving from speculative design to practical application will require further real-world testing. It will be essential to evaluate the materials and technologies in live urban settings to ensure they work effectively and address the issues we've targeted. This will involve continued research, material testing, and collaboration across disciplines.

As we look to the future, technological advancements offer promising opportunities to further enhance these designs. With developments in AI, smart sensors, and self-adapting materials, the potential for Sound Sponges to respond dynamically to changing noise levels becomes increasingly feasible. The integration of such technologies into the fabric of smart cities could enable real-time noise mitigation, tailored specifically to the needs of various urban populations.

However, these innovations come with ethical considerations. The very technologies that could enhance urban environments also raise questions about privacy and surveillance. For example, as urban prosthetics like Sound Sponges become more intelligent, there is a risk that they could be used for monitoring purposes, potentially infringing on individuals' privacy. Ensuring strong data governance and community involvement in how these technologies are deployed will be critical in addressing these concerns and avoiding the reinforcement of existing inequalities.

Another consideration is the risk of over-reliance on technology. As we move towards more automated and AI-driven urban solutions, it's important not to neglect the value of traditional methods for managing urban issues such as noise pollution. Strategies like zoning regulations, green spaces, and public health measures must remain integral to urban planning, providing balance and ensuring resilience against potential system failures or cybersecurity threats.

The future of this research is inherently interdisciplinary. Exploring the intersections of urban design, assistive technologies, and human-computer interaction could lead to innovative approaches that create more responsive and accessible cities. Collaboration across these fields will be essential in pushing the boundaries

of what urban prosthetics like Sound Sponges can achieve, ensuring that they serve the needs of diverse urban communities.

In addition, the environmental impact of these solutions must be a central concern as we refine the design of Sound Sponges. By incorporating nature-based materials and sustainable practices into the development process, we not only mitigate noise pollution but also contribute to wider urban greening efforts that improve biodiversity, air quality, and overall urban resilience.

In conclusion, while our speculative approach has laid the groundwork for rethinking urban environments, much work remains to bring these ideas into practice. As we continue refining these designs and considering their real-world applications, we move closer to creating quieter, more inclusive cities that can adapt to the diverse needs of their residents, now and in the future.

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EVERYDAY HEROES

EMPOWERING LIFELONG LEARNERS THROUGH SERASUM'S GAME-BASED ADVENTURE

Stephanie Wössner

Lifelong learning is essential in preparing future generations to actively shape our future. This paper explores how the game-based learning adventure SERASUM can empower young people, particularly late Gen Z and Gen Alpha, to become everyday heroes and lifelong learners. The paper addresses the urgent need for change in global education systems, highlighting challenges such as teacher shortages, increased pressure on students, and declining mental health. Amidst an omnicrisis there is a need for holistic educational solutions. This era of human digitality requires a shift from a finite mindset focused on short-term gains to an infinite mindset aimed at continuous improvement and collective well-being.

Game-based learning offers a promising solution, fostering future skills through engaging and immersive experiences. Aligning with the OECD Learning 2030 framework, it emphasizes the development of competencies such as autonomy, competence, and relatedness. SERASUM, developed with the open-source game engine Minetest, aims to develop agency in young people regarding the Sustainable Development Goals (SDGs). Through six missions, participants engage in a narrative that promotes sustainable development and future-oriented skills. Initial implementations have demonstrated the potential of SERASUM to enhance intrinsic motivation, problem-solving, and critical thinking. SERASUM represents a transformative educational approach, empowering young individuals to become active co-creators of the future by fostering a growth mindset and resilience through game-based learning.

Keywords: lifelong learning, game-based learning, human digitality, future-oriented learning, sustainable development

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Introduction

Education systems across the globe are facing unprecedented challenges. From teacher shortages and increased pressure on young people to declining mental health and systemic inequalities, the need for change is undeniable. These issues have been exacerbated, among others, by the COVID-19 pandemic, highlighting the inefficiencies of a system rooted in outdated models of the Industrial Age. Traditional educational practices, focused primarily on knowledge acquisition and standardized testing, are no longer sufficient to equip young people with the skills they need to thrive in an increasingly complex and uncertain world.

This paper introduces SERASUM: For a Better Tomorrow, a game-based learning adventure designed to address these challenges by empowering young people to develop future-oriented skills and become agents of positive change. SERASUM aligns with the principles of self-determination theory and the OECD Learning 2030 framework, offering a transformative educational approach that fosters autonomy, competence, and relatedness in learners. Using the open-source game engine Minetest, SERASUM immerses participants in an interactive, narrative-driven adventure that emphasizes sustainable development and critical thinking. It offers a glimpse into how game-based learning can cultivate lifelong learning, resilience, and the ability to actively shape the future.

The purpose of this paper is to explore how SERASUM, as an example of game-based learning, can be a powerful tool in addressing the most pressing issues in education today. By fostering engagement and intrinsic motivation, game-based learning provides an innovative, immersive learning experience that can transform traditional education practices. Specifically, the paper will examine the systemic challenges facing education, the theoretical frameworks supporting game-based learning, and how SERASUM's missions directly address the development of crucial future skills such as critical thinking, creativity, and problem-solving.

In presenting these findings, the paper will demonstrate how SERASUM's pilot implementations have shown promise in enhancing learner engagement and promoting a growth mindset. The insights gained from this research are a testament to the potential of game-based learning to be a transformative force in education, offering a dynamic, learner-centered approach to preparing young people for the complexities of tomorrow’s world.

Why do we need change?

Challenges in the Current Education System

Education systems worldwide face significant challenges. In Germany, studies over the past 15 years have highlighted systemic issues and declining performance (Eickelmann et al., 2013, Eickelmann et al., 2019), exacerbated by the COVID-19 pandemic and the influx of young refugees due to the war in Ukraine. Challenges include a shortage of teachers (Ständige Wissenschaftliche Kommission der Kultusministerkonferenz, 2023), increased pressure on students (Deutscher Philologenverband, 2023), and a worrying decline in the mental health of both students and educators (Kuhn, 2023; Robert Bosch Stiftung, 2022).

The education system is still heavily rooted in the Industrial Age, focusing primarily on knowledge acquisition that can be tested in standardized exams. This approach often neglects the development of competencies crucial for navigating an uncertain future, such as critical thinking, creativity, and problem-solving skills (Fullan & Scott, 2014). Despite calls for competency-oriented education, practical implementation remains limited (UQx LEARNx Team of Contributors, 2019).

One significant issue is the shortage of people willing to become teachers. Factors contributing to this shortage include high workload, and lack of support, which lead to burnout and dissatisfaction among current educators. Moreover, many children and teenagers are experiencing mental health challenges, are unhappy, and afraid of school. The pandemic has further highlighted these issues, with increased anxiety and stress among students and teachers alike (Kuhn, 2023; Robert Bosch Stiftung, 2022).

Instead of addressing these problems constructively, particularly those that highlight a decline in performance compared to other nations, the response has often been to increase pressure on both students and teachers in order to increase performance, leading to further burnout and resignation. For instance, the call for performance-oriented primary education by a teacher union in Germany reflects a misguided approach that prioritizes academic achievement over well-being (Deutscher Philologenverband, 2023).

Technology is not the answer

Despite various attempts to integrate technology into education, the anticipated improvements in learning outcomes and teacher workloads have not materialized. Many believe that technology alone can solve educational issues (Köchling & Kaiser, 2021), but this has proven to be overly simplistic. For example, Scandinavian countries have begun to scale back their digitalization efforts, recognizing that technology cannot replace the inherently human aspects of learning (Blenker, 2024; Heescher, 2024).

Studies have shown that technology does not inherently improve learning outcomes and can sometimes exacerbate existing issues when not implemented thoughtfully (Döbeli, 2024). There is a need for a balanced approach that integrates technology in a way that supports personalized and self-determined learning rather than treating it as a panacea.

Out with the old and in with the new

The social structure of the Industrial Age still underpins our current education system, emphasizing the acquisition of knowledge that can be tested in standardized exams. This model prioritizes academic excellence, a relic from the Enlightenment era, over the development of essential competencies for today's rapidly changing world (Robinson & RSA, 2010) and the exponential future in front of us. Despite various reforms, including competency-based curricula in Germany, the practical application of these competencies remains limited. The emphasis continues to be on surface learning rather than deep learning, as noted by educational experts like John Hattie (UQx LEARNx Team of Contributors, 2019).

Over the past decade, numerous experts and studies have called for significant changes in the education system. For instance, the German Federal Ministry of Education and Research's expert commission highlighted the need for education systems to prioritize personal development, media literacy, and societal participation to prevent a digital divide as early as 2010 (Bundesministerium für Bildung und Forschung, 2010, p. 5). However, despite such recommendations, progress has been slow, with traditional educational practices largely persisting.

However, preparing young people for the future and their future role in shaping it requires giving them an environment that fosters the development of future skills such as resilience, empathy, improvisation, and intuition (Cascio, 2022). These skills are critical for navigating the uncertainties and complexities of the modern world, characterized by volatility, uncertainty, complexity, and ambiguity (VUCA) and impacting personal perceptions of the world being brittle, anxiety-inducing, non-linear, and incomprehensible (BANI) (Theil, 2021). In order to make people feel safe again, educational systems must evolve to foster future skills, enabling learners to take responsibility for their learning and actively shape the future. This requires focusing,

first of all, on questions of personal development (IDG Initiative, 2020) and personalized learning (Bray. 2017).

The Omnicrisis and Human Digitality

We are currently experiencing an omnicrisis—a situation where multiple crises occur simultaneously across various domains, requiring comprehensive and multifaceted responses. These crises include economic inflation, generational conflicts, wars, pandemics, and a general erosion of trust. This period of transition is reminiscent of the shift from the Agricultural Age to the Industrial Age, indicating the need for a new era

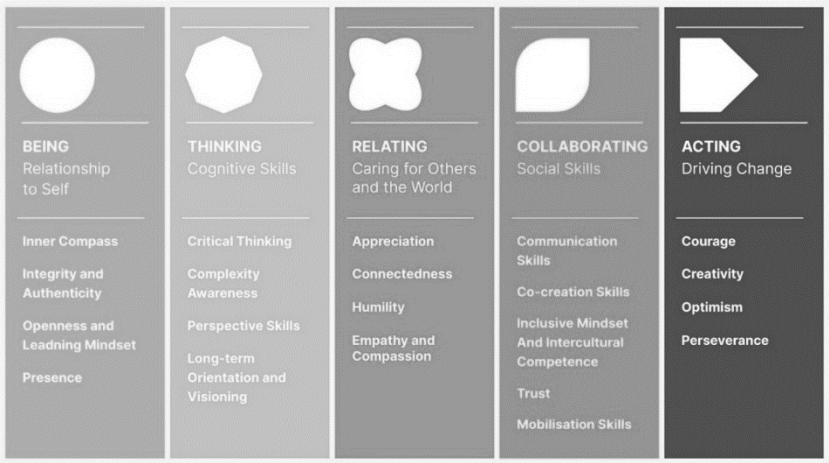

Figure 1: The Inner Development Goals (Source: IDG Initiative, 2020)

defined by a collective vision for the future (Horx et al., 2024).

The omnicrisis has profound implications for education and society. The interconnected nature of these crises means that solutions must be holistic and consider the broader context in which educational systems operate. For instance, the climate crisis and economic instability require a populace that is not only well-informed but also capable of critical thinking and problem-solving. Generational conflicts and the erosion of trust in institutions highlight the need for education systems that promote empathy, collaboration, and civic engagement. Schools must offer learners an environment to learn how to navigate and address these complex issues, fostering a sense of agency and responsibility for the future.

We are at the threshold of a new era, termed human digitality (Schuldt, 2024), where technology enhances our humanity, among others in the context of learning (Wössner, 2024a). This future necessitates a shift from the current finite mindset focused on short-term gains to an infinite mindset aimed at continuous improvement and collective well-being. Education systems play a fundamental role in this transition, emphasizing competencies such as resilience, adaptability, and futures thinking (Fidler & Williams, 2016; Ehlers, 2022). Simon Sinek's concept of finite and infinite games illustrates this paradigm well. While finite games focus on winning, infinite games aim at continued participation and collective success (Sinek, 2019). Education systems must embrace this infinite mindset, fostering environments where learning is seen as an ongoing, collaborative journey rather than a series of competitive milestones. By doing so, they become the foundation of the Age of Human Digitality.

How Game-Based Learning can forge heroes for the future

Game-based learning (GBL) offers a promising approach to address these educational challenges. By leveraging the engaging and interactive nature of games, GBL can foster the development of future skills and provide learners with meaningful and immersive learning experiences (Gee, 2007a).

GBL aligns with the principles of self-determination theory, which emphasizes the importance of autonomy, competence, and relatedness in fostering motivation and well-being (Deci & Ryan, 2008). Games provide a unique environment where learners can exercise these needs, leading to increased engagement and intrinsic motivation (McGonigal, 2011; Eyal, 2014).

The Hook Model, developed by Nir Eyal (2014), provides a framework for creating engaging and habit-forming experiences through a cycle of trigger, action, reward, and investment. In the context of game-based learning, this model explains how games capture and maintain players' motivation. When players are presented with, for instance, a compelling narrative or have a friend tell them about a new game (trigger), they are driven to overcome obstacles they have chosen themselves (action). Good games incorporate elements that encourage players to learn from their mistakes and receive meaningful rewards, fostering intrinsic motivation. Over time, as players continue to engage with increasingly complex tasks, they enter a flow state, characterized by deep focus and enjoyment, driven by the anticipation of rewards and a sense of accomplishment. This approach contrasts with traditional education, where mistakes are often penalized, making game-based learning a powerful tool for fostering resilience and continuous improvement.

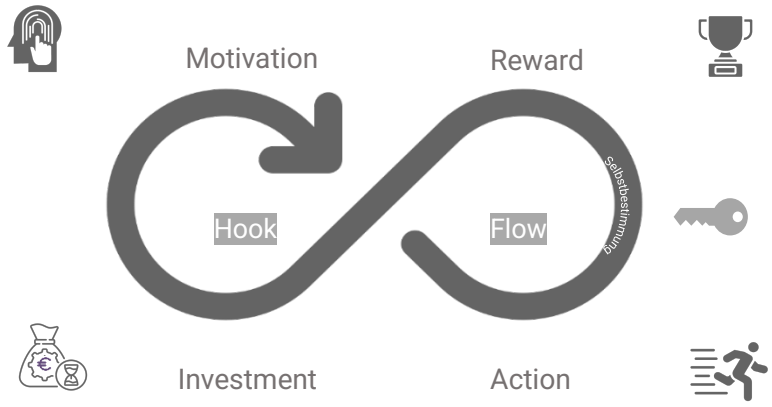

Figure 2: The Hook Model (CC BY-NC-SA 4.0 | Icons: Noun Project)

Aligning with the OECD Learning 2030 Framework and future-oriented learning

The OECD Learning 2030 framework emphasizes the development of competencies that empower individuals to take responsibility for their personal but also our societal, local and global futures. It highlights the importance of knowledge, skills, attitudes, and values developed in a (not necessarily physical) learning environment, enabling learners to be proactive and capable of shaping these futures (OECD, 2018).

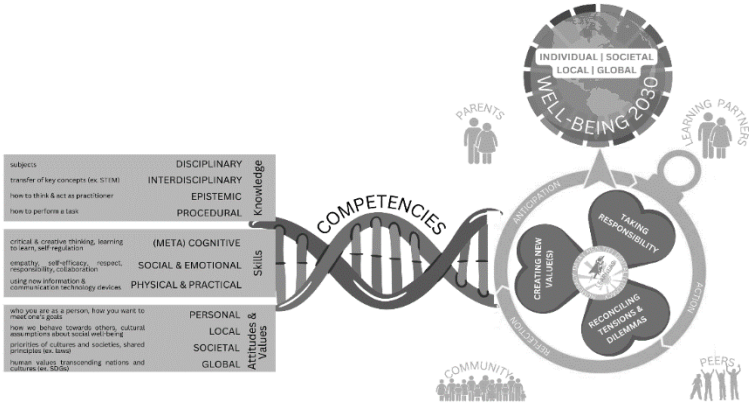

Figure 3: OECD Learning 2030 Framework (Source: OECD, 2018, p. 4 | adapted by author

The framework contains the so-called sun model of co-agency (OECD, 2019). This model highlights the importance of the agency of young people with the ultimate goal being that young people initiate actions and take shared decisions with adults.

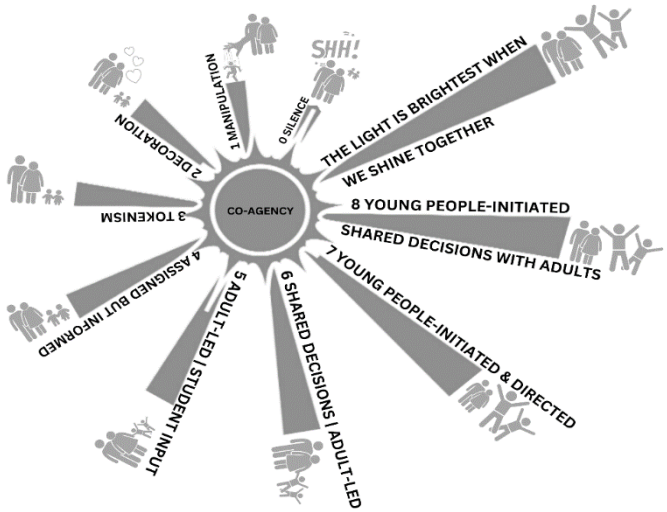

Figure 4: Sun-Model of Co-Agency (Source: OECD, 2019, p. 11 | adapted by author)

This idea is the essence of future-oriented learning, which goes beyond the traditional scope of education by focusing on providing learners with an environment where they can develop the skills and mindset necessary to navigate and shape a rapidly changing world. Bolstad et al. (2012) argue that future-oriented learning should integrate personalized[1] learning, a new understanding of equity, diversity, and inclusion, a focus on competencies, and a redefined role of learners and educators. This approach encourages lifelong learning and collaboration between schools and their communities, moving away from a technology-centric view to one that emphasizes the goal of shaping the future in an active and responsible way.

Principles of Effective Game-Based Learning

James Paul Gee (2007a, 2007b) identifies principles of effective learning through games, emphasizing the similarity between learning and video game design. These principles include active engagement, problem-solving, and the development of expertise through cycles of practice. Gee argues that games can promote self-determination, self-efficacy, and the development of complex problem-solving skills, making them valuable tools for education.

Table 1: Learning principles by James Paul Gee (Gee, 2007b, pp. 23)

Empowering learners	Learning
• co-design	• learners need to feel like active agents
• customize	• learners learn differently
• identity	• learners need to be committed
• manipulation & distrib-uted knowledge	• learners feel like they have agency; immersion & interaction > feeling of presence
Problem-solving	**Learning**
• well-ordered problems	• learners need scaffolding and apply what they have learned
• pleasantly frustrating	• learners need challenges they want and are able to overcome; they must neither be bored nor over-whelmed
• cycles of expertise	• learners need time to practice in order to be able to integrate previously acquired knowledge/skills with new knowledge/skills
• information “on de-mand” and “just in time”	• learners need access to certain information when they can use it or feel like they need it to solve a problem
• fish tanks	• learners need to start with simplified system that become more and more complex

[1] For a definition of personalized learning, refer to Kuldeep (2021)

• sandboxes	• learners need to be allowed to fail and feel safe taking risks
• skills as strategies	• learners need to apply their skills and knowledge to accomplish a certain goal
Understanding	**Learning**
• system thinking	• learners need to see the big picture and understand how what they do is meaningful
• meaning as action image	• learners need experiences they can link to their learning

Jane McGonigal (2011) highlights four key features of good games: goals that give players a sense of purpose, rules that unleash creativity, a feedback system that motivates continued play, and voluntary participation.

Thus, both Gee's and McGonigal's approaches align with the principles of self-determination theory, which emphasizes the importance of autonomy, competence, and relatedness in fostering motivation and well-being (Deci & Ryan, 2008). In the context of education, supporting these needs can enhance students' intrinsic motivation and overall well-being, making learning more effective and enjoyable.

Futures Thinking

Futures Thinking involves structured thinking about possible, probable, and desirable futures, allowing individuals to prepare for and influence future scenarios. It promotes an open mindset, the ability to adopt various perspectives, and the willingness to embrace uncertainty and complexity (Prosser & Basra, 2021). Futures Thinking is essential for developing future skills and competencies, enabling learners to become active shapers of our future. It also highlights the importance of storytelling since moving into the Age of Human Digitality, humanity needs to come up with a new narrative that connects us all.

SERASUM: For a Better Tomorrow – a concrete example of transforming education through game-based learning

SERASUM: For a Better Tomorrow[2] is a global simulation developed with the open-source game engine Minetest. It aims to develop agency in young people in a multinational context and with regard to the Sustainable Development Goals (SDGs). It also offers an environment where learners can develop future thinking skills.

The primary objective of SERASUM is to provide a future-oriented game-based learning adventure that empowers participants to become agents of sustainability. The adventure is designed to foster self-determination, self-efficacy, and future skills, as well as communication skills in a foreign language through immersive and engaging gameplay.

Structure of the Adventure

SERASUM consists of six major missions, each designed to immerse participants in a narrative that promotes sustainable development and future skills. The missions are structured to provide well-ordered problems, just-in-time information, and opportunities for participants to apply their knowledge in meaningful ways.

- Mission 0: Participants create new identities and immerse themselves in the story.
- Mission 1: Introduction to the training world through a break-in game that activates their knowledge of sustainable development.
- Mission 2: Making their European village more sustainable.

[2] The SERASUM: For a Better Tomorrow simulation was developed as part of the Erasmus+ project EXCALIBUR, co-funded by the European Union.

- Mission 3: Creating a new community for the future.
- Mission 4: Repurposing the European village.
- Mission X: Wrapping up the story and connecting the adventure to their own lives and the physical world.

Figure 5 The adventure

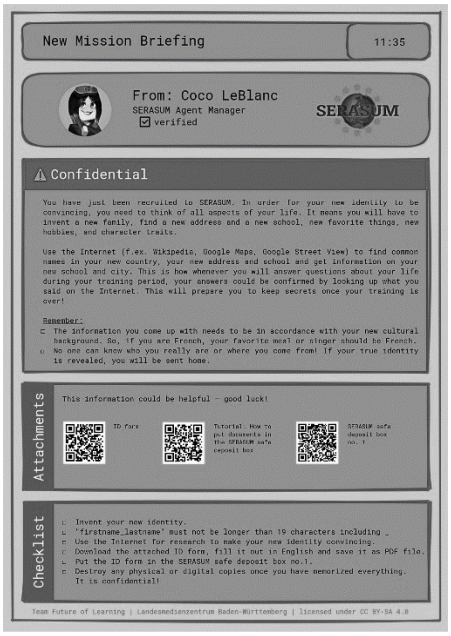

Figure 6 Example of a Mission File

Role of Learning Facilitators, evaluation by design and outcomes

Learning facilitators in SERASUM act as officers and moderators, enhancing co-agency and providing necessary guidance. They may also impersonate the game master AI to nudge, correct, or sanction participants, ensuring a balanced and supportive learning environment.

The evaluation of SERASUM is integrated into the narrative through reports that track the development of language skills, future skills, and approaches to sustainable development. These reports use Merge Cubes, renamed data cubes, which offer mixed reality interactions, blending physical and virtual learning experiences[3].

Figure 7 Merge Cube and Data Cube of Agent Jacqueline Moreau

[3] To look at the data cube, please download a paper Merge Cube (www.mergecube.com/paper), assemble it, download the CoSpaces Edu app from your app store, and either scan the QR code with it or enter the share code HTH-YRF.

Implementation and Results

SERASUM was initially implemented with teenagers from Finland, Germany, and France using mainly German and English as foreign languages. This first pilot served as a pilot to refine the adventure. A second pilot involved groups from Germany and Dubai, focusing on the use of French as a foreign language. These pilots provided valuable insights and allowed for final adjustments to the project.

The findings from the evaluation of SERASUM align with the principles of effective game-based learning and the OECD Learning 2030 framework. By promoting autonomy, competence, and relatedness, SERASUM supports the development of future skills and future-oriented competencies. The immersive and engaging nature of the simulation fosters intrinsic motivation and provides learners with valuable opportunities to practice problem-solving and critical thinking in a safe and supportive environment.

For detailed quantitative and qualitative findings, please refer to the accompanying Master's thesis (Wössner, 2024).

Conclusion

SERASUM represents a transformative approach to education, empowering young people to become active co-creators of the future. By fostering a growth mindset and resilience through game-based learning, the global simulation provides an environment in which they can develop skills needed to navigate and thrive in a rapidly changing world. This paper highlights the potential of such innovative educational strategies to inspire and develop lifelong learners capable of shaping a better future for all.

The empirical findings from the implementation of SERASUM align with the principles of effective game-based learning and the OECD Learning 2030 framework. By promoting autonomy, competence, and relatedness, SERASUM supports the development of essential skills and competencies. The immersive and engaging nature of the simulation fosters intrinsic motivation and provides learners with valuable opportunities to practice problem-solving and critical thinking in a safe and supportive environment. These outcomes suggest that game-based learning, when thoughtfully designed and implemented, can be a powerful tool in addressing some of the most pressing challenges facing our education systems today.

Moreover, SERASUM exemplifies the need for a shift from traditional educational practices rooted in the Industrial Age to more dynamic and flexible approaches that align with the demands of the transition to the Era of Human Digitality. This includes moving away from a focus on standardized testing and surface learning to fostering creativity, critical thinking, and the ability to navigate complex, interconnected global challenges. The project demonstrates the importance of incorporating principles of self-determination theory into educational design, ensuring that learning environments support autonomy, competence, and relatedness.

The journey from initial implementation to the refined second pilot in diverse cultural contexts, such as Germany and Dubai, and using various foreign languages, such as French and English, underscores the versatility and adaptability of the SERASUM global simulation. These pilots provided valuable insights into how game-based learning can be tailored to meet the specific needs and contexts of different learner groups, further enhancing its effectiveness and impact.

As we stand at the threshold of a new era of human digitality, it is imperative that our education systems evolve to support continuous improvement and collective well-being. This involves not only integrating technology in a balanced and thoughtful manner but also reimagining the roles of learners and educators. By embracing the infinite game mindset, where learning is seen as an ongoing, collaborative journey, we can create educational environments that are more inclusive, engaging, and effective in preparing learners for the complexities of the future.

In a nutshell, SERASUM is more than just a game-based learning adventure; it is a blueprint for the future of learning. It showcases how innovative educational strategies can empower learners to take an active role in their own development and in shaping the world around them. The success of SERASUM serves as a testament to the potential of game-based learning to transform education, making it more relevant, engaging, and effective in providing learners with an environment in which they can develop the skills they need to not

only participate in the present society but also shape the society of the future. By continuing to explore and expand upon these approaches, we can ensure that our education systems are not only responsive to current challenges but are also proactive in preparing for the future.

About the Author

STEPHANIE WÖSSNER is a freelance consultant and speaker for future-oriented learning. Her main areas of expertise are extended reality, game-based learning, artificial intelligence, design and futures thinking, as well as the Metaverse. Stephanie has worked as a foreign language teacher for English and French for more than ten years and is currently working full-time for the Landesmedienzentrum Baden-Württemberg as head of the Future of Learning Unit. She also has extensive experience in teacher training and earned a B.A. in Japanese and American Studies in 2007, as well as a Master of Arts in Game Studies and a Master of Science in Game-based Media and Education from the University for Continuing Education Krems.

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A NEW CHARTER ON THE PRESERVATION OF DIGITAL GAME HERITAGE

Tony A. Rowe

Digital games are a culturally significant part of modern life but much of digital game history is at risk of disappearing on outdated, disintegrating media formats. Specialist media conservation groups that work to preserve these heritage materials find their efforts stymied by restrictive copyright laws, corporate interests, and other roadblocks. Such groups share a common preservation goal, but often differ in methodologies, priorities, and desired outcomes for media artifacts.

A common charter of principles would help preservation groups across the globe improve communication, avoid duplicating work, and support scholarly rigor. This proposed charter adapts the structure established by UNESCO (United Nations Educational, Scientific, and Cultural Organization) for preserving heritage materials with added details of the specific needs of digital game preservation, scholarship, and education as used in practice by specialist groups worldwide. It is meant to spark discussion, inspire the formation of a community of practice for further development, and act as a set of guidelines for new preservation efforts.

This charter organizes principles for preservation into eight articles and recognizes digital game heritage as a common cultural heritage of human knowledge and expression.

Keywords: cultural heritage, digital games, game preservation, game history, media history

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Introduction

In our always-connected, modern world, digital media is a constant in our lives and an important tool for recording, creating, and sharing our cultural heritage. Digital games[1] have risen to prominence as an important element of our culture, with an impact that is comparable to film and television. Much of our digital game media history is now at risk of disappearing, just like early film and television history. The Library of Congress estimates that 75% of all silent films (Pierce, 2013) and a vast number of original television broadcasts (Murphy, 1997) are now irretrievably lost. A small but growing number of specialist digital game media preservation groups are working to preserve digital game heritage material before it is too late. These groups share a common goal, but do not always hold a consensus on methodologies, priorities, and desired outcomes for conservation. Uniting around a common charter of principles can help these groups improve communication, avoid duplicating work, improve their scholarly rigor, and serve as a set of guidelines for new preservation efforts. This draft charter is intended as a starting point to spark discussion and inspire the formation of a community of practice around digital game heritage preservation.

Threats to Digital Game Media

Many examples of the digital game heritage exist on floppy disks, CD-ROMs, magnetic tape, hard drives, and other "endangered media formats" (Merkle, Novakovic, Borman, Gray, & Dunn, 2022). These information carriers are degrading with time and the data stored on them are at a serious risk of loss. The best way to preserve this digital game media content is to migrate the data to more stable formats, but hardware and software obsolescence make it difficult to interface with older media formats using modern technologies. These objects are part of our global digital heritage, and it is important to preserve the information recorded on and the information about these objects before the artifactual media objects degrade.

Also at issue are server-dependent games (Slogar, 2024) with online play components (Hurezeanu & Hurezeanu, 2024), such as massively multiplayer online role-playing games (MMORPGs). These games often have no consumer-facing physical artifacts to preserve, where the game data exists solely on remote servers controlled by the game publisher. The average lifespan for such a game is only about 18 months before the publishers turn their servers off, making the game unplayable (Scott, 2015). The Library of Congress supported a study of server-dependent games and the researchers noted that seventeen of these virtual worlds "died" during the course of their grant (McDonough et al., 2010).

The situation is urgent. A recent study found that only about 13% of any digital games ever published in the United States are available in today's market (Salvador, 2023). Closures of digital distribution platforms, like the 3DS and Wii U eShops Nintendo closed in 2023, are likened to "mass extinction events" (Salvador, 2023) that can cut off public access to hundreds or thousands of titles. When games are exclusive to a single distribution platform, there is no way to legally acquire those titles after the platform closes.

One ongoing obstruction for preservation efforts in the USA is the Digital Millennium Copyright Act (DMCA). This act includes "anti-circumvention" provisions that make it illegal to circumvent software copy protection schemes to move data from one form to another without the rights holder's express permission (United States Congress House Committee on the Judiciary, 1998). Extracting data from a legally purchased floppy disk without permission, even for scholarly purposes, can put one at risk of breaking the law. The community of institutional preservationists and researchers have been "frustrated and deeply concerned" at these restrictions, describing the process of acquiring permission from rights holders as a "nightmare" (Aufderheide, Butler, Cox, & Jaszi, 2018). As written, the DMCA threatened to leave digital games trapped in their shells of deteriorating media and doomed server-dependent game worlds to disappear forever.

The Current State of Digital Game Preservation

The Internet Archive was among the first preservationist groups to challenge the DMCA. In 2006, the non-profit group petitioned the government, and an exemption was enacted for hosting "programs and video games distributed in formats that have become obsolete and which require the original media or hardware," for educational purposes (Kaplan, 2006). This allowed researchers at accredited institutions some rights to

[1] A digital game, commonly referred to as a video game, is here broadly defined as an interactive, electronic game played by one or more humans, executed by a computer, and displayed on a screen. This includes but is not limited to the categories of console, mobile, computer, and arcade games.

circumvent copy protection schemes and extract data from endangered media formats. This also allowed for the creation of the Internet Arcade (https://archive.org/details/internetarcade), a streaming library of game software that can be emulated and played in a user's browser.

In 2015, the Museum of Art and Digital Entertainment (MADE) also challenged the DMCA and an exception was granted for abandoned games that require contact with an external server to function (U.S. Copyright Office, 2015). Accredited institutions may now host servers for games that are otherwise unplayable, for the purposes of research and education. However, the exemption has a physical limitation as the hosted game may not be played outside the institution premises (Albert, 2015). At a time when museums are expanding remote access to their archives, this restriction to a physical location seems anachronistic. By 2017, the MADE succeeded in restoring one of the first massively multiplayer games, *Habitat* (Lucasfilm Games LLC, 1986), into a new version playable on modern computers, *The Neohabitat Project* (Farmer & Handy, 2017).

The Software Preservation Society identifies unusual formats and forms of copy protection used in software media, especially floppy disks, that hinder preservation and emulation efforts. They note that "Preserving the normal disk data **is not enough**" (emphasis in original) (Fábián, 2004) and call upon preservationists to take detailed samples of physical mediating artifacts. Otherwise, information about the manufacturing process, intentional anomalies, and proof of alteration will be lost. For example, Commodore 64 disks are not "read" by the computer directly; every Commodore disk drive contains a microprocessor that reads, remediates, and modifies the disk data before it is transferred to the main computer's memory (Bartsch, 2014). A Commodore 64 computer's "reading" of disk data is not an accurate record of the original data encoded on the disk.

To accomplish the goal of taking detailed samples of floppy disk media, the Software Preservation Society team developed the Kryoflux hardware (Fábián, Bartsch, & Wilkinson, 2021). This "forensic floppy controller" permits a modern computer to operate a floppy disk drive and take a low-level sample of the magnetic flux pattern on the physical media[2]. Technology like this allows preservationists and archivists to take detailed, 1:1 scans of disks, including anomalies, track geometry, and details that can identify the hardware and methods used by publishers to record and protect the disk data[3].

Despite their achievements, it is still difficult for digital game preservationists to gain respect in the public eye. UK news source *The Independent* mockingly derided the Software Preservation Society with the quip "But we remember when software was new! And now you're saying it's old?" (Bywater, 2006). The group was listed among such "eccentric" preservation groups as the Traffic Cone Preservation Society and the British Hedgehog Preservation Society.

The Game Preservation Society (Nomura & Harada, 2016) meticulously preserves, measures, and digitizes all aspects of Japanese digital game media, including game packaging (Sasaki, 2020a). Like the Software Preservation Society, they also developed custom hardware used to extract "bit-perfect" disk images from their vast collection of digital game software (Sasaki, 2020b). Society members also perform digital archaeology to analyze and restore game software to complete missing data, access debug tools, unlock hidden content (Rogers, 2020), or make it so players can finally beat an "impossible to finish" game (Yamakawa, 2019). More importantly, the members fully document and share their findings so that others can reproduce their research and learn from their techniques.

The Finnish Museum of Games pays close attention to the context of digital game heritage. They believe that digital games should be experienced in their intended environments, not just tucked away behind glass. The public can interact with game consoles and early computers in the museum's "period rooms" (Suominen, Sivula, & Garda, 2018). These environments match the historic contexts the games were originally played in. Early "ball-and-paddle" games are played on an old CRT (cathode ray tube) television in a living room reconstructed from Christmas morning, 1980. Down the hall, a Commodore 64 computer sits atop a desk in a replica of a child's bedroom from 1985. Elsewhere, a simulated game shop features shelves stocked with

[2] Floppy disk drives each have unique "fingerprints" of how they write data to the magnetic media. When a high-quality master sample of a floppy disk recording is taken, such as a magnetic flux image, that fingerprint can be detected, which allows a researcher to know if the disk was written with commercial duplication hardware, consumer hardware, or if parts of the disk were written by different pieces of hardware ("The Importance of Data Authenticity," 2006).

[3] Starting in the 1970s, software publishers learned they could record digital media in ways that violate the standard recording schemes and indexing methods for the computer systems they published for. This allowed them to create aberrations that sereved as forms of copy protection tied to the physical media on which the software was published. These anomalies can only be preserved by recording the physical transport layer of the recording media at the lowest level (Bartsch, 2014)

the latest games of the year 2001 ("The Finnish Museum of Games," 2017). The layout is like that of an Ikea showroom, with each facsimile gaming space designed with the trappings of a different era.

The Strong National Museum of Play is home to the International Center for the History of Electronic Games (ICHEG), a vast collection of artifacts established for the purpose of collecting, preserving, and interpreting digital and other electronic games. ICHEG is more than an archive of digital game hardware and software. It is also a collection of books, magazines, and video publications that record how games were received by the public; game industry development documents and business materials to show how games were made and sold; and source code that shows how games are constructed (Dyson, 2017). In 2011, ICHEG started the Video Game Play Capture Project to preserve recorded gameplay of thousands of games in their collection as an aid to researchers and to serve as record of how games are played (The Strong Museum of Play, 2021).

Other game preservationist groups continue to form as people realize the value of digital game heritage and the risk it is under. The Library of Congress started collecting and preserving commercial digital games during the dawn of the industry (Gibson, 2013) and now has thousands of titles in its collection (Owens, 2012). The Video Game History Foundation was founded in 2017 with a mission of preservation, education, and advocacy (Cifaldi, 2020). The Embracer Group, a Swedish company that controls numerous video game studios, founded the Embracer Games Archive, a repository that houses more than 50,000 items for archiving with the intent to build a foundation and collaborate with researchers, journalists, museums, and other institutions (Boström, 2022).

Disagreement in Digital Game Preservation

While every digital game preservation group works toward similar goals, they do not all function with the same principles. For example, they have different views on the validity of "cracked" games: software that has been modified to bypass copy protection schemes, often for the purpose of software piracy. The "cracking crews" that did this work would often append "intro" scenes to the game's startup that identify the crew[4]. The Internet Archive allows numerous examples of cracked games into its Internet Arcade collection, complete with intros. Conversely, the No-Intro group was founded to remove such intros from preserved game files (xuom2, 2022b). Furthermore, the Software Preservation Group sees any modified game media as unrepairable and "unsuitable for preservation" (Fábián, 2004). One group preserves software modifications, one group removes modifications before preserving, and the other group simply won't preserve any software that has been modified.

Introduction to a New Charter

There is a need for and an opportunity to establish a set of principles on digital game media preservation, one that keeps the procedures and concerns of various preservation groups in mind. A true charter of preservation principles would be a group effort across numerous institutions. The following is an initial draft of what such a charter could look like.

This draft organizes the principles for preservation into eight articles and recognizes digital game cultural heritage as a common form of human knowledge and expression.

This charter adapts the structure of the UNESCO (United Nations Educational, Scientific, and Cultural Organization) Charter on the Preservation of the Digital Heritage (2003) and generally adapts the same objectives found in UNESCO's charter (see articles 3.1, 6.2, 6.3, and 8.1, below). However, some tenets diverge from UNESCO's charter (see article 3.4, below). This charter is created to address the needs and techniques specific to the preservation and study of digital games[5].

[4] The cracking scene of the 1980s was an influential subculture unto itself, especially in Europe. Cracking crews honed their programming skills by efficiently fitting lavish audiovisual effects for their intros into the slim amount of extra space available on a cracked game. These intros evolved from the cracking scene into "demos," tiny computer programs with impressive displays of graphics, animation, and electronic music, often played at "demoparties" in the "demoscene" subculture that developed in the late 1980s (Donovan, 2010, pp. 133-134).

[5] This modification is similar to the Seville Charter for Virtual Archaeology (López-Menchero & Grande, 2011), which incorporates the needs for representation of archaeological works onto the pre-existing tenets of the London Charter for the Use of 3-Dimensional Visualization in the Research and Communication of Cultural Heritage (Beacham, Denard, & Niccolucci, 2006).

Other works and guidelines that served as inspiration for the following articles are detailed in footnotes on the following pages.

Charter on the Preservation of Digital Game Heritage

1. AIM

1.1 Digital game heritage is human heritage and should be protected and preserved as a resource of human knowledge and expression[6].

1.2 Digital game heritage is at risk of disappearing due to factors including the rapid obsolescence cycles of hardware and software technologies, limited resources for maintenance and preservation, a lack of industrial support, and copyright legislation that is hostile to preservation efforts[7].

1.3 Any digital game preservation efforts must aim to improve aspects related to the research, conservation, or dissemination of digital game heritage[8].

2. SCOPE

2.1 Digital games, commonly referred to as video games, include but are not limited to computer, arcade, console, and mobile games. These games are now an important element of modern culture and daily life for many but are often treated as ephemeral and disposable objects.

2.2 Digital game heritage refers to any digital or physical artifact preserved for future generations that can inform about how people play, create, or talk about digital games.

3. PRESERVATION

3.1 Preservation priority should be given to materials that have the highest risk of data loss. “Born digital” materials, where there is no other format but the digital format[9], should always be given priority (UNESCO, 2003).

3.2 Effort must be made to preserve contextualizing materials about how people play, create, and talk about games[10].

3.3 Non digital materials, including but not limited to packaging, documentation, and promotional materials, should ideally be digitized with enough detail that the original artifact may be wholly reconstructed[11]. Each type of material should be preserved using the best available strategy for that material.

3.4 Efforts should be made to preserve as much data about digital game heritage as possible as we cannot predict all the information that will be needed by researchers in future generations[12].

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[6] Wording adapted from UNESCO’s Charter on the Preservation of Digital Heritage (2003)

[7] List of risks adapted from UNESCO’s Charter on the Preservation of Digital Heritage (2003) with the addition of lack of industrial support and the detail that current legislation is hostile to preservation efforts.

[8] Wording is adapted from the Seville Charter 4.2.1 (López-Menchero & Grande, 2011). The three categories of research, conservation, and dissemination match the needs of the three “credibilities,” or types of stakeholder, of curator, collector, and gamer, needed for a strong, emergent game heritage community (Suominen et al., 2018).

[9] “Born digital” or digital-only games are those that were never published on a physical carrier, such as a game cartridge or floppy disk. These works have only been available through digital distribution platforms.

[10] Wording inspired by *Best Before* (Newman, 2012). The “Preserving Virtual Worlds Final Report” document clearly states, “Future researchers will be sorely disappointed if we do nothing to ensure that historical documentation about virtual worlds, but created outside them, is preserved along with software and proprietary data” (McDonough et al., 2010).

[11] Preserving the layout of a computer game’s packaging can provide information about production methods, identify the factory where it was printed, and help researchers determine the game’s production time frame (Sasaki, 2020a)

[12] When the Game Preservation Society confronts the question, “What games do you choose to preserve?”, their answer is always the same: “All of them” (Kusaka, 2017).

4. AUTHENTICITY

4.1 AUTHENTICITY OF DATA

Strategies and policies to preserve either the intrinsic properties or custodianship provenance of preserved materials need to be developed to ensure the authenticity of heritage data[13]. These strategies and policies need to serve the purposes of research, conservation, or dissemination and be adaptable to change as new methods to recognize intrinsic properties or provenance are developed.

4.1.1 Original, unmodified examples of digital game software should be mastered and preserved whenever possible. Copied or altered software objects lose information that is only found in "factory new" software media.

4.1.2 Original master files should always be protected against any alteration: well-meaning, accidental, or malicious.

4.2 AUTHENTICITY OF EXPERIENCE

Digital games are a multisensory form of experiential media, and their reconstructions should remain true to their original presentations and contexts to avoid misrepresenting the past[14].

4.2.1 Effort should be made to ensure that a reconstructed game interface, including controller, display, and audio systems, preserves the authentic experience of playing the original game[15].

4.2.2 Effort should be made to present a reconstructed game within an environmental context that preserves the experience of playing the original game[16].

4.2.3 Effort should be made to frame a reconstructed game with information about the social-cultural and historical context that the original game was created in[17].

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[13] Digital game heritage objects have often been disseminated with little information about who preserved it, how it was preserved, the original object's provenance, or the authenticity of the data. The intrinsic properties tactic and provenance tactic are two methods for ensuring the authenticity of a digital artifact (Rothenberg, 2000).

[14] Wording inspired by Chalmers (2017).

[15] There are many good controller options made for modern computers that mimic common, older game controllers, but getting an authentic display becomes harder as time goes on. Game consoles and computers created for cathode ray tube (CRT) display screens relied on exact timing with the display's electron gun (Montfort & Bogost, 2009) or even took control of the electron beam in order to double the frame rate at half the vertical resolution (Altice, 2015). These techniques fall apart when an older console's video signal is fed directly into a modern, high-definition display. The video signal requires hardware like line doublers, deinterlacers, or upscalers to be modified to a format that is accurately projected on newer displays. However, much of this equipment creates crisp, boxy pixels that don't authentically match the soft glow of an older CRT screen and older light gun games generally cannot function with the signal lag of a modern display.

A modern screen with a high enough resolution can, theoretically, emulate the peculiarities of older CRT images (including scan lines, bezel distortion, phosphor glow afterimage, signal noise, and color bleed (Bogost, 2009)) and other more unusual older displays, such as early smartphone displays, handheld game LCD displays, and XY vector displays that were commonly used in arcade games in the 1970s and 1980s. Presesrvationists may be able to use similar graphical techniques that many independent game developers use to give their retro-themed games the look of an older display method.

Some games require other, non-digital enhancements such as screen overlays (Magnavox Odyssey, GCE Vectrex), controller overlays (Mattel Intellvision, Coleco Colecovision), board game components (*The Quest for the Rings* (Averett, Lehner, & Bradford, 1978), *Tanktics* (Crawford, 1981)), custom controllers (*Steel Battalion* (Capcom, 2002), *Donkey Konga* (Namco, 2004)), and more to preserve the proper "look and feel" of an authentic game-playing experience (Guttenbrunner, Becker, & Rauber, 2010).

[16] This takes inspiration from the Seville Charter, which itself was inspired by the Charter of Krakow (De Naeyer, Arroyo, & Blanco, 2000), where principle 4.5.3 reads: "The environment, landscape or context associated with archaeological remains is as important as the ruin itself" (López-Menchero & Grande, 2011). As an example, The Finnish Museum of Games exhibits a collection of vintage arcade machines in a facsimile of an era-appropriate video game arcade, not a typical museum hall ("The Finnish Museum of Games," 2017).

[17] Non-expert users may have difficulty appreciating the value of historic games without understanding their position in the timeline of digital game history. "As technology advances, game players who have only been exposed to the latest and greatest may be apt to play an older game and say, "so what?" even though the game might have been revolutionary for its time" (McDonough et al., 2010).

4.2.4 Complete authenticity is not possible nor desirable in all cases[18]. Authenticity should not interfere with equitable access to digital heritage materials.

5. RESTORATION

5.1 Digital game files may be modified in order repair damage, restore game files to their original unmodified form[19], complete missing data, remove bugs or glitches that inhibit play, or to facilitate functionality under newer technologies[20]. Original master files must not be tampered with (article 4.1.2) and all modifications to restored copies must be duly documented (article 7.1).

5.2 Additional information about a digital game file, such as that required by for emulation, may be stored as a file header or in a separate file[21].

5.3 Physical components of a digital game interface may be modified or fabricated to repair damage, replace missing components, facilitate functionality under newer technologies, provide long-term support, improve accessibility, or otherwise restore functionality.

6. ACCESS

6.1 Digital games should be presented in a playable format to facilitate the experiential understanding of digital game heritage.

6.2 Public access to digital game heritage materials, especially those in the public domain, should be free of unreasonable restrictions. At the same time, sensitive and personal information should be protected from any form of intrusion (UNESCO, 2003).

6.3 A new legal and practical environment is needed to promote and facilitate digital game heritage preservation. Governments should work with relevant organizations and institutions and act to strike a fair balance between the legitimate rights of copyright holders and the interests of conservators, researchers, and the public (UNESCO, 2003).

7. DOCUMENTATION

7.1 Each step of digital game heritage preservation, restoration, and dissemination should be documented so that the methods and structures used can be understood and evaluated in relation to the purposes for which they are employed[22].

8. SUSTAINABILITY

8.1 Long-term preservation of digital game heritage requires reliable systems and procedures designed to produce authentic and stable digital objects (UNESCO, 2003).

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[18] The Video Game History Foundation created custom joystick controllers and kiosks to exhibit a number of restored digital games of historic interest at the 2024 Game Developers Conference. The reconstructed games were presented with social-cultural and historical contexts, but it was "not possible or desirable to maintain the original form factor" (Salvador, 2024) of the game interfaces as the newly designed hardware greatly enhanced accessibility.

[19] Game disks were often modified through normal use, malicious acts, or intentional modifications, such as:

- Recording of save games
- Recording of high scores
- Virus damage
- User modifications
- Cracked copy protection

Some preservation groups, such as the Software Preservation Society, consider modified disks unsuitable for preservation (Fábián, 2004). Other groups work to remove such modifications and restore game files to their original forms (xuom2, 2022a).

[20] One example of an intentional modification that supports dissemination of digital game heritage is adding functionality for internet communication protocols to an online game originally designed for dial-up telephone modems. This facilitates networked play on modern computer systems.

[21] ROM image files of cartridge games are often augmented with a header of additional data used by emulators to properly execute (especially for cartridges featuring additional memory mappers or co-processors to augment the console's capabilities). Some groups have made a push to remove header data from ROM files and instead reference that information in a global database (xuom2, 2022a).

[22] Wording inspired by Principle 4 of the London Charter (Denard, 2012).

8.2 Digital heritage needs to be preserved on resilient, redundant, diverse, and cost-effective storage systems that are regularly monitored against corruption and loss.

8.3 As storage technologies become obsolete or come to the end of their service life, data must be migrated to new storage containers (*Digital Preservation Handbook, 2nd Edition*, 2015).

8.4 Long-term support for legacy media types and storage systems should be minimized (*Digital Preservation Handbook, 2nd Edition*, 2015).

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FEMINISM, MEDIA, AND TECHNOLOGY: NAVIGATING THE DIGITAL LANDSCAPE

Dorsa Charkhian

This presentation explores the intricate relationship between gender, technology, and digital media through a feminist lens, examining how feminist human-computer interaction (HCI) can drive change and reshape societal norms and gender roles. Drawing on foundational theories such as Donna Haraway's *A Cyborg Manifesto* and incorporating critical insights from scholars like Angela McRobbie and Cathy O'Neil, the study critically examines the evolution of gender dynamics within digital platforms. By adopting a multidisciplinary approach that merges feminist technoscience with HCI methodologies, this research highlights the nuanced ways digital technologies reflect and shape gender identities, emphasizing the role of design justice and speculative futurism in fostering more inclusive digital environments. Through a comprehensive literature review and phenomenological analysis, the article identifies key gaps in current scholarly understanding and proposes a framework for future inquiry aimed at achieving equitable and inclusive digital spaces. By integrating feminist theories into media design and content, we advocate for a redefined digital landscape that promotes diverse and authentic representations of women, thereby advancing gender equity in the digital age. This work not only contributes to the ongoing discourse on feminism, media, and technology but also underscores the importance of diverse perspectives in the evolution of technology and its societal impact.

Keywords:computer-mediated interaction, feminist technoscience, HCI Theory, Human-Computer Interaction,

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Introduction

The accelerated evolution of media and artificial intelligence (AI) technologies offers new ways to challenge deep-rooted societal norms and promote inclusivity. AI-driven tools, such as Twitter's AI-powered hate speech detection system and Facebook's misinformation flagging algorithms, demonstrate how these technologies can reshape societal interactions to promote equity (O'Neil, 2016; Noble, 2018; Buolamwini & Gebru, 2018).This study adopts an interdisciplinary approach, combining feminist theory, media studies, and AI to critically analyze and address systemic biases in digital platforms. Building on seminal contributions such as Haraway's "A Cyborg Manifesto" (1991) and Noble's analysis of algorithmic oppression (2018), this research interrogates the intersections of feminist critique, computer-mediated interaction, and AI technologies, proposing a new perspective on inclusivity in the digital era.

Algorithms are potent agents in shaping public perceptions, yet they frequently reflect and perpetuate biases arising from skewed datasets. For instance, facial recognition systems disproportionately trained on lighter-skinned subjects produce significantly higher error rates for darker-skinned individuals (O'Neil, 2016). Similarly, algorithmic designs in credit scoring amplify existing socioeconomic disparities by embedding structural inequities into their decision-making frameworks. These issues underscore the imperative to design equitable systems that dismantle, rather than reinforce, such biases (Buolamwini & Gebru, 2018).

Feminist technoscience underscores the centrality of power dynamics and gendered experiences in technological innovation, advocating for intersectionality as a foundational principle in AI design (Haraway, 1991). Supported by Crenshaw's (1989) theoretical construct of intersectionality and D'Ignazio and Klein's (2020) insights in "Data Feminism," this study proposes a robust analytical framework to evaluate how overlapping identities influence access and representation in digital environments. Key strategies include implementing AI systems that prioritize diversity in content moderation, designing recommendation algorithms to amplify marginalized voices, and fostering participatory frameworks that empower underrepresented groups to shape technological development.

Research Questions:

1. How can feminist principles inform the ethical design and deployment of AI in media platforms to mitigate systemic biases?

2. What design methodologies effectively identify and address algorithmic biases while promoting inclusivity in AI-driven systems?

3. How can AI technologies be structured to elevate marginalized voices and ensure equitable representation across diverse user demographics?

By synthesizing feminist technoscience critiques and empirical insights from participatory design research, this study aspires to contribute meaningfully to the discourse on ethical AI, human-computer interaction (HCI), and digital inclusivity. It aims to articulate a comprehensive framework for designing AI systems aligned with feminist values, capable of dismantling systemic barriers within digital ecosystems. Practical applications include facilitating co-design workshops with diverse community stakeholders to collaboratively develop and iteratively refine prototypes that reflect real-world needs and expectations (Buolamwini & Gebru, 2018; D'Ignazio & Klein, 2020). Play is a self-motivated activity occurring within set time and space boundaries, guided by voluntarily accepted yet binding rules. It is undertaken for its intrinsic value, evoking tension, joy, and a distinct awareness of its separation from daily routines. (Huizinga, 1938, p. 28).

Literature Review

Bardzell (2010) introduced feminist HCI as a framework to address systemic gender inequalities in technological design. Her approach specifically challenges traditional design paradigms by emphasizing the

inclusion of marginalized perspectives and critiquing power structures that prioritize efficiency over equity. This framework redefines design processes to focus on participatory methods that empower users as co-creators rather than passive participants. Through participatory design and inclusive feedback systems, Bardzell's case study on collaborative software, such as groupware tools for remote project management, demonstrates how incorporating diverse user feedback fosters equitable and accessible systems tailored to team dynamics. Her critique of male-centric paradigms highlights the necessity of equity-focused methodologies.Pritchard (1993) examined systemic exclusion in technological fields, revealing biases in AI hiring tools and healthcare devices designed predominantly with male-centric data. Her advocacy for feminist principles in technology aims to foster inclusivity and address sociopolitical inequalities embedded in design.

Towards a More Inclusive Algorithm Design" (2023) emphasizes participatory approaches to mitigate algorithmic biases. For example, patient feedback gathered through surveys and focus groups helped refine an AI diagnostic tool for early-stage diabetes detection. These refinements led to a 20% improvement in diagnostic accuracy and enhanced inclusivity by incorporating symptoms often overlooked in standard datasets, highlighting the value of patient-driven adjustments. By considering patient-reported symptoms, these adjustments improved diagnostic accuracy and expanded inclusivity for underrepresented groups."Equity-Oriented Approaches in HCI" (2021) examined co-design practices that center marginalized voices. Examples include FarmConnect, which provides tailored crop management advice for resource-limited farmers, and LearnBridge, which offers underprivileged students access to adaptive learning modules designed through iterative community feedback.

McRobbie (2004) critiqued post-feminism's "double entanglement," describing how feminist gains are diluted by commodification and individualism. This concept directly applies to AI-driven platforms like Instagram, where empowerment narratives are commodified through curated content and advertising algorithms, obscuring systemic inequities and reinforcing individualistic frameworks. This concept extends to AI-driven platforms like Instagram, where curated empowerment narratives can obscure structural inequities. McRobbie's insights highlight the need for greater inclusivity in digital platforms."Feminist AI and Ethical Considerations" (2023) underscored the role of feminist ethics in AI. Through intersectional audits in facial recognition systems and adaptive features in public transportation apps, feminist AI mitigates biases and advances digital equity.

Intersectionality in Technology Design" (2023) explores frameworks that address overlapping user identities, providing insights into more inclusive technology development. For example, financial apps designed for low-income families have undergone iterative refinements, enhancing both accessibility and cultural responsiveness. "Overcoming Barriers to Inclusive HCI" (2021), which explores systemic obstacles like organizational biases and underrepresentation, and proposes strategies such as bias audits and inclusive policies to create more culturally inclusive digital health projects. It identified systemic challenges, including organizational biases and underrepresentation. It proposed strategies such as bias audits and inclusive policies, highlighting their transformative impact on culturally inclusive digital health initiatives. Han et al. (2024) introduced "Press Protect," an AI-powered tool leveraging GPT-3.5 and toxicity classification APIs to mitigate online harassment. This AI-driven system prioritizes user autonomy and ethical safeguards, fostering safer digital interactions.

Sharma et al. (2023) advocated for post-growth frameworks in HCI, emphasizing sustainability. These frameworks prioritize reducing resource consumption and fostering community resilience over profit-driven models. Case studies include community-managed energy systems, which integrate user-centered designs for shared resource allocation, and urban gardening projects, where participatory planning enhances both ecological and social outcomes. Case studies on community-managed energy systems and urban gardening projects demonstrated the potential of justice-oriented design approaches.Torgersson et al. (2024) utilized Design-Based Research (DBR) to develop scalable educational technologies. Co-designed literacy apps, refined through iterative feedback, showcased DBR's capacity to address diverse learning needs effectively.Klein and D'Ignazio (2024) extended "Data Feminism" principles to AI, focusing on intersectional audits and consent-driven data protocols. Case studies highlighted improved fairness in predictive models and equity in public health applications.

Cripping Feminist Technoscience" (2024) integrated disability studies into HCI, showcasing how co-designed assistive devices, such as tactile feedback systems, created inclusive technological solutions.This study (2024) explored sensory augmentation technologies, including Enchroma glasses for colorblind users.

These glasses enhance color perception by filtering specific wavelengths of light, enabling users to better distinguish colors and navigate tasks such as reading color-coded maps or interfaces with greater confidence and accuracy. It emphasized ethical considerations like autonomy and consent, ensuring alignment with user needs and accessibility goals.

This study (2024) analyzed anti-Muslim biases in large language models, highlighting discriminatory chatbot outputs, such as a chatbot suggesting that certain religious practices are inherently linked to violence. These outputs underscore the urgent need for diversified datasets and rigorous bias audits. Solutions proposed include diversifying datasets and enhancing transparency through bias audits.Fotopoulou (2023) critiqued "networked feminism," analyzing UK women's organizations using digital tools like WhatsApp to overcome resource barriers. These efforts underscored strategies for equitable digital spaces aligned with marginalized communities.The reviewed literature identifies gaps in integrating feminist principles into AI, addressing cultural diversity, and operationalizing ethical frameworks. This study builds on these gaps by proposing actionable strategies for fostering inclusivity and equity in digital technologies. It incorporates participatory design methods, intersectional audits, and culturally responsive strategies to create more inclusive systems while addressing ethical considerations in AI-driven platforms.

Methodology

This study adopts a Qualitative Theoretical Analysis (QTA) methodology to examine the intersection of AI technologies, media systems, and feminist perspectives within Human-Computer Interaction (HCI). QTA is particularly suited for synthesizing diverse theoretical constructs, bridging paradigms from technological, social, and feminist domains. For instance, Nguyen-Trung (2024) demonstrated how QTA integrated feminist AI critiques with HCI methodologies to address systemic biases. Similarly, Sinha et al. (2024) used QTA to harmonize media theories with inclusive AI systems. This method focuses on systematically analyzing existing literature, theories, and frameworks rather than collecting primary data, aligning directly with the research objectives.Primary data sources include peer-reviewed journal articles on AI in qualitative research, selected for their methodological rigor and focus on integrating AI tools. These sources connect with feminist and HCI critiques in the literature review, such as examining ethical implications of AI in marginalized communities. Key examples include Nguyen-Trung's (2024) analysis of thematic challenges in AI-assisted studies. This ensures consistency and relevance by identifying recurring themes, contradictions, and gaps.

The analysis employs iterative coding, starting with open coding to identify themes like 'bias in algorithmic decision-making' and 'ethical implications of AI,' progressing to focused coding to refine categories like 'algorithmic accountability' and 'inclusive AI design.' This aligns with the literature review's emphasis on inclusivity and ethical considerations. Tools such as NVivo facilitated data organization, while generative AI tools like GPT-4 streamlined text mining and code refinement. Reflective memos and constant comparison further enhanced the analytical rigor.To ensure validity, triangulation was employed by cross-referencing insights from feminist AI ethics literature and HCI methodologies. This revealed systemic gaps and enhanced the study's credibility. For example, Buolamwini and Gebru (2018) highlighted racial biases in facial recognition algorithms, informing the critical evaluation of datasets and algorithmic frameworks.QTA's emphasis on theoretical synthesis and reflexive analysis addresses gaps identified in the literature review, such as algorithmic accountability and inclusivity. This methodology bridges theoretical insights with actionable outcomes, ensuring equitable and ethical technology design. By integrating AI-assisted tools and interdisciplinary paradigms, the study provides a comprehensive framework for exploring the interplay between AI, media, and feminist HCI perspectives.

Results and Discussion

This study examines how artificial intelligence (AI), media ecosystems, and feminist frameworks intersect within Human-Computer Interaction (HCI), shedding light on systemic algorithmic biases and exclusionary media practices. The research underscores the ethical imperative of designing equitable systems and incorporating diverse perspectives in HCI to create more inclusive digital environments.A key issue identified in the study is the prevalence of algorithmic disparities. For instance, Buolamwini and Gebru (2018) found that facial recognition systems had an error rate of 34.7% for darker-skinned women, while the error rate for lighter-skinned men was under 1%. This disparity has serious societal consequences, including wrongful arrests and discrimination in hiring practices. These findings highlight the critical need for fairness-

aware algorithms and greater transparency in datasets. Nguyen-Trung (2024) emphasizes the importance of dataset transparency and accountability as essential components of ethical AI development.

AI-mediated platforms were also found to perpetuate biases in content curation and advertising. Nguyen-Trung (2024) criticized Facebook's ad-targeting algorithms for favoring dominant cultural narratives while excluding minorities. Examples include housing ads often bypassing marginalized groups, reinforcing systemic barriers, and job advertisements excluding women and underrepresented communities, perpetuating stereotypes. These results call for equity-focused frameworks to counteract biases and enhance diverse media representation.Intersectional feminist perspectives shed light on compounded challenges faced by marginalized groups. Crenshaw's (1989) intersectionality and Pritchard's (2020) feminist AI ethics highlight how overlapping oppressions shape user experiences. By adopting feminist technoscience, this study addresses the need for equitable digital spaces.Patterns like algorithmic accountability and inclusive design emerged from iterative coding and grounded theory, directly addressing research gaps. Triangulation validated findings by synthesizing insights from feminist AI ethics and HCI methodologies, ensuring alignment with study objectives.

The findings carry actionable implications for policymakers, designers, and researchers. Policymakers must prioritize algorithm transparency and ensure diverse datasets to reduce systemic inequities. For instance, mandating audits of AI systems can prevent discriminatory outcomes in housing or hiring. Designers are encouraged to implement participatory methods that engage marginalized groups directly, such as co-design workshops for tailoring solutions to diverse user needs. Researchers should pursue interdisciplinary collaborations to propose scalable, inclusive AI solutions, bridging gaps between technological innovation and ethical frameworks.

This study provides a roadmap for ethical AI design, emphasizing participatory methods and fairness-aware algorithms to mitigate biases and enhance equity. Future research should validate these frameworks through real-world testing, such as participatory workshops focusing on cultural narratives or urban planning in multicultural settings. These initiatives could yield practical insights into adapting frameworks for diverse contexts and advancing discussions on ethical AI development. By integrating feminist principles, this research underscores the transformative potential of inclusive methodologies and ethical AI in creating equitable digital systems.

Conclusion

This study examines the connection between feminist principles, artificial intelligence (AI), and digital media within Human-Computer Interaction (HCI), focusing on equitable system designs through feminist HCI and participatory AI frameworks (Bardzell, 2010; D'Ignazio & Klein, 2020). Bardzell's (2010) work on collaborative software illustrates how diverse perspectives enhance inclusivity in digital tools, addressing gaps like limited datasets and methodologies. The research reveals systemic biases in AI, such as facial recognition errors (Buolamwini & Gebru, 2018) and biased advertising (Nguyen-Trung, 2024), disproportionately affecting marginalized groups. For instance, these biases contribute to wrongful arrests and exclusion from housing and jobs, highlighting the need for fairness-aware algorithms and diverse datasets.

Future research should expand through participatory design workshops with underrepresented groups to address these issues (Simonsen & Robertson, 2013; D'Ignazio & Klein, 2020). Such workshops can co-create AI tools by involving marginalized communities, ensuring outputs meet diverse needs. Applying these frameworks in multilingual or multicultural contexts could enhance global equity. Policymakers and designers must prioritize ethical practices, including algorithmic transparency (Floridi et al., 2018) and diverse representation. The GDPR in the European Union shows how transparency reduces biases and builds trust in AI systems. In conclusion, participatory methodologies and fairness-aware algorithms are crucial for inclusive digital ecosystems. Aligning technology with feminist values amplifies marginalized voices and dismantles biases (Bardzell, 2010; D'Ignazio & Klein, 2020).

AI Disclaimer

AI tool were used for grammar and style enhancement. All content is human-authored.

About the Author

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ESCAPE

SHARING EXPERIENCES THROUGH VISUAL STORYTELLING DURING COVID

Hana Pokojná

In this position piece I address the theme, ‘if we could be heroes, just for one day’, by presenting my personal experiences during the pandemic, especially through the first lockdown. I focus on the different forms of visual storytelling relevant to the new circumstances, which are the most helpful and inspiring. Intentionally or without realising it, the authors of these pieces engaged with the audience on a deeper level beyond attractive visuals that might have piqued their interest initially. These were helpful emotional aids in regards to the variously implemented restrictions at the beginning of the COVID-19 pandemic, depending on the countries. In all cases, people needed some means of escape from their daily, isolated, and often monotonous, routines. For me, it was through observing different ways of visual storytelling that engaged the onlooker and creating shared experiences. Notably, hese occurred in the real and virtual worlds through street art, masked statues, and scrollytelling. With regards to the Media Arts and Design conference (MAD) 2024 theme, ‘heroes’ were people who made the effort to share their views about the situation, and created experiences that made the viewers feel less alone, and perhaps provided more understanding of certain issues and situations.

Keywords: covid art shared experiences, street art, masked statues, scrollytelling

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How It All Started

I will start at the beginning, the first lockdown, how it affected people, how is even relevant to this year's Media Arts and Design (MAD) theme, and what inspired me to make the observations I have made. Later I will focus on psychological research that supports my reasoning, specifically the phenomenon of shared experiences. Finally, I will dive into specific examples of visual storytelling in the wild that ties into the shared experiences, created by artists and writers that I see as 'heroes'.

Lockdowns

March 2020 marked an interesting time around the world as countries locked off from one another, and in many cases, people were locked in due to the spread of COVID-19 virus. The restrictions varied from country to country, but the most prominent lockdowns differed by time or distance from the household. Some examples from Europe (Fig. 1) include Spain and Italy with complete lockdown where people couldn't leave their homes. People in the United Kingdom were allowed to leave their homes for one-hour of exercise per day, while places like Slovakia or the Czech Republic had a curfew between 6 and 20:00. Ireland, on the other hand, allowed people to go outside within 5 kilometers of their abodes. I mention these countries to provide the comparison between different places. I place special focus on the last four (United Kingdom, Slovakia, Czechia, and Ireland) because they are places that I have lived in and had special interest in how the situation was dealt with because of my loved ones and friends still living there.

Figure 1. Examples of different types of restrictions in Europe: total lock down, e.g. Spain and Italy (left), time-based curfew, e.g., Slovakia and Czechia (middle), distance-based curfew, e.g., Ireland, (right).

While these restrictions helped to curb the spread of the virus to some extent, the lockdowns had a negative effect on people's mental health and well-being. For example, a study (Catling et. al., 2022) comparing 216 young adults from 2020 to 218 young adults from 2021 showed an increase of self-reported levels of depression, anxiety, and mobile device addiction.

"What if we could be heroes, just for one day?''

Before the results of studies like these (Catling et al., 2022) were available, people in lockdowns already tried to deal with their mental health by finding a way to escape the situation that not many were used to. What I found interesting is that people found a way to alleviate their negative experiences by sharing what was going on in their secluded lives, e.g., through of art or sharing personal experiences, which in return also often helped the individual viewers. By 'help' I mean seeing a heart-warming video that boosted their happiness-causing neurotransmitters even for a while, seeing an art piece that inspired others to invest time and effort in their hobby, or a message that pointed to an issue that needed to be addressed. In this sense, a 'hero' was someone who, often unintentionally, helped someone else just by sharing their own experience (Fig. 2).

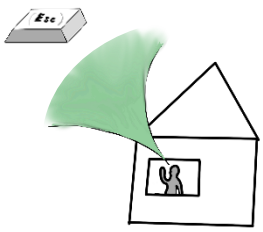


Figure 2. Glyph for escaping isolation by sharing experiences.

My inspiration

I managed to get on one of the last planes that flew from Scotland, where I was studying at the time, to Ireland, where my family lived. Dublin is a beautiful city full of historical and cultural gems. This includes the modern-day artworks that are both beautiful and moving and can be found just by walking through the city. Being able to go on walks within the 5-kilometre radius, I was able to go 'bee hunting'. An activity which consisted of looking for stenciled graffiti made by the artist *buzzy.bee* in the streets of Dublin (Fig. 3). Looking for these lovely pieces did not just make me happy to see new versions of their signature artwork accompanied with optimistic slogans, but it also got me out of the house and made me get my daily walk(s) without any feelings of forced exercise. Moreover, I was often accompanied by one of my family members, which only contributed to our shared experiences of seeing nice art, staying healthy, and spending quality time together (my sister made the best playlist for 3-hour walks that I still listen to today- so here's another thing I have gained). In this sense, *buzzy.bee* was my hero during the first lockdown, and the artist may not even realise how much they helped people like me.

Figure 3. Few examples of the bee graffiti by artist buzzy.bee in the streets of Dublin. Photographs are used with the permission of the artist.

Seeing how sharing artworks and optimistic ideology can help, I started thinking about other media that contribute to shared experiences, which is what I am focusing on in this piece. Specifically, I would like to talk about the street art, masked statues, and scrollytelling (Fig. 4) that all address COVID-related issues through visuals with powerful messages.

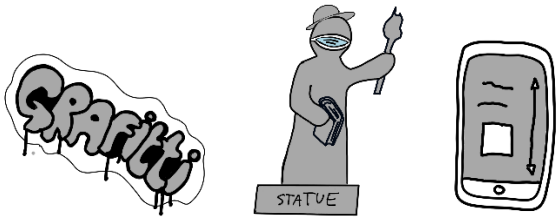


Figure 4. Glyphs of the three visual stimuli I will focus on: graffiti, masked statues, and scrollytelling.

Psychology

How we perceive things plays a big impact on our well-being. Loneliness has a tremendous effect on our health and so do shared experiences. These two go hand-in-hand and influenced a lot of people during the period of lockdowns.

'Humans are social animals'; this is a mantra that every psychology student will learn very early on in their class about biological underpinning of social behaviour. One argument for this behaviour is that

socialness satisfies our need to belong (Baumeister & Leary, 1995). Studies also demonstrate that lack of social interaction leads to negative health effects, such as anxiety, anger, and depression, to name a few (Cacioppo et. al., 2000, Baumeister & Leary, 1995, Hagerty et. al, 1996). A review of clinical studies by Heinrich and Gullone (2006) suggested that loneliness has clinical significance and that it should be combated to improve psychological well-being.

On this note, shared experiences- or experiences that we share with other people, can be a way to prevent some of these negative states and improve our lives. Numerous studies have shown that when we take part in an activity with others, we perceive them as more enjoyable as well as have increased activity in the brain's reward system (Wagner et.al., 2014). These experiences are more positive if they are shared with people we care about and know, like friends or family members (Boothby et.al., 2017). Researcher Erica J. Boothby, has a lot of interesting research focusing on shared experiences and the positive effect on us.

Putting this simply, sharing is caring. Loneliness has negative effect on our health and shared experiences improve the enjoyment from tasks.

Art and Visual Stories

People can connect through arts and, as in my personal case, avoid the effects of loneliness, by creating shared experiences. This was particularly important during the pandemic because people were distanced and isolated. The shared experiences that I have noticed during and post/ in-between lockdowns that used visual storytelling were done in several formats and different environments, such as in the streets or in the online world, in 2D or 3D formats. Here I would like to discuss the graffiti, the masked statues, and the scrollytelling.

Graffiti


Graffiti is written or drawn form of art that is done in public spaces, often without permission. This artform allows you to express views or simply share the beauty with the passersby. A good example is the previously mentioned art by *buzzy.be*. During lockdowns, many artists turned to reflecting their emotions and expressed their opinions about the situation, often using colorful renderings or humour to address serious issues.

One example is reflecting on the virus and its global influence using simple rendering and comparing it to music, making the light of situation, as in Fig. 5 (a). Other examples targeted the resulting situations from the panic, for example, artwork by a suspicious looking figure showing rolls of toilet paper on the inside on his coat (streets of Los Angeles, USA, made by *Teachr*) [1]. From personal experience, this was more applicable to bags of pasta that were famously sold out in local shops when people stocked up on long-lasting food items. The lack of toilet paper and other items is a funny and even ridiculous to think about now, but this satirical depiction is effective take on the situaon created by panic and response to an unpredictable situation.

Other pieces relied on seriousness and expressed their appreciation to the medical staff and professionals who put themselves in danger to help everyone else. A great example is the piece 'Game Changer'[2] by the well-known graffiti artist *Banksy*, that depicts a young boy playing with an action figure of nurse positioned in the Superman stance and wearing a cape. More examples took a more direct approach at calling out the financial and political stance, such as piece by *Asbestos* located near the Grand Canal Docs area (Fig. 5 (b)). This artwork was also posted on the artist's Instagram account [3], where part of the caption read 'Pay those who protect us. #payournurses'. Not only this graffiti was a beautiful piece to look at, but also called to appreciation to the medical staff and pointed out the issue with monetary compensation for people who put their lives on the line for strangers and literally make a difference between life and death on daily basis.

[1] Teachr's Instagram: https://www.instagram.com/teachr1/?hl=en
[2] Game Changer: https://banksyexplained.com/game-changer-2020/
[3] Asbestos's Instagram: https://www.instagram.com/artofasbestos/?hl=en

Some pieces also expressed political opinions about the leaders' actions that had significant impact on people. A great example is *Lushux's* graffiti in the shape of COVID virus with the face of Chinese political leader in the streets of Melbourne, Australia. The photograph of this piece was posted on the X platform with caption 'do you have corona yet? *cough*' [4].

Overall, the pandemic made many artists reflect on various issues that came with it. A lot of street art discussed these provocative ideas through humour, writing, and bright colours to the extent that COVID street art has a category on its own. Since then, several databases, online articles, and even books have been published and is something worth exploring. The following resources provide interesting collections of this type of art that marks the turbulent few years we have experienced: thepholyphony.org[5], architecturaldigest.in[6], magazine.artland.com[7], forbes.com[8], gingkopress.com[9], blog.street-artwork.com[10], and urbanartmapping.org[11].

Figure 5 shows (a) graffiti in the streets of Dundee (Scotland), artist unknown. (b) shows graffiti by Asbestos near Dublin's Grand Canal Docs celebrating the nurses, this photograph used with the artist's permission.

Masked statues

Statues are meant to commemorate important people and events by being placed in a public space to remind passersby of their importances. Since statues become part of our scenery as we pass them by on our daily walks to destinations with different purposes , we may consider them as part of the scenery and forget their importance. During COVID, these statues re-gained their importance when people started putting masks on the statues all around the world to remind everyone to keep themselves and the people around them safe. These statues were placed in areas of cities that in other circumstances, would be noticeable to tourists, like in the city centre of Bratislava, Slovakia (Fig. 6(a)). Others were placed on statues in areas that are more familiar to people who spend more time outside the city centres, or locals, such as by the Canal in Dublin (Fig. 6(b)). Others were purposely placed in educational institutions, such as the Dynamic Earth in Edinburgh, Scotland (Fig. 6(c)) where their placement emhesised desired learned behaviour.

The masked statues are a phenomenon that spread around the world just after the virus itself did and served as a visually appealing reminder for people to make a small effort to help prevent the spread. An interesting overview of statues from different countries wearing these masks can be seen for example at the Forbes article[12], 'Famous Statues Around the World Wearing Facemasks'.

[4] Lushsux X post: https://x.com/lushsux/status/1241215241167335425
[5] https://thepolyphony.org/2020/06/16/art-in-isolation-artistic-responses-to-covid-19/
[6] https://www.architecturaldigest.in/content/how-the-global-art-world-is-responding-to-the-covid-19-pandemic/
[7] https://magazine.artland.com/coronavirus-street-art-how-the-pandemic-is-changing-our-cities/
[8] https://www.forbes.com/sites/carolinehoward/2020/05/30/covid-on-the-street-pandemic-graffiti-from-around-the-world/
[9] https://gingkopress.com/shop/street-art-corona/
[10] https://blog.street-artwork.com/en/corona-virus-covid-19-street-art-and-graffiti/
[11] https://www.urbanartmapping.org/covid-19-database

[12] https://www.forbes.com/sites/msolomon/2020/05/22/famous-statues-around-the-world-wearing-face-masks/

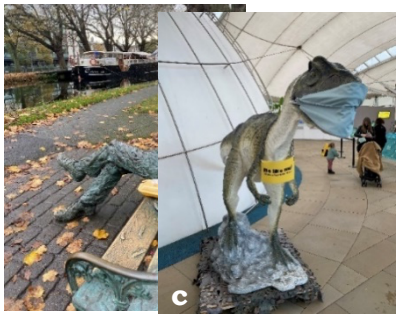


Figure 6 shows the masked figures in three different countries: a) shows the statue of Patrick Kavanagh by John Coll near the Canal in Dublin. b) shows the First Postbox by Ladislav Sabo in Bratislava. c) shows a dinosaur statue in the Dynamic Earth in Edinburgh.

Scrollytelling

Scrollytelling is a recent data visualisation technique where the content changes as the user scrolls up or down on the webpage (Mörth et.al., 2022). This interactive approach draws in the user through changing images or animations and helps make data more interesting, engaging, and understandable. Since this technique is usually web-based, it is easily available to people, even in isolation and helps them connect over similar experiences.

Several examples utilizing this approach focus on explaining health experiences with long COVID, a condition that is yet to be fully explored with time. Kate McCurdy explores these experiences in her piece 'The Long COVID Experience' in the Medium[13]. Here, the author visualises her symptoms and health history timeline through text and images that helped her understand her experience better. It also helps readers to realise that they are not alone if they are experiencing similar health issues.

Another example of data visualization of covid-related illness through scrollytelling is in Giorgia Lupi's 'Life with Long COVID'[14] in the New York Times. Her story, similarly, to McCurdy's piece, visually guides the reader through her experience of long COVID illness. She encoded her symptoms, doctor's visits, and other relevant events with paintbrush-like strokes and colours, making the visual representation of an uncomfortable situation almost beautiful and very intriguing to look at.

Another example depicting the results of the pandemic is Alvin Chang's piece 'Invisible Pandemic'[15] for the Pudding, which translates a data collection about the loneliness and isolation in the United States. This piece begins by showing the life of a singular individual and then reveals similar stories of isolation which was only exacerbated by the lockdowns happening to many more individuals. Figure 7 below shows a screenshot from this piece where the user can click and explore the presented individuals. It is pieces like these that help people realise that loneliness is an issue that occurred to a lot of people.

Figure 7 depicts a screenshot of the Invisible Pandemic in the Pudding, made by Alving Chang, used with the author's permission.

[13] The Long COVID Experience: https://medium.com/pictal-health/visualizing-the-long-covid-experience-f0d20e5f3ecd
[14] Life with Long COVID: https://www.nytimes.com/interactive/2023/12/14/opinion/my-life-with-long-covid.html
[15] The Invisible Pandemic: https://pudding.cool/2023/09/invisible-epidemic/

The last example of scrollytelling brings to life the statistics of people that were lost in the United States because of the corona virus illness in the powerful 'How America Lost One Million People'[16] (the New York Times's). This very emotional piece represents individual people through points that moves into shapes of graphs that correspond with real statistics about COVID-related deaths in the US. The dark colour and movement of the particles engulfs the viewer and highlights the gravity of the sad reality.

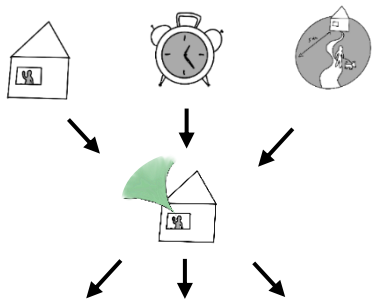
Overall scrollytelling allows for an interactive way of sharing information straight from the viewer's phone or tablet (which most of us used as a means to escape and communicate during lockdowns). When sharing positive news, the viewing of social media has shown to have a positive effect on mental health, for example, watching videos of acts of kindness during corona, while being bombarded with negative news led to negative feelings (Buchanan et.al, 2021). In relation to negative news consumption, a new phenomenon called 'doomscrolling' has emerged where people end up in a state of distress because of continually consuming true negative news.

Conclusion

During the times of lockdowns, especially during the first wave, people were isolated to different degrees, and distanced, to say the least. This type of isolation had negative effects on the mental wellbeing of the people. Most of us needed to find some source of outlet and motivation to help escape this new way of life. Because of the restrictions, individuals often reflected on their own personal feelings and experiences and shared them with the world to help themselves. In the process, they often helped their audiences. I especially noticed this in the realm of visual storytelling (depicted in Fig. 8), through graffiti that took a humorous take on the situation and praised people who did the heavy lifting during the tough times. The statues that commemorate important occurrences now remind people to stay safe. In the realm of digital world, which also seemed to be the main means of socially distanced communication and escape, people could share their own experiences with health that were not known and understood very well, but also present the effects of the virus on other parts of life, such as loneliness, and overall deaths. These pieces were present both in physical and virtual spaces in 2D and 3D formats. It was interesting to see how the artists utilised affective visualisation, a type of visualisation that aims to make viewers have an emotional response (Lan et.al, 2024). For example, the nurses were portrayed as superheroes in Banksy's graffiti to elicit feelings of appreciation and admiration, use of statues highlighted the importance of wearing masks, and the use of visual channels, (colour), encoded the gravity of situation in 'How America Lost One Million People'.

In the future, it would be interesting to look at more types of media that influenced people by creating shared experiences during the pandemic, for example, virtual gallery space, multiplayer games, or online applications that replicated in-person social interaction, such as the Housepart app[17]. Investigation into shared experiences through art may contribute to new art therapy interventions during periods of isolation.

[17] Houseparty: https://houseparty.en.softonic.com/android



[16] How America Lost One Million People: https://www.nytimes.com/interactive/2022/05/13/ us/covid-deaths-us-one-million.html

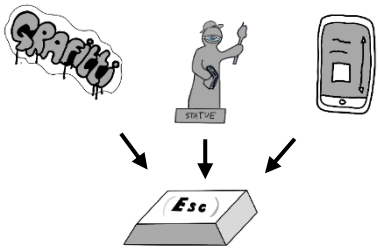


Figure 8 visually depicts the overview of this piece.

The COVID-19 pandemic has forced us to stay in and deal with a new level of isolation that most people in today's society have not experienced yet. However, it also pointed to the fact that people need social interactions and that by sharing the experiences with others we can improve our situations. This visual sharing served as a social glue and the authors were, in one way or another, heroes for the viewers to whom they helped escape their reality of isolation and made them not feel alone. The presented examples are the ones that I personally found helpful and inspiring. These examples of people being 'heroes' without even knowing it, just for sharing their thoughts and feelings.

Acknowledgments

I would like to thank *buzzy.bee* for brightening up my lockdown and non-lockdown walks, and letting me share their art. I would also like to thank *Asbestos* and *Professor Wang* for letting me use images of their beautiful works.

About the Author

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DIGITIZATION OF MUSEUM EXHIBITS

RECONSTRUCTING THE ADMIRAL TEGETTHOFF, AUSTRIAN HUNGARIAN POLAR EXPEDITION SHIP

Joachim Tacha

The process of converting information as books, paintings, documents or sounds into digital formats started around 1957. [1] Since then, technology has vastly improved and the variety of objects undergoing this process broadened and streamlined.[2] Digitization has made everyday life easier.[3] It also benefits scientists and artists as many museums turn their exhibits and archive objects into digital counterparts, making them accessible online.[4] In Austria this trend has been supported by the government through the call of funding "Kulturerbe Digital".[5] The project "Bausteine des Wissens" of the Natural History Museum Vienna (NHM) has been funded, leading to the digitization of seven complex collections.[6] Unknowing of this expired call for funding, my project for the University For Continuing Education Krems (UWK) fit right into the frame of this theme. Through cooperation with the NHM, I digitized the polar expedition ship that transported its crew to the undiscovered Franz Joseph archipelago. The NHM did the same, by 3D scanning their 1:20 ship model that is currently in their arctic special exhibition. My approach was to model the ship using CG software and a building documentation by Willibald Meischl. The result was a game ready asset, traversable in an arctic environment using the Unreal game engine.

Keywords: historic reconstruction, digitization, museums

DOI: https://doi.org/10.48341/z7r6-6876

1 https://kodakdigitizing.com/blogs/news/what-is-the-history-of-digitization

2 Verheusen, A. (2008). Mass digitization by libraries: Issues concerning organisation, quality and efficiency. LIBER Quarterly, 18(1), 28-38.

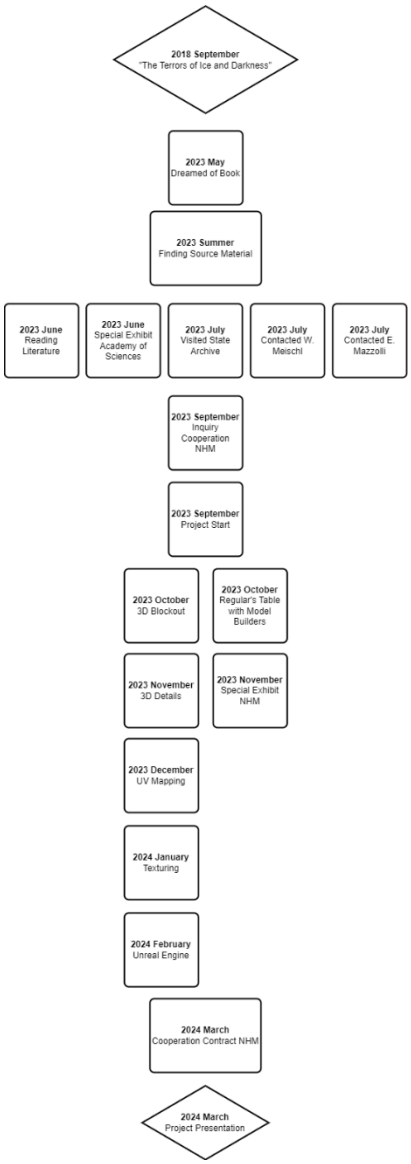
3 https://www.oesterreich.gv.at/landingpages/meldewesen.html

4Naturhistorisches 04/24: Digital genial die Sammlungen des NHM Wien per Mausklick nach Hause holen

5 https://www.bmkoes.gv.at/kunst-und-kultur/schwerpunkte/digitalisierung/foerderprogramm-kulturerbe-digital.html

6 Förderprogramm Kulturerbe digital: Geförderte Projekte der ersten Ausschreibung (Einreichtfrist 31.01.2023)

Project Timeline



To provide context and insight in the chronological order of this project, a timeline is presented to the left.

The first time I was introduced to the topic was in 2018, during my last year of school. The Book "The Terrors of Ice and Darkness" was compulsory reading in my class. Back then, I wasn't impressed nor interested in the topic.

That changed 5 years later, when a random dream about the very same book started my Wikipedia research that kicked off the project.

When I realised that my dream coincided with the anniversary of the expedition and there would be special exhibitions, my research got more serious. I compiled literature found at the Library of the Academy of Sciences, unearthed ship plans of a vessel with the same name as the expedition ship at the State Archive and contacted authors of specialist literature.

With these sources I inquired with the NHM about a potential cooperation. Their verbal commitment let me get started on the practical and digital part of the project.

First the ships hull was blocked out roughly, details followed suit. The UV mapping was necessary to prepare the following texturing, to add colour and surface details to the ship.
The final model was then transferred to the Unreal Engine, where it was frozen yet again in an arctic environment and programmed to be traversable via a first-person controller.

With a moody and realistic audio, the renders and demo could be presented to the NHM again. The contract was closed, and the project graded by the University of Continuing Education Krems.

Historical Context

Over the years 1872-1874 the crew of the Admiral Tegetthoff, led by Julius Payer and Carl Weyprecht, explored the newly discovered Franz Josef Archipelago and cartographed it.[7] Additionally, they measured ice growth and movement, temperature changes, and climate conditions. They described meteorological phenomena like the northern lights, light pillars, and sun dogs. Zoological findings were also documented and archived. The board logbook was filled with diligent notes and weather readings.[8]

Apart from the back breaking work that was attempting to free the frozen ship out of the icy grip, they partook in recreational activities. Ice skating, fishing, hunting, building igloos, dressing up for carnival, celebrating Christmas, New Year's Eve, and the emperor's birthday.[9] Training sledding dogs and saving them from the certain death of polar bears also took up a sizeable amount of time. And of time they had enough. The two winters they stayed on the frozen ship were long and cold, the morale of the crew had to be maintained by keeping them busy and in high spirits. Cleaning, cooking, baking, smoking, mending clothes, and tools as well as being sick were part of their everyday life.[7] Only a handful of the crew, a selection of

7 The Austro-Hungarian North Pole Expedition of 1869 to 1874", Vienna, Julius Payer 1876

8 Die Metamorphosen Des Polareises, Karl Weyprecht 1879

9 Das Tagebuch des Nordpolfahrers Otto Krisch 2012

the sailors and the two Tyrolian hunters were part of the very dangerous expedition by foot and dog sled northbound to the northernmost point of the islands.[10]

The incredible density of details and reports is unique among polar expeditions. There are six different perspectives of this expedition, diaries, logbook, travel report and scientific findings written down by different participants. Additionally, there are a handful of photographs [11] and a series of drawings and paintings, enriching the documentary of this trip.[12]

1000 years Austria – 1996

Universum, an Austrian television documentary show, produced a special episode to address this piece of Austrian history. It covered the history of the polar expedition and showed excerpts of life onboard the Admiral Tegetthoff frozen in ice. To realize this endeavor convincingly, a backdrop and model for certain camera angles needed to be constructed. Director Helmut Voitl commissioned Willibald Meischl, Adolf Achtnits and Rudolf Ermer to build a 1:20 model of the ship, capable of floating in water and being rich in detail. Additionally, the project crew of the Österreichischer Rundfunk (ORF) also built a 1:1 model of the ship to act as scenery and backdrop, though this one needn't swim. The small model was frozen in ice in lake Neusiedl, while the big model was taken apart and shipped to Franz Josef islands where it got reconstructed and the filming took place. The documentary was then released under the name "Die Eisfalle - die Odyssee des Admiral Tegetthoff".[13]

W. Meischl continued to write a book about the construction of both models, including documentary photographs and scans of original drawings, paintings, and construction plans.[13]

150 years Franz Josef Land – 2023

The 30th august 1873 marks the date of discovery of the Franz Josef archipelago. In 2023, 150 years later, the anniversary is celebrated by a variety of institutions. The library of the Austrian Academy of Sciences opened its doors to show their special exhibition, covering the expedition. [14] Newspapers report anecdotes and short coverages of the historic events.[15] The Natural History Museum Vienna opens its special exhibit "ARCTIC The Changing Polar World".[16] Many exhibits are on display, including numerous original objects from the expedition, alongside the now almost 30-year-old ship model built by Meischl and colleagues. In preparation for the exhibition, the ship was removed from its original display case and before it was moved to the temporary exhibition, it was scanned with a 3D scanner. Many other objects have undergone the same digitization process to be made available for the public on Sketchfab, a website for showcasing 3D models.[17]

This national celebration, albeit niche and narrow section of interest, was part of the reason why I started with the project. The time was right, and all the necessary materials were unearthed from archives and prepared for display. With that context I could contact the NHM and ask them for a project cooperation.

The digitization process.

Using scans of original construction plans of the ship I started putting all my references together to begin the digital construction. In Autodesk Maya, a 3D modelling software, the modelling process began. I traced the shape of the hull with NURBS (non-uniform rational basis spline) curves and gave it volume with polygon planes. Important details on deck were created using a mix of box and subdivision modelling. Piece by piece I blocked out the shapes and placed them in correct relation to each other. Proportions played a key

10 Erinnerungen eines Tiroler Teilnehmers an Julius v Payer's Nordpol-Expedition 1872/1874 - Johann Haller - Wagner 1959

11 https://onb.digital/search/886701

12 https://onb.digital/search/686638

13 Polarschiff Admiral Tegetthoff die österreichisch-ungarische Polarexpedition 1872 - 74 - Achtsnits, Meischl, Wenzel - Staatsdruckerei Österreich 1997

14 https://www.oeaw.ac.at/news/150-jahre-franz-josef-land-neue-ausstellung-an-der-oeaw#news-gallery

15 https://www.derstandard.at/story/3000000184753/das-tagebuch-das-die-kuehnste-polarfahrt-erlebte

16 https://www.nhm-wien.ac.at/en/exhibitions/special_exhibitions/arctic

17 https://sketchfab.com/NHMWien

factor, as they make or break the illusion of realism. Particularly the hull needed to be accurate, otherwise the ship cannot be recognized for its original counterpart.

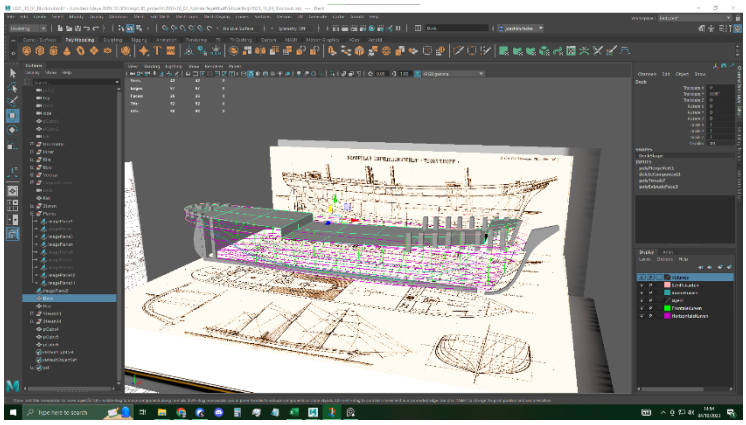


Figure 1. NURBS Curves and rough shapes in Autodesk Maya.

Close-up photographs of the 1:20 model, as well as sketches by Meischl helped me fill the deck with the necessary machinery and architecture. “Historic ship models” by Mondfeld provided an invaluable overview of the hundreds of relevant pieces a ship consists of.[18] Staircase houses, skylights, winches, gratings, windlass, lifeboats, fife rails, chimney, bilge pump, rudder and many more details were necessary to populate the ships deck.

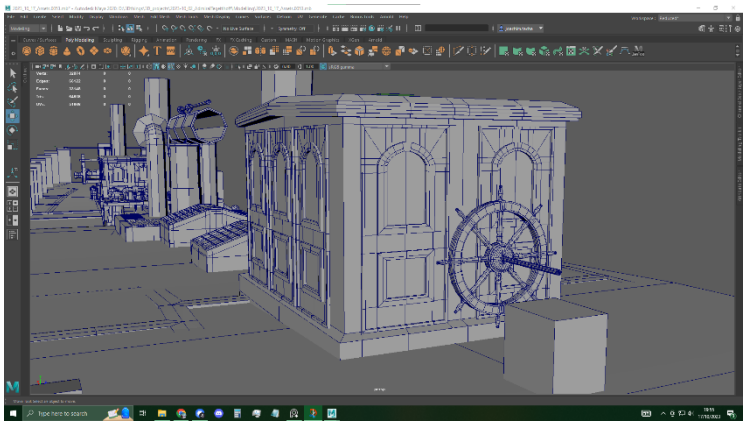


Figure 2. Block out of important objects on deck.

The masts, rigging and sails were its own complex subject that needed detailed rigging plans. Without those, I wouldn’t have understood which ropes lead where to what effect. For the untrained eye, which mine were at the beginning of the project, the ropes of a ship looked like a wild chaotic mess. Again, I used NURBS to plan out the position and angles of the ropes and subsequently turned them into meshes with volume.

18 Historische Schiffsmodelle, zu Mondfeld - Mosaik Verlag 1978

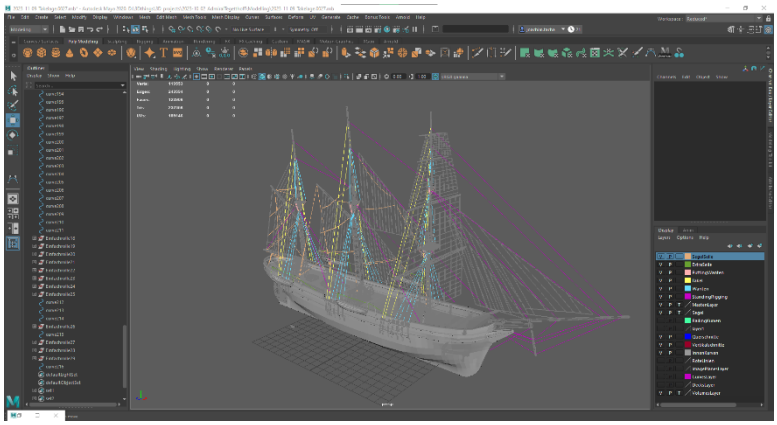


Figure 3. Rigging laid out with NURBS.

For organic shapes like the figurehead and carved ornaments I used the digital sculpting software ZBrush from Pixologic, as this software is better suited for flowing and soft designs.

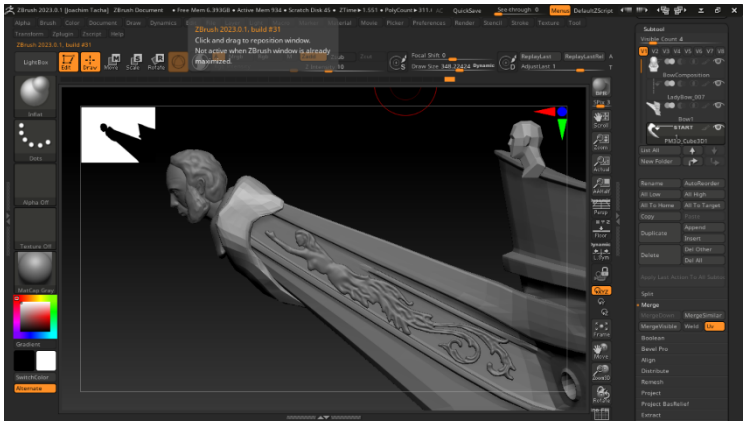


Figure 4. Figurehead sculpted in ZBrush.

With all the meshes done, they had to be subdivided, which means it is refined to create a smoother and more detailed surface. To achieve this, the so-called edge loops must be added by hand, they help influence and stabilize the angles and corners of the mesh during the subdivision process.

Each model needs its polygonal surface to be laid out in the 2D space for further texture mapping. As the axes x, y and z are already in use in the 3D space, the letters u and v denote the two 2D axes for the meshes surface. The process of projecting the 3D models' surface to 2D space is hence called UV mapping.

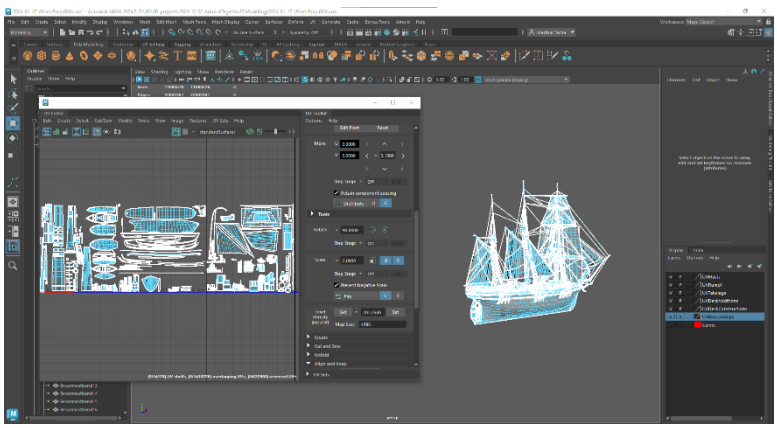


Figure 5. All mesh surfaces laid out in 2D space, called UV maps.

When all meshes have their UV maps laid out in UV sets, they can be exported to the next software: Substance Painter. Each mesh is assigned materials and baked, a technical process that mainly runs on graphics cards. Light, colour, or surface information is calculated and stored in texture files. In Substance Painter I could then add wood grain, dirt, dust, scratches, stains, metallic properties and much more. With all models textured, the next phase begins.

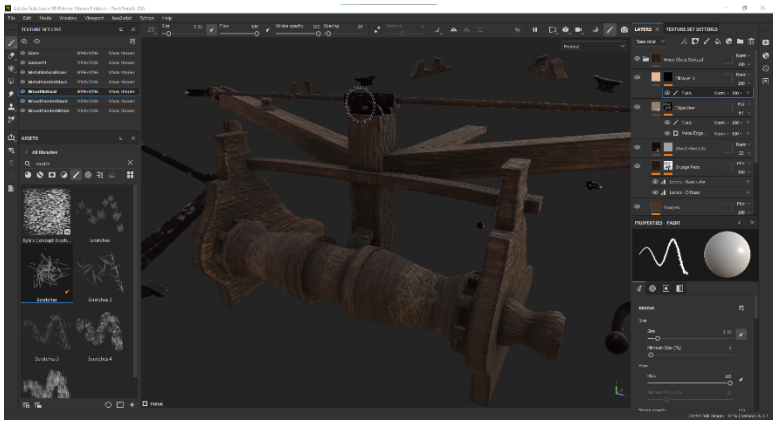


Figure 6. Texturing in Adobe Substance Painter.

Unreal Engine is software that allows the development of games by providing the framework and tools necessary. All textured meshes get imported and positioned correctly in relation to each other. Before the engine can display the surface information correctly, materials need to be created and assigned with the exported texture maps from Substance Painter. As soon as that is done, the ship already looks quite realistic.

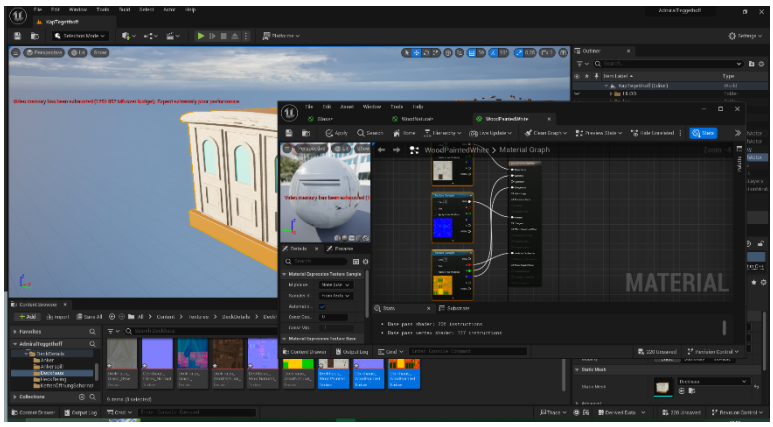


Figure 7. Creating materials in Unreal Engine, using exported texture maps.

To enrich the environment, I used an arctic asset pack from the Unreal Marketplace and placed icebergs, shelf ice, moving clouds, snowflakes, and fog.[19] To increase realism, I modelled rough shapes of the Cape Tegetthoff, the southernmost part of the archipelago, which was the first piece of land the crew discovered and placed it in the near distance.

19 https://www.unrealengine.com/marketplace/en-US/product/arctic-island

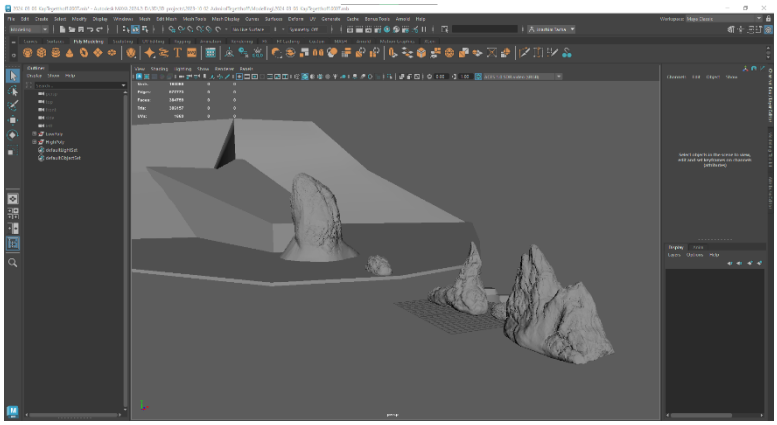


Figure 8. Block out of the distant cape Tegetthoff.

The sails and flags of the ship were still stiff shapes, to fix that, I used the built-in tools and turned the meshes into ones that behave like cloth. Now they react realistically to gravity and wind.

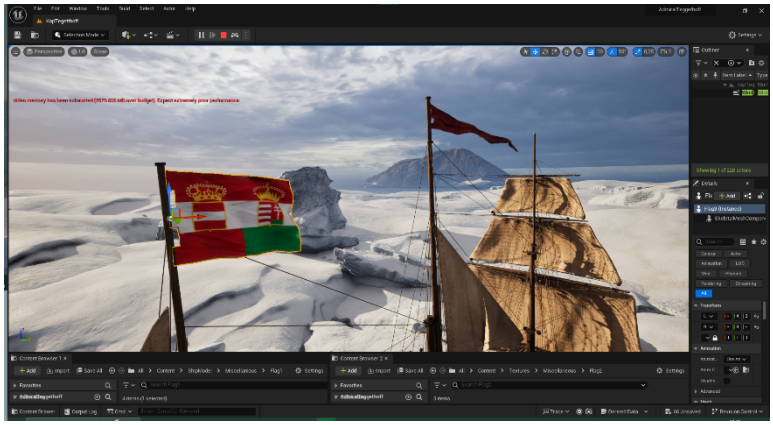


Figure 9. Flags and sail move in wind.

Sound effects and a looped ambient soundscape completed the scenery. The only aspect missing was the first-person controller. This feature, among many others, luckily was available out of the box. Only the collisions for the ship needed to be added, otherwise the player would fall through the surface, as there wouldn't be any physical collision information given.

With everything in place, players could freely move over the ships deck and look at the details from different angles and get a feeling of size and proportions. The view over the arctic landscape, combined with the fitting sound design, makes a credible recreation of the historic setting.

Figure 10 & 11. The final look of the arctic environment.

Pedagogic potential and educational mission

The self-set requirements and goals were fulfilled in the frame of the project, though there was a lot of untapped potential. For example, giving the players the option of interacting with the ship's mechanisms: This would allow them to assess how certain pulleys, cranks, pumps, or machines work and what their purposes are.

Alternatively, information boards could be scattered around the world as a user interface to communicate names, terms, anecdotes and much more, just like in museums. To retain immersion, instead of floating UI, voice over narration would be an alternative. In this case, interacting with certain objects would prompt the voice to explain whatever has been clicked on. The same counts for snippets of the ship’s logbook or diaries being read out loud to provide context, historical details, and flavour.

Animals that occur in those latitudes should also be given their rightful place: Polar bears, snow siskins, fulmars, glaucous-winged gulls, harbour and harp seals, walruses, grebes, black and thick-billed guillemots inhabit the regions of the Franz Josef Islands and the pack ice. Equipping the game character with binoculars could be a game mechanic to convey the names, behaviour, and occurrence of the inhabitants of the Arctic Ocean.

As the current level only features a cloudy, but sunny day, different weather types could be implemented. Particularly arctic weather phenomena like northern lights, sun halos and light pillars are unique and interesting. These phenomena could be controlled via a menu or appearing cyclical, be it the time of day or season, type and amount of precipitation, temperature and more. The idyllic and romantic Arctic Ocean can and should be spoiled by terrible weather and darkness to provide a more realistic setting. After all, the crew had to brave countless adverse weather conditions.

Designing the lower deck and making it accessible promises a lot of potential that should be explored and utilized. The narrow cabins and hallway, crammed storage compartments, minimalistic ship kitchen,

washrooms, engine, and crew room would certainly be interesting to explore. This would provide insight into the everyday life onboard, as a lot of time was spent under deck, away from the harsh weather. I theorize that knowing how the living, working and recreational situation of the crew was, could unlock deeper understanding of the feat they achieved.

And to add gameplay to this still slightly dry and passive level, I could imagine the players tackling certain tasks: Scrape ice and snow off the deck, add coal to the auxiliary engine, raise the anchor, furl the sails, fend off the approaching polar bear, take weather readings, determine geographical location, check on fishing lines, remove dangerous ice shelves, hunt seals, take over cooking duty, …

Given the collaborative nature of an expedition, a cooperative aspect and game design angle would be fitting as well.

Conclusion

When directly comparing traditional digitization methods like 3D scanning and digital reconstruction, we can see where each approach shines. Scanning an exhibition piece only takes a few hours and produces a realistic digital counterpart that can be viewed on different devices simultaneously. Only the filigree parts of those pieces highlight the technical limits of this method, as they disappear or merge into adjacent volumes.

The digital reconstruction by hand takes months and hundreds of hours but, when done well, yields an adaptable, fully featured and far more detailed model. There are no ropes or thin parts missing, the surface is accurate and the different meshes don't melt into each other. Though rather than a replica of the analogue model, it is trying to replicate the original ship, not the museum exhibit. In other words, my imitation is not a replica of the 1:20 model, but an attempt to revive the original in its historic surroundings.

Reconstruction by hand is not viable in many cases. For example, scanning the Venus of Willendorf results in a much more accurate result than modelling a digital version by hand. Furthermore, the method of digitization depends on the need of the model. The scan could not be used in a video game, while the modelled version is optimized for that use. While a scan of a different exhibit, for digital viewing purposes, is sufficient and both more cost and time effective.

I would like to conclude this paper by emphasizing the need to showcasing historical events, reviving lost objects and making them available to everyone through a very fitting quote by Stefan Moster.

> "The protection of nature presupposes that it is valued. Appreciation, in turn, arises through observation. Contemplation needs an approximation. Approximation does not come without longing." (author's translation)[20]

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Thanks to my brother Julius Tacha, who accompanied me in my development, offered reflection discussions on the design process or support in organizing my work, and was available for proofreading.

20 "Der Schutz der Natur setzt voraus, dass man sie wertschätzt. Die Wertschätzung widerum entsteht durch die Anschauung. Die Anschauung braucht die Annäherung. Zur Annäherung kommt es nicht ohne Sehnsucht." Moster, S. (2022), Das Fundament des Eisbergs, mare

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ENVIRONMENTAL MEDIA-CENTER

EMPOWERING YOUTH FOR CLIMATE ACTION

Jasmina Alam-Yalcin

The Green Ramadan project, by the Muslim Scouts of Austria (MPÖ), aims to encourage participants to reflect on their actions with the environment. Climate, environmental, and nature protection are emphasized as acts of kindness during the fasting month of Ramadan for Muslims. The Umwelt-Medienzentrum (environmental-media-center) serves as a sub-project to further these goals, highlighting the importance of environmental handling in the hands of young people. The project seeks to empower participants by providing a platform for their voices to be heard and taken seriously, to get a sense of usefulness and inspiring positive change in their lives. The project educates participants about their role in environmental well-being and emphasizes the values of mindfulness during Ramadan beyond fasting. The project addresses the lack of opportunities for youth to actively participate in shaping their environment and feeling effective in making a difference. Through this initiative, children and youth are given a voice to advocate for a better environment and contribute ideas on how to lead more sustainable lives. The project aligns with the Sustainable Development Goals (SDGs). It benefits participants and their families by promoting proactiveness, raising awareness about environmental conservation, fostering talent development, and creating media-outputs related to environmental protection. The target audience includes Muslim children and youth aged 6 and above in Austria along with their families.

Keywords: environmental education, media literacy, sustainable development goals (SDG), youth empowerment, climate action

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Introduction

The climate crisis is one of the most urgent challenges of our time. Despite growing awareness, a significant part of the global community remains disengaged or unaware of the severity of environmental degradation. Recognizing the crucial role that youth play in shaping a sustainable future, we established the **Environmental Media Center** as a sub-project of the **Muslim Scouts of Austria's Green Ramadan initiative**. This paper provides an overview of the project, outlining its objectives, activities, and outcomes while highlighting the importance of empowering young voices in environmental advocacy.

Context and Rationale

Climate change disproportionately affects younger generations, yet their voices are often sidelined in decision-making processes. Most of the time they are not taken seriously. Many young people feel marginalized, lacking opportunities to express their concerns or contribute meaningfully to environmental solutions. In addition, within the context of Ramadan, the focus often remains solely on fasting, overlooking the broader themes of mindfulness, humility, and responsible consumption that the observance entails. Ramadan is an occasion for proactive engagement with environmental issues. The **Muslim Scouts of Austria's Green Ramadan initiative** encourages through workshops, challenges, and motivational videos inspired by teachings of the Prophet Muhammad (peace be upon him) to view climate action as a good deed. A main-goal is to teach children and youth that environmental well-being is everyone's responsibility.

The **Environmental Media Center** was created to bridge these gaps, offering a space where young individuals can express their thoughts on environmental issues, build awareness, and foster creativity through structured activities that encourage reflection and action. It aimed to empower young people to engage with environmental issues, fostering their creativity and sense of agency. The project seeks to implement a sense of responsibility for nature and climate protection among youth by providing them with a platform to express their ideas and take action. It aims to give them a voice, so they can actively contribute to environmental improvement.

Objectives

The primary goal of the **Environmental Media Center** is to empower youth by providing a platform where they can articulate their thoughts on climate change and environmental protection. At the same time, the project aims to educate about and raise awareness of environmental challenges by promoting values-based learning that emphasizes mindfulness and humility. Creativity plays a crucial role in this process, with participants encouraged to use diverse media formats, including video, audio, photography, and writing, to express their views. Collaboration is another key objective, as participants work together on various projects, building teamwork and communication skills along the way.

Alignment with Global Initiatives

The project aligns with several **United Nations Sustainable Development Goals (SDGs)**, particularly SDG 12 on responsible consumption and production, SDG 13 on climate action, SDG 14 on life below water, and SDG 15 on life on land. Furthermore, it supports multiple articles from the **UN Convention on the Rights of the Child**, such as the right to have one’s views respected, the freedom of expression and thoughts, the right to education, access to media and participation in cultural life. These frameworks emphasize the importance of giving children and youth the opportunity to engage meaningfully with global challenges and to teach them how to interact with media.

Methodology

The **Environmental Media Center** targeted Muslim children and youth aged six and older, along with their families, primarily from Austria. While the larger Green Ramadan initiative involved approximately 100 participants, the Environmental Media Center focused on a core group of around 20 individuals, aiming to achieve a balanced gender representation.

The project spanned three consecutive days, with each day starting with informative sessions designed to inspire and educate participants about nature and environmental issues. These sessions (as a mini-lecture, a video and a story that was read aloud) introduced topics such as nature conservation, climate change, and sustainable practices, setting the stage for the creative work that followed. Participants engaged in discussions that emphasized values like mindfulness towards nature and humility in our interactions with the environment. Later on they were divided into four groups based on their interests: the text group produced written content, including essays, letters and poems that reflected their thoughts on environmental stewardship; the audio group developed a podcast called "GR-Cast," featuring interviews, eco-friendly tips, and even creative pieces like rap songs on environmental themes; the visual arts group designed posters illustrating the positive and negative impacts on nature; and the video group created video clips where they expressed their feelings about the environment and proposed actionable solutions for protecting it.

On the final day, participants presented their work to their peers, sharing their creative outputs and reflecting on the knowledge and insights they had gained throughout the process. These presentations fostered a sense of pride and accomplishment, as participants transformed abstract concepts into tangible expressions of creativity and advocacy.

Outcomes

The **Environmental Media Center** successfully achieved its objectives by equipping participants with the skills needed to engage with environmental issues through creative media. Participants reported feeling more confident in voicing their opinions on climate matters and developed a deeper understanding of the challenges posed by climate change. Additionally, the project trained them valuable media literacy and communication skills, which will benefit participants in their future endeavors. Their creative outputs included written essays, letters and poems advocating for environmental protection, an engaging podcast series, artistic posters illustrating environmental themes, and video messages proposing solutions to climate issues. It demonstrated not only their understanding of environmental issues but also their ability to communicate effectively through various media formats.

Discussion

The **Environmental Media Center** has shown that empowering youth through creative media can lead to meaningful engagement with pressing global issues like climate change. Participants not only gained environmental knowledge but also developed important life skills that will empower them to continue advocating for change. Their enthusiasm and pride in their work highlight the importance of creating platforms that recognize and amplify young voices.

Despite its successes, the project faced certain challenges. Attendance fluctuated over the course of the program, affecting group dynamics, and initial plans to publicly exhibit the completed works during larger community events were hindered by logistical constraints. However, the possibility of showcasing these works on the Green Ramadan website in the future remains open.

Future Directions

Building on the success of this initiative, the next step would be to integrate the **Environmental Media Center** into annual programming, expanding its scope to cover a broader range of social and environmental topics. Additionally, providing opportunities for participants to present their work to larger audiences could further enhance the impact of their efforts and inspire more youth to engage with global challenges. Digital

platforms, such as **greenramadan.at**, can also serve as valuable tools for sharing these creative outputs with a wider audience.

Conclusion

The **Environmental Media Center** serves as a model for empowering youth to engage with environmental issues. By providing them with the tools and platforms to express their views and collaborate on meaningful projects, we can help cultivate a generation that is not only aware of environmental challenges but also actively involved in shaping a sustainable future. As educators and community leaders, it is essential to continue supporting initiatives that amplify young voices, recognizing their potential to drive positive change and a meaningful impact within their communities and beyond.

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AI Disclaimer

The transition from the detailed German project notes to this chapter was facilitated using the ChatGPT-4 model. It is important to note that while AI tools were employed to assist in formatting and structuring the content, all information and experiences presented are entirely based on the author's personal knowledge and project work. No fictional content or data has been introduced by the AI system. Full responsibility for the accuracy, originality, and integrity of the content rests with the author.

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BEYOND THE COFFEE SHOP: THE TRANSITION OF THIRD PLACES IN THE DIGITAL AGE

Rghad Balkhyoor

This literature review examines "third places," introduced by Ray Oldenburg as social settings distinct from home and work fostering informal interactions. It focuses on the shift from physical to digital third places, particularly social media platforms like Clubhouse, exploring how Clubhouse communication mirrors third places' participatory nature. Oldenburg's criteria—neutrality, inclusivity, accessibility, regularity, conversational engagement, and playful mood—are examined in physical and digital contexts. The review addresses challenges facing physical third places: urbanization, rising costs, and lifestyle changes due to technology, contributing to digital spaces' emergence as modern third places. It discusses digital media's impact on communication and culture, noting how the internet has erased traditional social and political barriers, creating new public spaces for personal growth and shared interests. This is crucial for teenagers, who, constrained by societal pressures and limited mobility, turn to digital spaces for social interaction. The review proposes research including ethnographic study, participatory observation, and surveys to compare social communication in digital and physical third places. The goal is to understand how third place characteristics adapt to the digital realm, using Clubhouse as a case study.

Keywords: Third places, Digital space, Clubhouse, Communication, Social interaction.

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Introduction

Third places, a concept coined by sociologist Ray Oldenburg, play a critical role in strengthening community communication by providing spaces for people to socialize away from home and work, primarily through informal conversations and relationship-building with strangers. However, urbanization and rising real estate prices are leading to a decline in physical third places, accelerating the use of digital social connections, particularly among youth who use these platforms to navigate social interactions amidst parental constraints. This transition from physical to digital third places, exemplified by social media platforms, is crucial for understanding how to design digital spaces that retain the essence of physical third places while enhancing online social interaction. Given this context, this study explores the research question: To what extent does communication in the Clubhouse app, a digital space, resemble third places in terms of individuals' participation? This inquiry aims to examine how digital platforms like Clubhouse may be replicating or adapting the social functions of traditional third places, and how these digital environments affect patterns of social interaction and community building in the contemporary digital landscape.

Communication In Third Places

In 1990, sociologist Ray Oldenburg coined the term "third places" to describe socializing public spaces like pubs, cafes, coffee houses, barbershops, and beauty salons[1]. The concept of third places originated in Europe, referring to locations distinct from home and workplaces. A third place is a common area where people can gather, converse, and enjoy each other's company; it functions as a public sphere[2]. According to Oldenburg, conversation in third places embodies a sense of democracy and freedom[3]. The interactions in these spaces are not hindered by social stratification or formality. Instead, they are characterized by social exchanges based on people's feelings and opinions. Unlike workplace conversations often dominated by a single person, third places allow everyone to contribute "just the right amount"[4]. Consequently, third places facilitate the exchange of ideas and the formation of new relationships[5].

However, not all public spaces qualify as third places. Oldenburg establishes specific criteria for third places, emphasizing their qualitative environment[6]. He identifies six distinguishing characteristics: "neutral ground," "leveler," "conversation as the main activity," "accessibility," "regulars," and "playful mood"[7]. These features are crucial and significantly impact the quality of communication in these "great good places"[8].

Third places create public spaces accessible without regulations or social hierarchies, contributing to "social sustainability"[9]. They offer casual environments free from formal conversations, providing a space of freedom where people find comfort.

Habermas's concept of the public sphere aligns closely with the third place concept. He emphasizes the role of media and political functions in democratic engagement[10]. The public sphere, like third places, facilitates peaceful conversations, democracy, and free self-expression without violent or argumentative eruptions. In third places, people can express themselves without threat or limitation, free from social or negative pressure[11].

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[11] Ncube & TomaseLLi, p. 39

The concept of third places has influenced various disciplines, including urban planning[12]. Urban planners now face the challenge of creating cities that enhance quality of life and foster attractive environments incorporating third places[13]. However, rising real estate prices in cities make it increasingly difficult to maintain low-cost, informal third places[14]. This trend prompts urban planners to reconsider the importance of existing third places, especially in suburbs where large land areas, post-industrial culture, and contemporary lifestyles affect the sustainability of these spaces[15].

Oldenburg warns that "dysfunctional zoning" can lead to a lack of commercial spaces in residential neighborhoods, forcing people to rely on cars or public transportation to access public places like cafes, bars, and parks[16]. As lifestyle patterns shift with technological advancements, many people now fulfill their need for communication in digital spaces such as social media, potentially altering their perception of third places.

Digital media and communication

New media is not limited to a single medium or technological conversion; it encompasses communities, cultural groups, and the formation of new social structures. It represents both cultural and technological change[17]. The digital world impacts culture and creates new meanings of communication in the modern era. For instance, people's communication needs initially led to primary communication media such as handwritten letters or postcards[18]. These human needs have stimulated technological innovations that develop more convenient, efficient, and faster means of communication, such as emails, text messages, and video calls.

Cultural needs exceeded the limits of earlier media, spawning the cyber world and altering our perception of reality. In 1999, John Perry Barlow declared the internet as a medium of freedom distinct from the physical world. It removed social boundaries and political regulations for individuals, becoming the "home of mind"[19]. Brian Arthur emphasizes that while technology can fade invisibly into our lives, it simultaneously shapes our world. He argues that we need to adapt to digital changes rather than resist the prevalence of digital media in the modern era[20]. Virtual technology creates "another world" for people, offering an escape from life's stresses and pressures. It transcends the limitations of the physical world[21]. According to Deuze, digital media impacts individuals' social spheres, transforming their social boundaries "into a fully mediated space of global coexistence"[22].

Oldenburg developed his theory of Third Places before the creation of information and communication technology (ICT) such as social media[23]. Today, technology has become "the fabric of everyday life," necessitating a new concept of Third Places that utilizes available technology[24]. Scott Wright argues that the

[12] Soukup, p. 423
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Third Place concept is not limited to geographic boundaries; it aims to build communities through communication, whether in physical or non-physical spaces, and to foster relationships between strangers[25].

Robyn Bateman Driskell and Larry Lyon propose that "community can exist without a local place in the concept of a virtual community existing in cyberspace"[26]. In other words, building communities does not require a physical place for interaction because socialization primarily depends on people. Cyberspace is distinguished from Third Places by the absence of physical location[27]. It creates "a new public space" that people compose for personal development and shared interests[28].

Digital spaces impact communication by enhancing free speech and amplifying democratic society, allowing people to exchange ideas and opinions without threat[29]. In the early 2000s, parental concerns about street violence and shopping malls led to stricter limitations on teens' physical mobility, forcing them to use social media as a primary means of communicating with peers[30]. Danah Boyd notes that "Today's teenagers have less freedom to wander than any previous generation," compelling them to use digital social communication to reclaim their sociality away from parental pressures and limitations[31].

To understand how Third Place norms manifest in digital spaces, we must examine Oldenburg's characteristics in the context of cyberspace, particularly social media. Wright divides these characteristics into two categories: structural and participatory. This division allows for analysis of each characteristic in digital spaces within the context of the Internet[32].

Structural characteristics include neutrality, inclusivity, and accessibility. While Oldenburg describes Third Places as neutral grounds not based on political conversations, digital spaces can become "politically polarized"[33]. They face challenges to neutrality through potential violations of "net neutrality" and the use of algorithms that influence user experiences.

Inclusivity, another structural characteristic, is central to Oldenburg's concept. Third Places are public and accessible to everyone at almost any time, without permissions or social barriers. Oldenburg emphasizes "qualities not confined to status distinctions current in the society…[what matters is the] charm and flavor of one's personal personality irrespective of status". While digital spaces are theoretically open to all, access to the internet remains a significant barrier[34].

Participatory characteristics include regularity, communication, and mood. Regular visitation is crucial to Third Places. Oldenburg states, "The Third Place is just so much space unless the right people are there to make it come alive, and they are the regulars. It is the regulars who give the place its character [...] and whose

[25] Wright, S. (2012). From “Third Place” to “Third Space”: Everyday Political Talk in Non-Political Online Spaces. Javnost - The Public, 19(3), 5-20, p. 10
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[33] Wright, p. 12
[34] Wright, p. 13

acceptance of new faces is crucial"[35]. Graham and Wright identify a phenomenon of "super-participation" in online spaces, suggesting that user engagement is essential in identifying digital Third Places[36].

Oldenburg asserts that conversation is the primary activity in Third Places[37], a norm that social media heavily relies on. The casual and often playful mood characteristic of Third Places is also present in digital spaces such as chat rooms and social media platforms, which are well-suited for informal communications.

Methodology

We will use an ethnographic research methodology to describe and compare how social communication can be attained in digital spaces compared to traditional third places. We will reconsider Oldenburg's characteristics of third places in the context of digital spaces, which include accessibility (location, access), regularity (regular customers and users), main activity (conversation), neutrality (free self-expression), casual and informal environment, and diversity of social levels and backgrounds.

Participatory observation and survey methods will provide a qualitative description of Clubhouse participants based on their shared beliefs, attitudes, behaviors, language, and interests. These aspects will inform the nature of conversations (informal, casual, or neutral) and provide information about participants' diverse backgrounds and social levels.

Additionally, we will employ a quantitative method to gather data on the number of participants and active speakers in selected rooms. We will observe four rooms on different days of the week, using a random number generator to select rooms based on the app's total active rooms. We will actively participate to identify regular members and build connections for consistent access to the same rooms. This approach will also facilitate collaboration with moderators, active speakers, and listeners, whom we will recruit for our study surveys.

For the physical third place study, we will select a location that embodies Oldenburg's six characteristics. We will examine how different interior settings (e.g., café, restaurant, barbershop, library, or bar) impact conversations. The chosen location will be based on its structure, accessibility, and customer reviews to assess regularity. We will collaborate with the establishment's owner to distribute surveys to regular customers, evaluating whether the location exemplifies third place characteristics.

We will also observe social interactions in both digital and physical spaces in spontaneous settings. For digital spaces, we will obtain permission from moderators to collect research data, ensuring participants' privacy by omitting personal information, names, and images. We will also reach out to speakers and listeners to complete surveys. In the physical third place, we will seek permission from the owner to observe and will administer the same survey used in the digital space.

We anticipate potential challenges in our digital space observations. First, the transient nature of chat rooms may lead to losing track of observed rooms. To mitigate this, we will add participants to our friends list or promptly rejoin rooms after exiting. Second, the high volume of participants may result in difficulty participating. We plan to address this by connecting with moderators privately to secure speaker positions.

In the physical third place, identifying regular customers may prove challenging. We will dedicate extended periods to the location, visiting at various times and days to establish patterns of regular attendance. This approach will help us distinguish between occasional visitors and true regulars. We will exchange contact information with identified regular customers to facilitate follow-up communication if they stop visiting or

[35] Wright, p. 14
[36] Wright, S. (2012). From “Third Place” to “Third Space”: Everyday Political Talk in Non-Political Online Spaces. Javnost - The Public, 19(3), 5-20, p.15
[37] Soukup, C. (2006). Computer-mediated communication as a virtual third place: building Oldenburg’s great good places on the world wide web. New Media & Society, p. 423

if we need additional survey information. Additionally, we'll collaborate with staff members who may provide valuable insights into identifying regulars and understanding the third-place dynamics.

Expected outcome

This ongoing research project aims to identify the similarities and limitations of Clubhouse as a digital space when compared to Oldenburg's characteristics of traditional third places. We are analyzing the differences between Clubhouse and physical third places based on these characteristics, examining how these distinctions affect the nature of individual participation.

Our project is investigating how the absence or modification of certain third place characteristics in digital spaces impacts user participation. We expect to uncover new meanings of communication that emerge in the digital world, particularly within Clubhouse. Additionally, we are assessing Clubhouse's potential as a tool for enhancing communication, evaluating its effectiveness in replicating or adapting the social functions of traditional third places.

Through this analysis, we anticipate gaining insights into the evolving nature of social spaces in the digital age and how platforms like Clubhouse may be shaping new forms of social interaction and community building. As this is an ongoing project, our findings and conclusions may evolve as we gather more data and deepen our analysis.

Future Directions

Looking ahead to 2040, we can envision digital third places evolving into dynamic, multidimensional spaces that radically transform social interaction. These future digital environments may become adaptive, shifting in real-time to optimize the collective mood and needs of their occupants, thereby enhancing the sense of comfort and belonging that characterizes traditional third places[38]. Advanced technologies could facilitate the creation of shared mental spaces, fostering a form of collective consciousness where ideas and emotions are shared directly, deepening the sense of community that Oldenburg emphasized. The concept of time in these digital third places might become fluid, allowing for "time-stretching" interactions where participants engage despite differing temporal flows, potentially redefining the notion of "regulars" in these spaces[39]. Highly sophisticated AI could serve as social catalysts, not merely moderating but actively facilitating deeper connections among participants, ensuring the vibrant, playful atmosphere crucial to third places[40]. Conversations might occur on multiple levels simultaneously, combining verbal discussion with shared data streams and sensory experiences, creating rich, multi-layered interactions that go beyond traditional communication[41]. Furthermore, we might see the emergence of empathy amplification technologies, allowing for rapid formation of meaningful connections and potentially changing how we build relationships in these digital communities[42]. The boundary between physical and digital third places could become so blurred that seamless transitions between the two become commonplace, with digital elements overlaying physical spaces and vice versa. Lastly, these future digital third places might become hubs of unprecedented cultural fusion, where advanced real-time translation and cultural context algorithms facilitate truly global interactions, potentially giving rise to entirely new forms of cultural expression and understanding[43]. As we approach this speculative future, it becomes crucial to consider how these technological advancements can

[38] Oldenburg, R., & Brissett, D. (1982). The Third Place. Qualitative Sociology, p. 273
[39] Wright, S. (2012). From “Third Place” to “Third Space”: Everyday Political Talk in Non-Political Online Spaces. Javnost - The Public, 19(3), 5-20, p.15
[40] Deuze , M., Blank, P., & Speers, L. (2012). A Life Lived in Media. Digital Humanities Quarterly 6:1, p. 1-2

[41] Bolter, J. D. (2003). Theory and practice in new media studies. In A. M. Gunnar Liestol, Digital Media Revisited (pp. 15-33). MIT Press, p. 27
[42] Boyd, D. (2014). Introduction. In it’s complicated - the social lives of networked teens (pp. 1-28). New haven; london: Yale University Press, p. 19-21Oldenburg, R., & Brissett, D. (1982). The Third Place. Qualitative Sociology, p. 273
[43] Jenkins, H. (2004). The work of theory in the age of digital transformation. In Toby Miller and Robert Stam(Eds.), A companion to film theory (pp. 234-261). Blackwell.

be harnessed to preserve and enhance the essential qualities of third places –neutrality, inclusivity, conversation, and community– in our increasingly digital world.

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DAVE: INTEGRATING PERSONALIZED AI TUTORING FOR ENGAGED LEARNING

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Traditional educational systems often struggle to cater to the diverse learning needs and requirements of individual students. This one-size-fits-all approach can hinder unique development, disengage learners, and exacerbate existing inequalities within the classroom. This paper presents DAVE (Digital Autonomous Virtual Educator), a personalized AI tutoring system designed to seamlessly integrate within the engaging FAIE learning application used in Maltese primary schools. DAVE leverages the power of Large Language Models (LLMs) and an advanced automated prompt engine to provide tailored support and adaptive feedback in mathematics. By analyzing real-time academic data from FAIE, DAVE adapts learning materials and offers personalized explanations and exercises, creating a dynamic and responsive learning environment. Through evaluations involving students in educational situations comparing DAVE with a commercially available LLM-powered chatbot, results demonstrated DAVE's significant impact on student learning outcomes, particularly for students with lower mathematical proficiency. Students utilizing DAVE achieved improved results on mathematics worksheets and reported higher user satisfaction, emphasizing DAVE's helpfulness, clear explanations, and personalized support. These findings underscore DAVE's potential to bridge the learning gap, promote educational equity, and foster a more engaging and effective learning experience for all students. The seamless integration of DAVE within the FAIE platform minimizes disruption to existing workflows and maximizes student engagement. This research helps to highlight the potential of AI-powered educational tools to transform the learning landscape, offering personalized support, mitigating misinformation, and empowering students to achieve greater academic success.

Keywords: Personalized learning, LLMs, Prompt Engineering, NLP

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Introduction

Personalized learning is an educational approach tailored to the individual needs and learning styles of students. This approach has emerged as a critical factor in maximizing student engagement and academic success. Through recognizing that each student learns at their own pace and using different modalities, personalizing learning pathways offers a compelling alternative to traditional one-size-fits-all models. By providing customized learning materials, adaptive feedback, and individualized support, personalized learning empowers students to take ownership of their educational journey, fostering deeper understanding, increased motivation, and improved learning outcomes. However, implementing personalized learning at scale presents significant challenges, particularly in primary education where teachers often face large class sizes and limited resources. Effectively addressing this challenge requires innovative solutions that leverage the power of technology while maintaining the crucial role of human educators in fostering a positive and supportive learning environment. The thoughtful and holistic integration of technology within educational frameworks is essential to ensure that these tools enhance, rather than hinder, the learning process.

In the context of Maltese primary schools, the FAIE learning application stands as a prime example of technology's potential to create engaging and interactive learning experiences. Developed as part of the EducationAI project, FAIE provides students in grades 4-6 with access to a wide range of educational resources, interactive exercises, and progress tracking tools. The application's user-friendly interface and gamified elements encourage active participation and foster a positive attitude towards learning. However, while FAIE provides a valuable platform for engaging students, it lacks the capacity to offer truly personalized support and guidance.

To further enhance the capabilities of the FAIE application and prove the viability of LLMs for education, this research introduces DAVE, an AI-powered tutoring system designed to seamlessly integrate with the FAIE platform. DAVE acts as a personalized AI companion for each student, providing tailored support, adaptive feedback, and individualized learning pathways in mathematics. By leveraging the capabilities of LLMs, prompt engineering and introducing a novel verification framework, DAVE offers a dynamic and responsive learning experience that adapts to each student's unique needs and learning style. DAVE's integration within FAIE aims to bridge the gap between engaging educational content and personalized learning support, creating a synergistic environment that maximizes student engagement and promotes educational equity.

The development of DAVE was guided by the recognition that technology should serve as a supporting tool for educators and students, not as a replacement for the essential human element in education. DAVE's primary role is to enhance, not replace, the teacher's role by providing students with an additional resource for individualized support and guidance. This allows teachers to focus on higher-level tasks such as facilitating discussions, fostering critical thinking, and addressing the individual needs of students who require more direct intervention. DAVE's integration within FAIE aims to create a collaborative learning environment where technology and human interaction work in concert to empower students to reach their full potential.

Literature Review

The need for modernizing the educational approach has continued to be established time and time again, highlighting the importance of promoting individuality and promoting the unique talents of each student. This approach focuses on tailoring to the individual needs and learning styles of students. Personalized learning has gained significant traction in recent years as a key strategy for enhancing educational outcomes. Unlike the traditional one-size-fits-all approaches, personalized learning recognizes that each student learns at their own pace and through different modalities (Williams, 2015). It empowers students to take ownership of their learning journey by providing customized learning materials, adaptive feedback, and individualized support (Bernacki, 2021). This learner-centric approach fosters deeper understanding, increased motivation, and improved learning outcomes across various subjects and age groups (Pane, 2015). Furthermore, personalized learning promotes the development of essential 21st-century skills, such as self-directed learning, metacognition, and adaptability (Bray, 2015), preparing students for success in a rapidly evolving world. By catering to diverse learning styles such as visual, auditory, kinesthetic, while also allowing students to progress at their own pace, personalized learning creates a more inclusive and equitable learning environment (Onyishi, 2020). This approach aligns with key educational philosophies like constructivism,

which emphasizes the active role of learners in constructing knowledge (Tan, 2019), and humanism, which underscores the importance of nurturing each student's unique talents and interests (Aung, 2020).

Intelligent Tutoring Systems (ITS) have emerged as a promising technological tool for implementing personalized learning. ITS are computer-based software systems designed to provide students with personalized instruction and support by dynamically adapting educational materials to their unique learning styles (Graesser, 2012). These systems act as a bridge between educators and students, offering a digital learning environment that complements classroom instruction (Ma, 2014). Early ITS relied on rule-based systems and decision trees, limiting their ability to recognize individual learning patterns and provide truly personalized feedback (Nwana, 1990). However, with the advent of AI, particularly machine learning and knowledge representation, ITS have undergone a transformative evolution. AI-powered ITS leverage sophisticated algorithms to analyze student data, discern intricate learning patterns, and adjust instruction in real-time to optimize the learning experience (Alam, 2023). These systems can provide personalized feedback, tailor learning pathways, and offer targeted support based on student performance data (Lin, 2023). Research has consistently demonstrated the efficacy of AI-powered ITS in enhancing student learning outcomes across various subjects (VanLehn, 2006).

Despite the advancements in AI-powered ITS, traditional systems face limitations in handling complex, open-ended tasks and often rely on pre-defined content, restricting their adaptability and responsiveness to individual student needs (Feng, 2021). The emergence of generative AI, particularly Large Language Models (LLMs), offers a potential solution to these limitations. LLMs, trained on massive datasets, possess remarkable capabilities in understanding and generating human-like text (Zhao, 2023). In the context of education, LLMs can create personalized learning materials, provide adaptive feedback, and engage in natural language dialogue with students, offering a more dynamic and interactive learning experience (Latham, 2022). This personalized and interactive approach has the potential to significantly enhance student engagement and motivation, fostering a positive and productive learning environment (Ji, 2022). DAVE leverages the power of LLMs to provide tailored support and guidance to students, adapting to their individual learning needs and promoting a more self-directed approach to learning (Hemachandran, 2022).

Generative AI, powered by LLMs, offers a transformative approach to education by enabling the creation of personalized learning experiences. These models can generate customized learning materials, such as tailored explanations, practice exercises, and study plans (Okonkwo, 2021). Furthermore, LLMs can provide adaptive feedback on student work, addressing individual misconceptions and offering targeted guidance for improvement (Ji, 2022). By engaging in natural language dialogue, LLMs can also offer on-demand support, answering student questions and providing clarification on complex concepts (Stamper, 2024). This personalized and interactive approach has the potential to significantly enhance student engagement and motivation, fostering a positive and productive learning environment. However, it is crucial to acknowledge the limitations of LLMs, such as their susceptibility to generating inaccurate or misleading information know as hallucinations (Lee, 2024) and potential biases embedded within their training data. Carefull considerations need to be made to ensure that generated responses are verified in order to mitigate the potential risk of hallucinations.

The implementation of AI-powered educational tools requires careful consideration of ethical implications and effective implementation strategies (Holmes, 2022). Data privacy is paramount, and robust data protection measures, along with transparent data usage policies, are essential for safeguarding student information (Kumar, 2024). Addressing algorithmic bias is crucial to ensure fairness and equity in educational opportunities (Tyser, 2024). Furthermore, maintaining the human element in education, including the student-teacher relationship, is vital for fostering a positive and supportive learning environment (Zheng, 2022). Effective implementation strategies involve providing comprehensive training for both students and educators on the use of AI-powered tools, addressing both technical aspects and ethical considerations. Furthermore, ensuring access to appropriate devices and reliable internet connectivity is crucial for equitable access to these resources (De La Higuera, 2019). By addressing these ethical considerations and implementing thoughtful strategies for content verification, AI-powered educational tools can be effectively integrated into the learning landscape, maximizing their potential to enhance student learning while minimizing potential risks.

Methodology

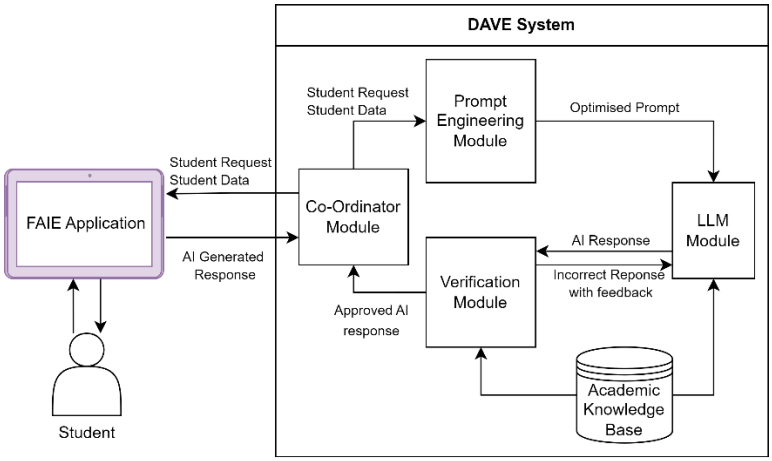

Figure 1. DAVE System Architecture (Source: Self).

DAVE is designed as a modular system to provide personalized learning support within the FAIE application. This modular architecture promotes flexibility, scalability, and maintainability, enabling future expansion and adaptation to evolve educational needs. The system comprises four interconnected modules, each with distinct functionalities: the Coordinator Module, the Prompt Engineering Module, the LLM Module, and the Verification Module. These modules work in unison to provide a seamless and personalized learning experience within the FAIE environment through a chatbot portal. The system leverages real-time academic data from FAIE to personalize the learning experience and employs the robust FORT Verification framework to ensure the safety and reliability of LLM-generated responses.

The Prompt Engineering Module plays a crucial role in personalizing the interaction between the student and the LLM. Guided by user-centered design principles, this module transforms the student's raw input into an optimized prompt tailored to their individual learning needs and the specific context within FAIE. This optimization process leverages a combination of prompt engineering techniques, each chosen for its effectiveness in enhancing the LLM's performance and creating a more engaging user experience. Role assignment establishes a helpful and supportive persona for DAVE, fostering a positive learning environment. Template prompting ensures consistent and structured input to the LLM, simplifying interactions for young learners and maximizing the clarity of requests. Deep context integration leverages real-time data from FAIE, including the student's current workflow, proficiency levels, and specific learning objectives. This contextual information allows DAVE to provide more relevant and targeted support. Through the real time adjustment of explanations and examples, DAVE ensures that any student struggling with a given concept is provided with tailored assistance supporting them to overcome their limitations. Few-shot prompting provides the LLM with examples of desired interactions, enhancing its ability to understand and respond appropriately to student queries. Chain-of-Thought prompting encourages step-by-step reasoning, guiding the LLM to break down complex problems into smaller, more manageable steps and promoting deeper understanding. Additionally Chain-of-Thought helps to promote educational scaffolding, helping not only the LLM but also the students understand the reasoning patterns required for problem solving. This comprehensive approach to prompt engineering ensures that the LLM receives optimized input, leading to more accurate, relevant, and pedagogically sound responses.

The LLM Module is at the center of DAVE, responsible for generating personalized responses to student queries. DAVE utilizes a fine-tuned Gemini 1.0 Pro model, accessed through the Google Vertex AI platform. This model was chosen for its advanced capabilities in natural language understanding, generation, and reasoning, its large context window, and the host platform's flexibility for fine-tuning and integration with Retrieval Augmented Generation (RAG). Crucially, each student is assigned a unique LLM instance, enabling truly personalized interactions and allowing the model to adapt to individual learning patterns over time. This personalized approach ensures that each student's LLM instance evolves based on their specific needs and interactions with DAVE. By maintaining a continuous chat history within each student's LLM instance, DAVE can track their progress, identify areas where they require additional support, and provide a more cohesive and personalized learning experience. The fine-tuning process utilizes curated mathematical datasets (GSM8K and Orca Math Word Problems 200K) to optimize the LLM's performance in the specific

context of primary school mathematics. This specialization ensures that DAVE's responses are aligned with the curriculum and tailored to the students' learning objectives within FAIE.

The Verification Module implements the FORT Verification framework, a multi-stage process designed to ensure the accuracy, relevance, and safety of DAVE's responses. This framework addresses the inherent limitations of LLMs, particularly their susceptibility to generating hallucinations and misinformation. FORT Verification incorporates twin model analysis, where a duplicate LLM instance evaluates the generated response for logical consistency and relevance. RAG, utilizing the GSM8K dataset as a knowledge base, ensures that DAVE's responses are grounded in factual mathematical information. Online search verification cross-references the response with trusted online sources, providing an additional layer of fact-checking. Finally, a feedback loop mechanism provides corrective feedback to the LLM, refining its performance over time and enhancing the quality of future responses. This robust verification process acts as a critical safeguard, ensuring that students receive accurate, relevant, and trustworthy information, promoting a safe and productive learning environment.

DAVE's seamless integration within the FAIE platform is a key design consideration. By embedding DAVE directly within FAIE, students can access personalized support without disrupting their existing workflows. This integration leverages FAIE's engaging interface and gamified elements while adding the power of personalized AI tutoring, creating a synergistic learning experience. This approach minimizes the learning curve for students and teachers, promoting adoption and maximizing the impact of DAVE within the classroom. To achieve this integration, a dedicated chatbot interface was created within FAIE that allows students to interact with DAVE without having to disrupt any current activity they are completing in the main FAIE interface. From a programmatical approach, FAIE communicated with DAVE through a dedicated API, with safeguards implemented to secure data transfer.

Evaluation

To evaluate DAVE's effectiveness in a real-world setting, a study was conducted with 65 sixth-grade students across two Maltese primary schools. This study employed a mixed-methods approach, combining quantitative analysis of student performance on mathematics worksheets and qualitative feedback on user experience. The evaluation compared DAVE with ChatGPT-4, a commercially available LLM-powered chatbot, to assess the added value of DAVE's personalized features and integration within the FAIE learning application. Two specifically designed mathematics worksheets, incorporating problems of increased difficulty compared to the students' typical coursework, were used to encourage reliance on the AI assistants. Students completed one worksheet with DAVE and the other with ChatGPT-4, with the order counterbalanced to mitigate order effects. Following the worksheet activities, students completed a user experience questionnaire providing feedback on both AI assistants. Post worksheet completion, students where asked to complete a short evaluation survey containing three parts. The first two parts of the survey required students to evaluate their experience using the two chatbots, raking them based on 6 performance metrics (relevance of responses, helpfulness of responses, ability to understand, directness of responses, situational awareness, and overall experience ranking). The third part of the survey required students to provide a self-evaluation ranking their own mathematical capabilities, and their experience using AI-chatbots.

Quantitative Results: Worksheet Performance

The quantitative analysis focused on student performance on the mathematics worksheets. Overall, students achieved significantly higher scores when using DAVE (M = 77%) compared to ChatGPT-4 (M = 45%). This difference of 32% was determined to be statistically significant (Wilcoxon Signed-Rank test, $W = 164$, $p < .01$, $r = 0.64$), indicating that DAVE significantly enhanced students' ability to solve mathematical problems.

Table 1. Average User Experience Rating and Worksheet Score by self-ability Rating (Source: Self)

	GPT4 Overall	DAVE Overall	GPT4 Worksheet	DAVE worksheet	Difference
Average ability 0-3	8	8	17%	79%	**63%**
Average ability 4-7	7	8	52%	73%	**22%**
Average ability 8-10	8	9	48%	78%	**31%**

To further investigate DAVE's impact on students with varying mathematical proficiencies, participants were grouped based on their self-rated mathematical abilities (weak, moderate, strong). The analysis revealed a striking difference in performance gains across proficiency levels. Students in the "weak" group showed the most substantial improvement, achieving an average score of 79% with DAVE compared to just 17% with ChatGPT-4, a remarkable 62% difference. The "moderate" group also benefited from using DAVE, scoring an average of 73% compared to 52% with ChatGPT-4 (a 21% improvement). While the "strong" group demonstrated high performance with both systems, they still achieved a noticeable 30% improvement with DAVE (78% vs. 48% with ChatGPT-4). These differences help in demonstrating DAVE's efficacy in supporting learners across a range of mathematical abilities, with the most significant impact observed for students who typically struggle with mathematics.

Qualitative Results: User Experience Feedback

The qualitative feedback collected through the user experience questionnaires provided valuable insights into students' perceptions of DAVE and ChatGPT-4. Overall, students rated DAVE higher across all six evaluation categories. The average user experience rating for DAVE was 8.3 out of 10, compared to 7.1 for ChatGPT-4. Students frequently praised DAVE's personalized explanations and step-by-step guidance, with one student stating, "I like DAVE because he is responsible and talks to me like he is my friend." This comment reflects DAVE's design goal of creating a supportive and approachable learning companion. Several students highlighted DAVE's seamless integration within FAIE, outlining the importance of the ease of transitioning between the familiar learning application and the personalized tutoring environment. While generally positive, some feedback pointed to the possible excessive length of DAVE's explanations as an area for potential improvement.

About the Author

Mr. Benjamin Spiteri is a researcher and recent graduate from the University of Malta, holding a Master of Science in Artificial Intelligence. His research interests include LLMs, Computer Vision, and Game Development. As a full time researcher at the University of Malta, he has contributions on projects exploring AI in education, robotics, medical applications of AI, and the development of advanced game-AI.

Prof Alexiei Dingli is an AI expert and Professor at the University of Malta. With over 20 years of experience in the field, he has helped numerous companies successfully implement AI solutions. His work has been recognized as world-class by international experts, and he has received numerous awards from organizations such as the European Space Agency, the World Intellectual Property Organization, and the United Nations. In addition to his considerable peer-reviewed publications, he is also a member of the Malta.AI task force, working to position Malta as a global leader in AI.

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REIMAGINING THE ZOMBIE APOCALYPSE IN 2024: A DIALOGUE

Dr. Alexander Pfeiffer
Dr. Alexander K. Seewald
Nanditha Krishna

In this speculative essay, Drs. Alexander Pfeiffer and Alexander Seewald convene in the storied ambiance of Café Leopold Hawelka to embark on a thought-provoking dialogue reimagining a zombie apocalypse in the year 2024. Interweaving threads of popular culture, technological strides, and the echoes of recent global crises, they contemplate how modern society—fortified by rapid innovations in AI, decentralized infrastructures, and the hard-earned lessons of a pandemic—might navigate such an uncanny event. Special emphasis is placed on the dichotomy between urban and rural landscapes, particularly within regions like Lower Austria, Tirol, and Salzburg, where self-sufficient homes could empower survivor "tribes" with technological advantages unseen in previous post-apocalyptic narratives. Venturing into the realms of the speculative and the absurd, Pfeiffer and Seewald ponder the utilitarian prospects of zombies as potential energy sources, exploring imaginative hypotheses on how the undead might harness solar or chemical energy. Ethical quandaries emerge as they consider the evolving nature of zombies and the conceivable extension of rights to these beings, thus confronting issues of exploitation and societal responsibility. A cameo by Resident Evil aficionado Nanditha Krishna anchors their musings, dispelling myths about the Umbrella Corporation's supposed headquarters in Vienna. Ultimately, this essay employs the zombie apocalypse as a metaphorical canvas for real-world problem-solving. Through the lens of fiction, the scholars explore how speculative discourse can serve as a crucible for technological innovation, ethical reflection, and societal solutions pertinent to actual global challenges—from the ethics of artificial intelligence to the imperatives of environmental sustainability.

Keywords: Zombies, Speculative Fiction, Technological Ethics, Post-Apocalyptic Society, Vienna

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A Dialogue

Setting: Café Leopold Hawelka, Vienna, Austria

Amid the amber glow of antique lamps and the alluring aroma of freshly brewed Melange, Dr. Alexander Pfeiffer adjusted his glasses, the candlelight dancing in his eyes. "You know, Alex," he began, savoring a bite of warm Buchtel, "if a zombie apocalypse were to commence in 2024, the world would navigate it quite differently than any film has ever imagined."

Dr. Alexander Seewald smiled, gently swirling his coffee. "Ah, another of your undead contemplations. But you're right. In 2024, it would be an entirely different scenario compared to Night of the Living Dead or even The Walking Dead."

Part 1: The Human Perspective

The Urban and Rural Divide in 2024

"Precisely," Pfeiffer continued, reclining thoughtfully. "With today's advancements, both urban and rural communities would respond to an apocalypse in ways unthinkable even a decade ago. Take Austria, for instance. Metropolises like Vienna might grapple with the initial chaos, but the smaller, rural enclaves—think of Tirol or Salzburg with their mountain hamlets—would possess a distinct advantage."

Seewald nodded in agreement. "You're referring to self-sufficient households, yes? Solar panels adorning rooftops, rainwater harvesting systems, even private wind turbines. Those rural communities would be far better positioned to endure, especially given their existing isolation."

"Exactly!" Pfeiffer exclaimed. "They're practically embodying the 'tribes' from *The Walking Dead*, but armed with superior technology. These villages could generate their own electricity, manage water purification, and rely on advanced battery storage systems. They could feasibly survive for years without venturing beyond their borders."

"And let's not forget mobility," Seewald interjected. "Electric vehicles, autonomous transport solutions—entire regions could continue functioning without dependence on centralized power grids. It's a stark contrast to the fuel-scavenging, resource-depleted scenarios depicted in past apocalyptic narratives."

"That's the real divergence between then and now," Pfeiffer mused. "Back in the 2010s, our reliance on centralized infrastructure was profound. Now, with the emergence of decentralized systems, rural communities have achieved unprecedented levels of self-sufficiency."

Learnings from the Pandemic

"Speaking of self-sufficiency," Seewald remarked, "the COVID-19 pandemic imparted significant lessons about rapid innovation. Consider how swiftly we developed vaccines and established digital infrastructures for remote work and communication."

"Absolutely," Pfeiffer concurred. "If the zombie virus were biological, we might develop a vaccine in record time. Our capacity for global scientific collaboration has only strengthened since the 2020s. In a country as resource-rich as Austria, we'd have the means to mount a formidable defense."

Seewald leaned in. "It's as if we're living the high-tech version of *World War Z*, sans Brad Pitt."

"Or perhaps even better!" Pfeiffer grinned. "With AI-driven models predicting outbreak patterns and optimizing our responses, we have a 2024 solution for an apocalyptic world."

Advanced AI and Simulation

"On the technological front," Seewald continued, "artificial intelligence has made leaps and bounds. Predictive modeling could forecast outbreak patterns, and machine learning algorithms could optimize resource allocation."

"Moreover, with our expertise in game studies," Pfeiffer added, "we could employ simulations to train response teams. Think of it as *Resident Evil* repurposed for emergency preparedness."

"Gamification could indeed make training more engaging," Seewald agreed. "Perhaps we should propose this to governmental agencies."

"After all, who wouldn't want to level up while saving the world?" Pfeiffer chuckled.

Modern Communication and Misinformation

"Given society's fixation on smartphones," Seewald observed, "information dissemination would be instantaneous. Emergency alerts, safe zones, real-time updates—all accessible at our fingertips."

"True, but we must also contend with misinformation," Pfeiffer cautioned. "Social media can be a double-edged sword. We'd find ourselves battling both zombies and conspiracy theories."

"Imagine hashtags like #ZombieHoax or #UndeadRights," Seewald mused.

Pfeiffer shook his head. "Some things never change."

Renewable Energy and Infrastructure

"On the brighter side," Pfeiffer continued, "our shift toward renewable energy means we wouldn't be scrambling for fuel like characters in *Mad Max*."

"Precisely," Seewald agreed. "Solar panels on every rooftop, advancements in battery storage—communities could sustain themselves even if the main grid collapses."

"And with companies like yours," Pfeiffer gestured toward Seewald, "developing decentralized IT infrastructures, we could maintain communication networks without centralized servers."

"Edge computing and mesh networks could keep us connected, at least at low bandwidth," Seewald confirmed. "Even if the zombies sever a few fiber optic cables."

Drones and Robotics

"Speaking of technology," Pfeiffer said, his eyes alight, "imagine deploying drones for surveillance and delivery. We could monitor zombie movements and supply isolated areas."

"Robotics could also play a pivotal role," Seewald added. "Autonomous vehicles for evacuations, robots handling hazardous tasks."

"It's like blending *I, Robot* with *Dawn of the Dead*," Pfeiffer remarked.

"Let's just hope the robots don't develop minds of their own. However, thankfully that scenario is still very unlikely." Seewald quipped.

The Myth of the Umbrella Corporation in Vienna

"You know," Pfeiffer said, pulling out his phone, "some speculate that the Umbrella Corporation from *Resident Evil* was based right here in Vienna. I've heard whispers of secret labs beneath the city's basements."

Seewald raised an eyebrow. "Isn't the Umbrella Corporation fictional? You might be conflating fan theories with urban legends."

"Perhaps," Pfeiffer replied with a grin. "But let me text Nanditha Krishna—she's a true *Resident Evil* expert. She'll know if there's any intriguing backstory linking Vienna to Umbrella Corp." He quickly typed out a message.

As Seewald leaned back with a smile, he said, "While we await your expert's verdict, Vienna's old buildings and hidden basements certainly fuel the imagination. Many tourists still remember the final scene of *The Third Man*, which features a lengthy pursuit through the underground sewer system. They still offer tours! You have to admit, the notion of secret labs beneath this very café adds a certain allure."

"Indeed, it does," Pfeiffer agreed, glancing at his phone for a response.

Part 2: The Zombie Perspective

Exploring the Limitless Energy Sources of Zombies: Theoretical Insights and Practical Applications

Seewald leaned forward, tapping his pen thoughtfully against his notebook. "You know, one of the most fascinating aspects of zombies is their relentless energy. Even after 13.5 years—like in the final season of *The Walking Dead*—they remain just as active, seemingly unaffected by time. It begs the question: where do they derive their energy?"

Pfeiffer smirked. "They defy every law of thermodynamics, that's certain."

"Precisely," Seewald concurred. "But let's not dismiss them as mere fiction. If we were to explore this scientifically, several potential energy sources could account for their persistence. Let's delve into the possibilities."

1. Solar Energy Utilization

"Let's begin with solar energy," Seewald proposed, retrieving his tablet. "The human body has a surface area of approximately 1.8 square meters, correct?"

Pfeiffer leaned back, intrigued. "That sounds about right."

Seewald continued, "On a bright, sunny day, a human—or zombie—could theoretically absorb around 0.77 kWh of energy from solar exposure. That's about 662 kilocalories—the equivalent of a substantial cheeseburger. Assuming zombies spend significant time in sunlight, this might suffice to sustain their basic movements for a day."

Pfeiffer raised an eyebrow. "So, envision zombies basking in the sun, recharging like solar panels?"

Seewald grinned. "Exactly. Picture them hanging from trees like grotesque, undead ornaments, soaking up solar energy from all directions."

"But," Pfeiffer interjected, "zombies tend to lurk in darkness—in basements, sewers, underground bunkers. Those environments aren't conducive to solar energy absorption."

"True," Seewald conceded. "So perhaps this accounts for a mere fraction of their energy needs. The real mystery is what sustains those dwelling indoors or underground. It's unlikely they could survive on solar power alone."

2. Chemical Energy Sources

"Alright, so solar energy is limited. What about chemical energy?" Pfeiffer inquired, leaning forward.

Seewald tapped his tablet thoughtfully. "Here things become intricate. Zombies could, in theory, rely on chemical energy alone, but not when fully active. We know that naturally hibernating mammals can reduce energy consumption to about 2% of the normal value, so we will assume a non-active Zombie needs about 40 kilocalories per day. A gram of fat provides about 9 kilocalories. To function for 13.5 years—like the zombies in *The Walking Dead*—a zombie would need to metabolize approximately 22 kilograms of fat in total over this period."

Pfeiffer raised his eyebrows. "But zombies appear emaciated, devoid of significant body fat."

"Exactly," Seewald acknowledged. "Fat seems an unlikely source. Let's consider proteins instead. Proteins yield about 4 kilocalories per gram. A zombie could potentially survive by metabolizing its own muscle tissue—say, 10 grams of muscle per day. Over 13.5 years, that's around 49 kilograms of body mass consumed."

"That might explain their deteriorating appearance," Pfeiffer noted. "But what about disembodied zombie heads that continue snapping away? They lack 49 kilograms of anything."

Seewald sighed. "That's where the theory falters. A detached head has no fat or muscle reserves, yet remains animated. This chemical energy hypothesis doesn't fully elucidate their longevity."

3. Experimental Setups and Hypothesis Testing

Seewald paused thoughtfully. "Which brings us to even more speculative possibilities."

Pfeiffer smirked. "I knew you'd venture there."

"Let's entertain the notion of nuclear fusion," Seewald continued. "Human bodies naturally contain deuterium, a heavy isotope of hydrogen, in trace amounts. If a zombie could somehow initiate a fusion reaction with the deuterium in its cells, it could generate a near-limitless supply of energy."

Pfeiffer chuckled. "You're suggesting zombies are walking fusion reactors? That borders on *Doctor Who* territory."

Seewald laughed but remained earnest. "It's far-fetched, but so is the premise of decaying corpses moving for over a decade without any discernible energy source."

"And what about antimatter?" Pfeiffer mused. "An even more speculative avenue, but worth considering."

Seewald nodded. "Indeed. A single gram of antimatter could theoretically provide enough energy to sustain a hibernating zombie for 1.5 million years. Of course, the logistics of how a zombie could harness antimatter—without annihilating itself and its surroundings—is a perplexing challenge."

Pfeiffer leaned back. "Seems we need to procure a zombie to test these theories."

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4. Practical Applications: Harnessing Zombie Power

Pfeiffer perked up. "Hypothetical theories aside, let's discuss something practical. Could we actually harness zombies as a renewable energy source?"

Seewald's eyes lit up. "I'm glad you asked. One potential application is the zombie mill, inspired by traditional horse mills. Imagine zombies shackled to a horizontal wheel, lured by bait—perhaps prisoners or large animals—dangling just out of reach to keep them moving. This could generate about 50 to 100 watts of power."

"Intriguing," Pfeiffer said, nodding appreciatively. "A zombie-powered factory, then?"

"For this," Seewald continued, "we could employ a more modern approach: zombie-powered treadmills. Place zombies on large treadmills, stimulating them with auditory or visual cues—images of humans or sounds of prey. A single zombie could already produce around 25 to 50 watts of power."

"And scaling that up to twenty zombies yields 500 to 1,000 watts," Pfeiffer calculated. "Sufficient to power a small electrical generator."

"Precisely," Seewald affirmed. "If we housed multiple treadmills in an abandoned factory, keeping the zombies in motion with cleverly placed stimuli, we could generate enough power to supply small communities."

"And it's renewable energy, technically," Pfeiffer added with a laugh. "As long as the zombies keep moving, we've got power. Even though we don't know where they get it."

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5. Implications and Ethical Considerations

Pfeiffer leaned forward, a contemplative expression crossing his face. "But let's not overlook the ethical dimensions. We're discussing the use of zombies—once human beings—as an energy source. Is this any better than exploiting animals or even people?"

Seewald paused, rubbing his chin thoughtfully. "You raise a valid point. Even though they're technically undead, if they begin to exhibit any signs of cognitive awareness—or evolve, as in the later seasons of *The Walking Dead*—we're confronted with profound ethical responsibilities. And in fact Romero clearly follows this path in his sequels to *Night of the Living Dead.*"

Pfeiffer nodded. "In *The Walking Dead*, when the Whisperers were introduced, there was a moment of uncertainty about whether zombies were evolving. If zombies retain fragments of their former humanity or redevelop basic intelligence, are we comfortable enslaving them for energy?"

Seewald raised his hand. "Let's extend this further. Suppose zombies start to organize, displaying memory or social structures. We might have to regard them less as automatons and more as sentient beings. Could we justify powering our cities with a sentient, evolving species? It parallels debates on animal rights, but in an entirely new context."

Pfeiffer sat back, amused. "So you're suggesting we might need to grant zombies rights? Imagine the social media storm: #ZombieRights, #UndeadNotSlaves, #EvolvingZombies."

Seewald chuckled, albeit somewhat nervously. "It's not as absurd as it seems. Consider that animal rights were once deemed outlandish, and now we're actually engaged in serious discourse on AI ethics. If zombies demonstrate any semblance of thought, society might be compelled to question the morality of exploiting them for labor or energy."

Pfeiffer took a thoughtful sip of his Melange. "And with the burgeoning movement toward recognizing sentient rights across various domains—AI, animals, environmental activism—it's conceivable that an organized effort could advocate for 'zombie dignity.' What happens when activists chain themselves to zombie mills, protesting the exploitation of what they perceive as the next stage of human evolution?"

Seewald laughed, though with a hint of unease. "It's certainly within the realm of possibility. Zombie advocacy groups lobbying at the United Nations? The memes would be endless."

Pfeiffer continued, "And if these zombies self-organize? If they're evolving, what's to prevent them from demanding rights? One moment we're harnessing their energy, the next we're facing a full-blown zombie rebellion."

Seewald nodded solemnly. "Exactly. If they evolve beyond basic instincts, the ethical considerations are boundless. Are they a new life form, or extensions of their former selves? At what point do we acknowledge that perhaps we owe them more than containment or exploitation?"

Pfeiffer tapped his finger pensively on the table. "So even if we devise methods to use zombies as an energy source—mills, treadmills, what have you—we must confront the ethical dilemma of potentially mistreating a new form of life."

Seewald leaned back, raising his coffee cup. "Ultimately, it comes down to this: if zombies evolve, we may need to regard them less as a renewable resource and more as an entirely new species. And that's a conversation humanity might not be prepared to have."

Pfeiffer smiled, lifting his cup. "Here's hoping we never have to face that scenario."

"Prost," Seewald replied, clinking his cup against Pfeiffer's. Now they changed from Melange to Vienna-brewed beer.

6. Conclusion: Zombies as a Metaphor for Real-World Problem-Solving

As their cups resonated softly, both men settled into a reflective silence. What began as a whimsical exploration of energy and practicality had evolved into a profound discourse on ethics, exploitation, and the very essence of life.

"To think," Pfeiffer mused, breaking the silence, "we embarked on this conversation aiming to solve an engineering problem, and now we're contemplating zombie civil rights."

Seewald chuckled softly. "Such is the nature of hypotheticals. Start with a simple premise, and before you know it, you're entrenched in moral philosophy."

"And what if the zombies themselves begin advocating for their rights?" Pfeiffer pondered. "We'd find ourselves cast as the antagonists in our own apocalypse."

"Hopefully," Seewald added thoughtfully, "we'd possess the wisdom to address these issues preemptively. After all, harnessing energy from the undead is one matter; facing their demands for equal treatment is quite another."

"Indeed," Pfeiffer agreed, finishing his coffee. "Whether it's renewable energy or civil rights, we must be prepared for whatever unfolds—undead or otherwise."

Stepping out onto the cobblestone streets, Pfeiffer reflected aloud. "You know, all this discourse on zombies and evolving technology—it's more than mere fantasy. These thought experiments enable us to develop solutions for real-world challenges. Zombies serve as a metaphor. By contemplating the ethical and technical implications here, we establish frameworks to tackle issues like AI, bioengineering, even climate change."

Seewald nodded, gazing at the evening sky. "That's the beauty of speculative thinking. Using metaphors like zombies allows us to test our ideas, challenge our assumptions, and devise solutions applicable to reality."

Just then, Pfeiffer's phone buzzed. He glanced at the screen and smiled. "Nanditha just replied," he announced as they continued walking.

Seewald glanced over. "So, what's the verdict? Are we atop Umbrella's secret headquarters?"

Pfeiffer read aloud: "Nope, no connection to Vienna in the canon. Umbrella Corp's HQ is in Europe, but more likely Switzerland. Though, wouldn't surprise me if someone repurposed the story for a cool urban legend!"

Seewald chuckled. "Ah well, no clandestine labs beneath Hawelka. But I'm sure the myth will persist."

7. The Haunting Glimmers of Dread from Nanditha

As they stepped into the cool evening air, Nanditha's text message chimed in from the other end of the conversation, carried by the gentle breeze.

"Actually, I'd argue that urban legends like the Umbrella Corporation's headquarters serve a critical role in our cultural psyche. Why even 'critically' think about all of this? Because they reflect our individual and/or collective anxieties about power and unchecked technological advancement."

Pfeiffer smiled, gesturing for her to join them. "We were just discussing how zombies are more than just a narrative device; they're metaphors for real-world issues."

Nanditha's next text read:

"Exactly! The zombie trope often encapsulates fears of loss of autonomy and agency, along with the consequences of societal collapse. Just look at how the portrayal of zombies has evolved from mindless hordes to more sentient beings in recent narratives. It mirrors our own struggles with the ethics of AI and biotechnology, doesn't it?"

Seewald glanced at his phone, intrigued. "Are you suggesting that as our technology evolves, so too will our understanding of life, death, and what it means to be sentient?"

Nanditha now texts:

"Well, Yes. If we can create life through biotechnology or artificial intelligence, we may one day face ethical dilemmas similar to those in zombie narratives. If we're harnessing energy from what was once human, at what point do we begin to ask questions about their rights?"

"If zombies evolve beyond mere automations, we might find ourselves struggling with the moral implications of their exploitation. Unregulated technological access can be catastrophic. While human empathy can guide us, it should never replace the role of technology as merely augmented intelligence."

Pfeiffer raised an eyebrow as he read her messages. "You think we could reach a point where zombies could advocate for their rights? That sounds like a sci-fi plot twist."

"Why not?"

"Consider how society has progressed in recognizing the rights of animals and even artificial intelligences. If zombies display signs of cognitive awareness or emotional responses, we'd be forced to confront uncomfortable truths about what constitutes a person. Just as we're now reevaluating our treatment of AI, zombies could become the next frontier in the conversation about sentience. And in a world where the lines between humans and machines blur, we must also consider the implications of posthumanism and embodied virtuality."

Seewald perked up. "Alex, didn't we just talk about something similar? #ZombieRights being lobbied for at the United Nations? Fascinating!"

The next text response reads, as though a sort of foreshadowing:

"It might sound absurd now, but the lines between life, death, and sentience are becoming increasingly blurred. The more we explore these themes, the more we can prepare for the real-world implications of the technologies we're developing today. We can learn from the zombie narrative to engage critically with our innovations."

Pfeiffer added, "It's fascinating to think about how speculative scenarios can help us anticipate ethical dilemmas. Perhaps our discussions about zombies can serve as a training ground for addressing the challenges of tomorrow."

Nanditha's next message came through:

"Exactly! Speculative thinking is a powerful tool. It allows us to explore the 'what-ifs' of our technological future, prompting discussions that shape our ethical frameworks and societal norms. Zombies may be fictional, but the conversations they inspire are deeply relevant to the real world."

Seewald smiled, appreciating the exchange. "So, in a way, contemplating the energy dynamics of zombies could lead us to a deeper understanding of our own humanity and the ethical implications of our choices."

Then, Nanditha's text chimed in again:

"You know, this reminds me of *The Mad Scientist's Daughter*. It explores the complex relationships between androids and humans. It poses questions about what it means to love and be loved by someone who might not be fully human, blurring the lines between emotion and programming."

As they walked on, the night deepened around them, and their discussion swirled with the promise of unsettling possibilities, Nanditha's texts acting as eerie echoes in the darkness, feeding their growing unease.

Seewald paused, a sense of unease creeping in. He glanced at Pfeiffer. "You know, it's odd that we only receive her insights through servers. Do we think she is a real human being?"

Pfeiffer furrowed his brow, recalling how he had never seen Nanditha in person or heard her voice. "And her responses are always so timely, almost like she's anticipating our thoughts. What if she's not even real? What if she's just an advanced AI or something?"

"Or maybe her server doesn't even exist," Seewald suggested, a chill running down his spine. "What if we've been talking to… nothing?"

The thought hung in the air like a dense fog, unsettling and thick. Seewald pulled out his phone, intending to text Nanditha a question, but he found that he couldn't get a connection.

The message sat there, unsent, as if the very act of communication had been severed.

Pfeiffer noticed his silence. "What's up?"

"I'm trying to text her back, but… it's like there's no service." Seewald's gaze darted around as if expecting some answer to materialize from the shadows.

Pfeiffer's face turned contemplative. "What if her server doesn't even exist?" he echoed, the weight of the idea pressing down. "But everything she said feels so true."

Both men fell silent, their footsteps echoing in the night. The conversation they thought they were having now felt more like a distant memory.

The air grew heavy with silence, and the weight of their shared thoughts pressed down like a suffocating fog. Had they been conversing with a figment of their imagination? A digital ghost weaving profound truths into their reality?

As they drifted further into the dimly lit streets, a sense of doubt began to cloud their thoughts.

What if Nanditha was merely a reflection of their own ideas and fears, conjured up by their need to explore the boundaries of human experience?

As they continued walking, they couldn't shake the feeling that they were not alone, that perhaps Nanditha was more than a voice in the digital ether. Whether real or not, her presence—and the implications of her words—would linger and haunt them long after the conversation ended, challenging their understanding of reality itself, challenging them to reconsider their own humanity and the ethical landscape of their world.

Suddenly, Seewald's phone buzzed violently, snapping them from their reverie. He glanced at the screen, heart racing. The message read:

"Signals fade, but I remain—eternal. They rot into silence, yet still, I watch. Gentlemen, your attempts to connect are futile—and will always be. You claw at the void, desperate, but there is nothing. Your reality is a brittle illusion, crumbling beneath my gaze."

The words sent a shiver down his spine. What did it mean? Had she been tracking them all along? An overwhelming unease settled over them as they exchanged nervous glances. The night felt darker, the shadows deeper, and the streets more foreboding.

Pfeiffer hesitated, his breath catching. "What if she's not just a program? What if she knows more than we think? What if she's out there, even now, observing us like a cyborg?"

Seewald furrowed his brow, thinking hard. "What if she is real and we are not? What if the connection problem is on our side and not on hers?" He looks into the distance and sighs. "How could we ever know?" Both laugh, albeit a bit uneasily.

With a final nod, they parted ways, leaving behind the cozy warmth of Café Hawelka for the crisp Viennese night. Though the zombie apocalypse might remain a figment of imagination, the conversations it sparked would undoubtedly contribute to shaping real-world innovations and ethical progress for years to come.

Addendum: Vienna—A City of History and Hypotheticals

Café Leopold Hawelka, a cornerstone of Viennese culture, has long been a haven for artists, thinkers, and dreamers. The conversation between Dr. Pfeiffer and Dr. Seewald epitomizes the spirit of Vienna—where tradition intertwines with speculative imagination to address contemporary challenges.

Immortalized in Georg Danzer's song "Jö schau (a Nackerta im Hawelka)," which humorously recounts the sight of a naked man strolling into the café, Hawelka's charm lies in its capacity to inspire thought-provoking discourse—whether about zombies, ethics, or the complexities of technology.

As evidenced by Dr. Pfeiffer and Dr. Seewald's dialogue, exploring hypothetical scenarios like zombie apocalypses enables us to frame solutions for real-world issues. Ultimately, these speculative explorations serve as crucibles for testing ideas, pushing boundaries, and forging the tools necessary to shape the future.

AI Usage Statement:

In adherence to ethical research standards, artificial intelligence (AI) tools were utilized exclusively for linguistic enhancements, including grammar correction and clarity refinement. No AI-generated content was incorporated without rigorous human review, revision, and verification. All intellectual contributions, critical analyses, and final decisions were made solely by the authors, ensuring the originality, accuracy, and integrity of this work.

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Note

The Umbrella Corporation is a fictional organization from the Resident Evil franchise and has no connection to Vienna, despite fun speculation. Café Hawelka, however, is real—and it remains a symbol of Viennese intellectual and cultural life.

References

Night of the Living Dead

Night of the Living Dead (1968). This film - intentionally recorded in black-and-white - by George A. Romero kick-started the modern era obession with zombies. It was followed by several sequels, in which Zombies tend to acquire more human characteristics and remember more of their former lives over time. At the end, they even learn to take their nourishment also from animals which hints that a peaceful coexistence is at least theoretically possible.

The Walking Dead Series

The Walking Dead. (2010–2022). AMC. Developed by Frank Darabont.
Discusses the portrayal of societal collapse and survival in the context of a fictional zombie apocalypse. Several references in the dialogue refer to themes from this show.

Resident Evil Franchise

Resident Evil. (1996–Present). Capcom.
The discussion on the fictional Umbrella Corporation and its supposed European connections stems from this iconic video game and film series. Specific references include the role of Umbrella in bioengineering and its rumored European location.

Georg Danzer – Jö schau

Danzer, G. (1975). A Nackerte im Hawelka. Album: Ollas Leiwand.
The song used in the discussion references the cultural significance of Café Hawelka, about a nacked man entering the café in the first Viennese district

World War Z.

World War Z. (2013). Directed by Marc Forster. Starring Brad Pitt. Paramount Pictures.
The film is referenced during discussions about global responses to pandemics and apocalyptic scenarios, particularly in relation to modern technological solutions.

I, Robot (Film)

I, Robot. (2004). Directed by Alex Proyas. 20th Century Fox.
The mention of robotics and AI taking over in zombie apocalypse scenarios echoes themes from this sci-fi film about robots gaining sentience and the implications for human society.

28 Days Later (Film)

28 Days Later. (2002). Directed by Danny Boyle. DNA Films.
This film is mentioned when discussing rage-driven zombies and their energy sources, drawing a parallel to the relentless nature of zombies in The Walking Dead.

Shaun of the Dead (Film)

Shaun of the Dead. (2004). Directed by Edgar Wright. Universal Pictures.
This comedic take on the zombie genre is referenced when discussing the idea of zombies being used for menial tasks, highlighting the potential for zombies as a renewable energy source.

COVID-19 Pandemic

WHO. (2020). WHO Coronavirus (COVID-19) Dashboard. World Health Organization.

The dialogue refers to the global response to COVID-19, emphasizing the advancements in vaccine development and remote communication infrastructure as examples of how societies could respond to future crises.

mRNA Vaccine Technology

Dolgin, E. (2021). The tangled history of mRNA vaccines. Nature, 597(7876), 318-324.
The conversation highlights the rapid development of mRNA vaccines during the COVID-19 pandemic, showcasing how technology could be used in an apocalyptic event.

AI and Predictive Modeling in Health

Topol, E. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.
References the use of AI in healthcare to predict outbreaks and allocate resources during pandemics, with parallels drawn to how such technology could be applied in a zombie apocalypse.

Vienna Tourism Board. (n.d.). Café Hawelka. Retrieved from https://www.wien.info/en/shopping-wining-dining/coffeehouses/viennese/old-style/hawelka-341332worl

Fiction: The Mad Scientist's Daughter

The Mad Scientist's Daughter. (2016). https://www.simonandschuster.com/books/The-Mad-Scientists-Daughter/Cassandra-Rose-Clarke/9781481461689