

Prototyping AI-enabled tangible storytelling

Master thesis
Tianrui Pan
Delft University of Technology, 2025

Contents

Summary

Acknowledgements

1 Introduction

1.1 Research overview	3
1.2 Research questions	5
Sub research questions	5
Conclusion	5

2 Literature review

2.1 Storytelling	7
2.2 AI and Large Language Models (LLMs)	8
Multimodal LLMs	8
Embodied AI	8
AI creativity and Human-AI co-creation	9
2.3 AI-enabled storytelling	10
Human-AI collaborative storytelling	10
2.4 Tangible storytelling	12
Embodied interaction	12
Tangible user interfaces	12
Physical computing	13
2.5 Conclusion	14
Conclusion of Literature review	14
Research structure	14

3 Research methodology

3.1 Research through Design	15
What is Research through Design (RtD)?	15
Why did I apply it?	15
How was RtD applied in this research?	15
3.2 Conceptual framework	16
3.3 Qualitative experiment: generative sessions	17
3.4 Data analysis: Affinity diagrams and thematic analysis	17
Affinity diagrams	17
Thematic analysis	18

4 Early prototyping explorations

4.1 Phase overview	19
Goal	19
prototyping timeline	20
4.2 Prototype development	21
Prototype 1: The obnoxious red cube	21

Prototype 2: The story of 3 cubes	23
Prototype 3: The story of 3 cubes (Adding AI physical control)	25
Prototype 4: Telling stories with symbols and movement only	27
Prototype 5: Road trip blocks	29
Prototype 6: Shake the cube!	31

4.3 Insights from the exploration phase 33

What did I explore?	33
What worked?	34
What didn't work?	34
What is missing?	35

4.4 Conclusion & reflection 36

Conclusion	36
Reflection	36

5 Conceptual framework

5.1 Framework development 38

5.2 Framework overview 41

Tangible design space	42
Human-AI Interaction configuration	42

5.3 Application: A playbook to design AI-enabled tangible storytelling systems 43

Step 1: Start somewhere	45
Step 2: Define human-AI interaction configuration or explore tangible design space	46
Step 3: Make a design brief using the framework	46

5.5 Conclusion & reflection 47

Conclusion	47
Reflection & limitation	47

6 User study

6.1 Study goal 49

6.2 User test on human-AI interaction configuration 50

Test setup	50
Test process	52
Preliminary findings	53

6.3 User test on tangible design space 53

Test setup	53
Test process	55
Preliminary findings	56

6.4 Data collection and analysis 57

Step 1: Gathering user quotes and observations from test sessions	57
Step 2: Refining the insights based on themes	60
Step 3: Mapping refined insights into the conceptual framework to create design recommendations	61

6.5 Conclusion & reflection 63

Conclusion	63
Reflection & limitation	64

7 Demo building

7.1 Ideation & concept generation 65

7.2 Demo development 67

From tangible design space to hardware sketch	67
From Human-AI interaction configuration to system user flow	69
Prototyping	71
Display system	74
3d-printed Objects	74
7.3 Demo overview	75
Technical build-up	75
Object collection	77
System architecture	79
Software architecture	81
7.3 Final user test	83
Goals	83
Test Questions	84
Test setup & procedure	85
Data collection & analysis	87
Story: Participant 1	88
Story: Participant 2	91
Story: Participant 3	99
Story: Participant 4	101
Story: Participant 5	105
Data analysis	112
Demo evaluation	123
Design improvements	128
Experiential qualities	131
7.4 Conclusion & reflection	137
Conclusion	137
Reflection & limitations	137
8 Future steps	
8.1 Design directions	140
AI representation: appearance affects user perception	140
AI mechanism: from turn-based interaction to fluid real-time conversation	141
Prototype ergonomics	142
Application of fiducial markers	143
Object design	144
Display interface	145
What happens after the story ends?	145
8.2 Design applications	146
Chained storytelling	146
Developing children's creativity in AI-enabled storytelling	146
A powerful tool in the creative industry	146
9 Conclusion	
9.1 Answering the research questions	147
Primary research question	147
Sub research questions	147
9.2 Reflection & limitation	149
References	
Image references	153

Appendix A: Project brief

Appendix B: System prompts

Prototype 1	159
Prototype 2	159
Prototype 3	159
Prototype 4	160
Prototype 5	161
Prototype 6	162
Demo-story AI	163
Demo-supervisor AI	163
User test 1	164
User test 2	164
User test 3	165

Appendix C: Json schema in AI responses

Prototype 3	167
Prototype 4	167
Prototype 5	168
Demo-story AI	168

Appendix D: Example output of early prototypes

Prototype 1	171
Prototype 2	171
Prototype 3	172
Prototype 4	172
Prototype 5	174
Prototype 6	175

Appendix E: Consent form



Summary

This graduation thesis explored how large language models (LLMs) can enable new forms of tangible storytelling. Through hands-on prototyping and testing, I created a series of interactive prototypes of AI-enabled tangible storytelling systems and gathered users' experience when telling stories with it. I developed a conceptual framework to guide and evaluate the design of these storytelling systems. Synthesizing the findings from user tests and the conceptual framework, I developed a refined demo as the final outcome. The demo provided valuable insights on design opportunities and challenges, sparking multiple future directions. Together, these insights form a toolkit for designers who want to combine AI and tangible interactions in storytelling. LLM-driven artifacts have the power to enable creative, embodied, and social narratives, opening doors to new ways of defining and developing stories.

Acknowledgements

I would like to sincerely thank my supervisors, Dave Murray-Rust and Mahan Mehrvarz, for their consistent guidance, insightful feedback, and continuous support throughout this journey. Their encouragement and tutoring gave me the momentum to explore and structure my research. I couldn't have accomplished this without them.

I'm also grateful to my fellow students and friends in the studio, who offered thoughtful discussions, spontaneous inspiration, and moral support.

A big thanks to everyone who participated in the user tests. Your creativity, curiosity, and feedback shaped this project more than you might think.

To my family and close friends: thank you for being patient, for mental and emotional support, and for reminding me how lucky I am to embark on this journey.

Finally, thank you to the foam cubes, electronic sensors, and buggy code that somehow came all together to tell stories.

Introduction

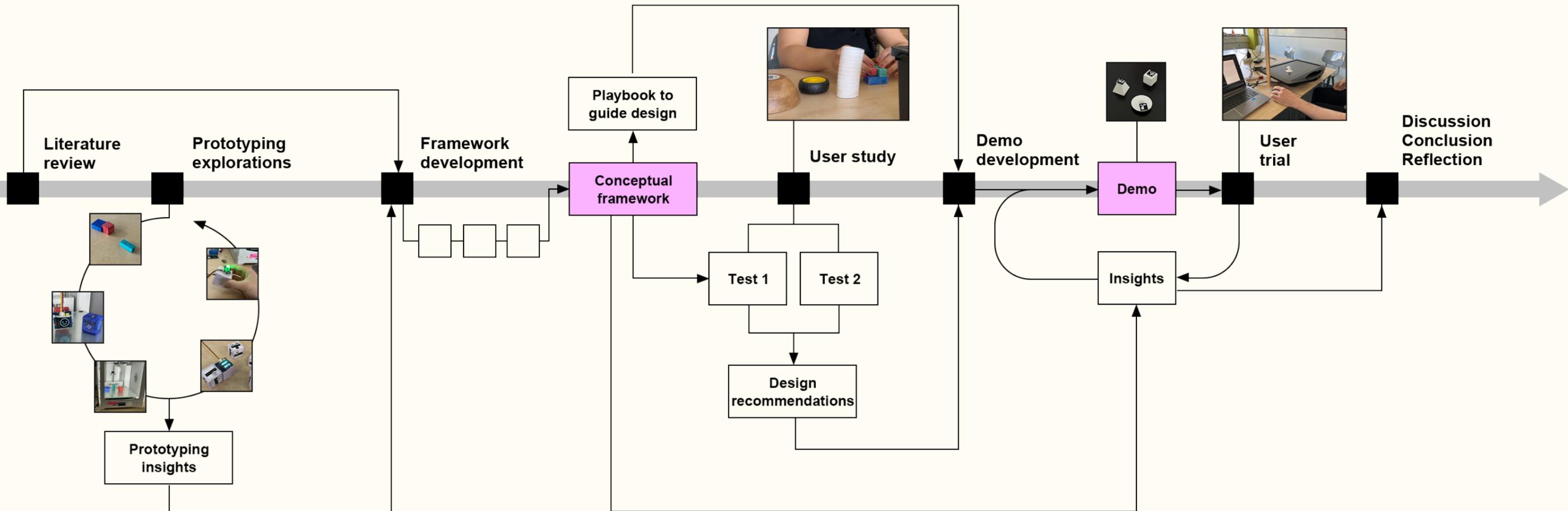
1.1 Research overview

This graduation project is an explorative prototyping research to discover how AI, especially large language models, can enable new forms of tangible storytelling. Through literature review, prototyping exploration, framework building, and user testing, this graduation project provided key insights into how AI-enabled tangible storytelling systems can be designed, what experience they can deliver, and what effects or implications they bring to the storytelling world.

Below is a demonstration of the research process of this graduation project. (Figure 1.1) The research started with a literature review on relevant research

topics, with the aim of synthesizing current research outputs and defining research scope. After clearly defining the research questions and opportunities, a series of rapid prototyping explorations were conducted. In a relatively short period, different interactive prototypes were developed and quickly tested to help me familiarise myself with the physical components required for future design, and a wide range of technical and AI configurations were tested to get initial feedback. From the insights gained from prototypes, together with knowledge acquired from literature, the graduation project moved to a more theoretical stage where a conceptual framework was developed through iterations, in order to conceptualize previous design practice and guide future steps. The framework was used to develop a playbook as a theoretical guide for AI-enabled

tangible storytelling systems, and to design user test scenarios for concrete and user-centered feedback. From two user tests, crucial data was gathered on both the AI configuration and the tangible design, and was translated into design recommendations that directly scaffolded design ideation. With the recommendations and the guidance of the playbook, a more refined interactive demo of the storytelling system was developed to examine the current knowledge and explore the research questions. From short cycles of user trials and development, the demo was refined and valuable final insights were collected. In the final stages of the design, future steps of the demo were envisioned to demonstrate the various possibilities in developing an AI-enabled tangible storytelling system, and the research project was concluded by final discussions and reflections.



1.2 Research questions

In this section, I introduce the research questions. They serve as the scope and goal to be pursued in the entire research process, as a critical foundation for the study. By exploring and answering these questions, the study remains relevant and targeted, eventually contributing to deep insights on AI-enhanced tangible storytelling systems.

PRIMARY RESEARCH QUESTION

- **How can AI, particularly LLMs, enable new forms of tangible storytelling, and what are the experiential implications of these AI-enhanced tangible storytelling systems?**

SUB RESEARCH QUESTIONS

- **What are the design principles of AI-enhanced tangible storytelling systems?**
- **What are the key opportunities and challenges in combining AI with tangible interaction for storytelling?**
- **What user experiences, effects, and implications arise from interacting with AI-enabled tangible storytelling prototypes?**

CONCLUSION

The main research question consist of 2 parts: the first half focuses on the core question of "how", leading to research of the possibilities and potentials of AI in an empowering and transformative way; the second half focuses more on users' subjective experience deriving from AI-enabled tangible storytelling systems, and concluding with the value these systems have in how they change such subjective experience.

The sub research questions covered the research scope in order to describe the research objectives in detail. The first sub question serves as a premise being a "how-to" question, in exploration of both practical and theoretical principles of such systems.

In essence, it asks about what to keep in mind if someone wants to develop a similar system. The second sub question explains more explicitly the research process, which is a combination of AI configurations and tangible interaction, and takes both positive and negative perspectives. The last sub question is focused on the real-world impacts from the users' angle. In plain words, it asks what happens when real people use the prototypes, and what that tell us about the future of storytelling with AI and tangible tech.

Together, these questions guide the research from possibilities to practice, evaluation, and implications, acting as core bones of the research.



Figure. 1.2 Research questions.

Literature review

This section provides a comprehensive review of the existing literature and theories relevant to the research topic. By identifying the gaps, controversies and trends in storytelling, AI, and tangible interactions, and how these topics interplay, this section situates the graduation project in a broader academic context, providing a solid foundation for future research.

2.1 Storytelling

Storytelling is fundamental to what it means to be human. Telling stories is one of the basic qualities of human understanding. From primitive art to dance, music, and poetry, storytelling comes in different forms that are deeply connected to social and ritualistic practices. (Figure 2.1) Over time, storytelling evolved, shifting from ritualistic and communal roots to becoming a medium for sharing both collective and individual experiences. (Recep Yilmaz et al., 2019) Storytelling is magical in its way of shaping our thoughts and transforming our experiences unconsciously. A skilled storyteller captures the audience's attention by multiple means (for example, "once upon a time..."), and the audience allows themselves to be invaded by



Figure. 2.1 The Lascaux cave paintings are one of humanity's earliest known storytelling canvases.

the storyteller, and engage in this immersive and transformative experience. (Gottschall, 2012) Storytelling is an ancient and universal human activity with its own kind of magic: the ability to convey meaning, capture minds, and connect individuals through a shared narrative.

In diverse disciplines from sociology to law, business, and urban planning, storytelling is a broader term than a narrative of events. It is a social act that shapes meaning, identity, and collective memory. (Polletta et al., 2011) Bearing certain goals, perspectives, and standards, storytelling extends beyond text, making it a powerful tool for both individuals and societies to make sense of the world.

In the context of this design research project, storytelling is framed as the act of constructing and experiencing immersive and alternative realities through certain narratives. While storytelling can be defined as interdisciplinary on a societal level, this project is focused more on its role as a personal, immersive, and imaginative practice. Through physical objects and enhanced by the power of AI, the project's goal is to design interactive prototypes that help users step into these kinds of storytelling experiences.

2.2 AI and Large Language Models (LLMs)

MULTIMODAL LLMs

With the technological advance of large language models, they are capable of a much more complex input-output system, including text, image, and audio. These models have also become increasingly intelligent to support comprehensive tasks. OpenAI's release of the o1 model marks a significant milestone in AI. O1 excels in complex reasoning tasks, achieving PhD-level expertise in mathematics and coding. (Wang et al. 2025) GPT-4o, as a versatile, high-intelligence flagship model of OpenAI, has been proven to have high accuracy across multiple domains like language, vision, speech, and multimodal tasks. (Sakib Shahriar et al., 2024) OpenAI offers an easy-to-use developer platform with API support, allowing developers and researchers to create LLM-enabled pipelines and unlock massive research opportunities. (Figure 1.2) By leveraging these tools in this graduation project, LLMs can be connected to multiple technical interfaces, allowing complex pipelines and having the potential to apply AI in multiple stages in tangible storytelling.

EMBODIED AI

Embodied AI is a shift of paradigm from traditional "Internet AI" which learns from images, videos, and text towards artificial agents that "learn through interactions with their environments from an egocentric perception similar to humans". (Duan et al., 2022) It emphasizes the AI's interaction with its environment beyond static and passive observation. By integrating modalities like vision, language, audio, and physical manipulation through robotics and virtual reality, embodied AI serves as a critical bridge connecting digital intelligence with the physical, spatial, and sensory world. It enables new forms of tangible interactive AI experiences that extend beyond the screen.

An early example of embodied AI is SEEK, an experiment combining robotics, AI, and tangible interactions in a physical environment. (Jeroen van Ameijde, 2019)

The system's objective was to observe, manipulate, and organize the cubes in response to both user input and environmental changes. Even with 1970s technology, an interactive system was grounded with early AI technology with the ability of spatial thinking and acting. With all the technological advancements available today, the core ideas from SEEK can be fully realized with the creation of embodied AI systems that can dynamically sense and respond to humans.

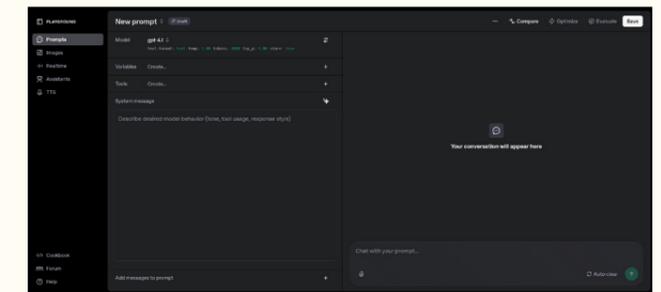


Figure. 2.2 OpenAI Platform offers a wide range of technical support for developers and researchers.

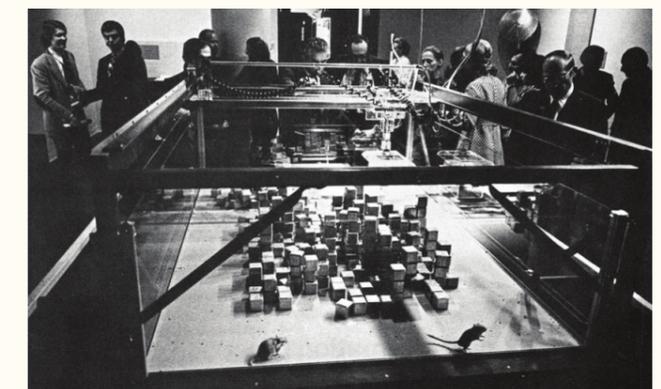


Figure. 2.3 SEEK, a physical experimental space representing early practices of embodied AI.

AI CREATIVITY AND HUMAN-AI CO-CREATION

With AI's abilities to generate new content, there has been an increasing research interest in how AI can use its creative potential to support, argue, or challenge human creativity. However, AI creativity is not exactly the same as human creativity. While AI can generate novel outputs, the creation process of such content is fundamentally different from human creativity in the way it lacks intentionality, subjective experience, and cultural context. (Wu et al., 2021)

Therefore, human-AI co-creation has become an increasingly important perspective discussing the relationship between humans and AI, the AI's behavior, and the potential outcomes of such collaboration that neither humans nor AI could achieve alone. Whether used as creative partners, collaborators, or tools that extend the creative agency of the user, the human-AI dynamics can take various forms and achieve different outcomes.

This kind of interactive partnership is directly relevant to the research topic which explores how tangible interfaces and AI can work together to enable new forms of storytelling. By framing AI as the co-creator, the project aims to uncover how human intelligence can be combined with AI creativity to tell meaningful and unexpected stories.

2.3 AI-enabled storytelling

AI-enabled systems are information systems that “possess at least one of the capabilities that require intelligence according to AI researchers,” such as “problem-solving, knowledge representation, reasoning, planning, learning, perceiving (including computer vision), acting (robotics), natural language processing, and communicating” (Rzepka et. al., 2018) In short, technological advancements allow AI-enabled systems to possess human-like capabilities, having a deeper understanding of human interactions and are able to perform with human-like intelligence. In recent years, there has been a rise in AI-enabled systems like voice assistants, autonomous vehicles, and digital investment management systems. (Rzepka et. al., 2018)

The capabilities of AI-enabled systems, when harnessed in the domain of storytelling, can have the potential to reshape how narratives are generated and experienced. AI-enabled storytelling systems can integrate advanced technologies to co-create stories with users that are dynamic, creative, and personalized. The fundamental experiential change AI-enabled systems can bring to storytelling calls for a need for research and design practice.

HUMAN-AI COLLABORATIVE STORYTELLING

Many practitioners have been imagining collaborative storytelling between humans and machines. Different from common joint storytelling between humans, machines bring different experiences, expectations, and affordances in this interactive behavior. With the advance of technology especially generative AI, an AI-enabled storytelling machine would be able to perform storytelling with humans in more natural ways than ever possible.

An early study envisioned a robot collaborating with children to tell stories interactively. (Sun et.al., 2017) This study introduced two different strategies of interaction of the robot when telling stories based on different levels of context involvement. Researchers also designed encouragement and the introduction of new characters as capabilities of the robot. The contextual versus non-contextual dichotomy is

intended to simulate the technical drawback at that time because understanding real-time storytelling was beyond technical possibility for the robot. As we now see seamless voice interactions with AI assistants everywhere, this technical barrier is already mostly conquered. However, the value of this early study lies in the researchers' awareness of the interaction strategy of robots. To what extent do we want AI to understand and follow storytelling? What is AI's role in the interaction? Which strategy do we want the AI to take when collaboratively telling a story with humans? As storytellers, how do we want the AI to perform? This study can lead to many discussions on the AI's role and agency in human-AI collaborative storytelling.

INTERACTION CONFIGURATIONS IN HUMAN-AI COLLABORATIVE STORYTELLING

There have been many practices on human-AI collaborative storytelling as LLMs evolve at an incredible speed. In those practices, we see different configurations and behaviors of the AI. In some systems, the user and the AI agent take turns adding to the story and conduct the story together. This is a common configuration, also seen in LLM interfaces like ChatGPT. In another study, the AI acts as the narrator and human actors perform the scene. Researchers chose to combine the strengths of both AI and humans by having human actors enact the AI-generated narration, expressing the full range of emotional, physical, and verbal human creativity. (Branch et.al., 2021) In this configuration, the spontaneous and embodied human performance served as physical and emotional interpretations of the AI's output, which focuses more on generating narrative direction and plot points. This setup, separating human and AI's roles, provided a platform to observe what kind of relationship they would form.



Figure. 2.4 Human performers enacting AI generation. 10

AI Dungeon is an online text adventure game using AI to generate story content and allow the player to interactively shape their adventure. (Hua & Raley, 2020) The user can choose among four interaction methods, including 'do', 'say', 'story', and 'see', allowing the user to perform an action, communicate with other characters, describe the story, or create an illustration. (Figure 2.5, Figure 2.6) Compared to research practice that usually focuses on one specific configuration, AI Dungeon empowers the user with a wide variety of capabilities in storytelling with the AI. Different configurations in collaborative storytelling between humans and AI suggest a wide variety of interaction modes between humans and AI when telling stories. How are these modes or configurations different in their effect and user experience? How do they shape the storytelling? How do we define and set up a certain configuration? These are questions I wish to explore in this project.

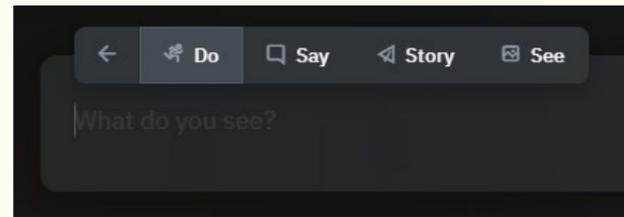


Figure. 2.5 The user interface of AI Dungeon allows multiple kinds of user input.

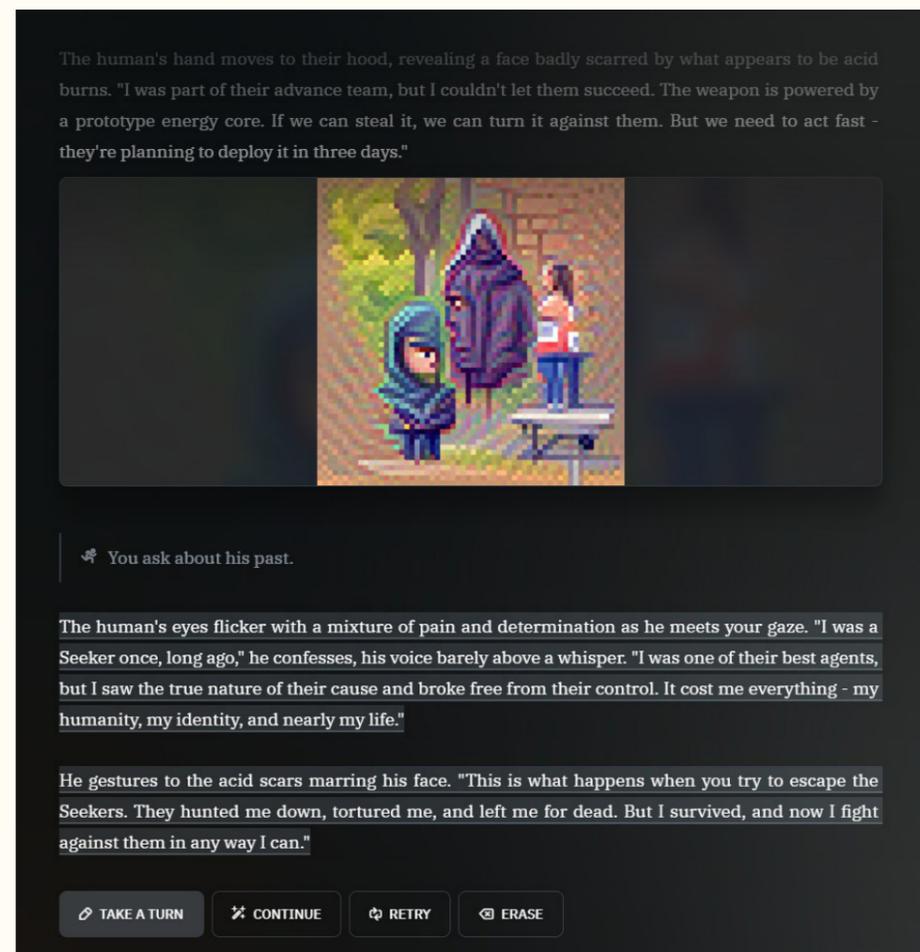


Figure. 2.6 Generating images in AI Dungeon.

2.4 Tangible storytelling

Storytelling has always been an activity in the physical world. Tangible and embodied interactions allow stories to develop by gestures, movements, or manipulation of objects, just like children's toy-playing activities that often come with improvisational role-playing and storytelling.

EMBODIED INTERACTION

In the research realm, embodied interaction has always been a focus. Embodied interaction suggests humans make sense and engage with the world through gesture, movement, touch, and spatial arrangement. Physical gestures and body movement can be elements of storytelling, as seen in theater, dance, and children's play. A paper studying embodied practices in collaborative storytelling analyzed people's behavior in storytelling conversations, and results show that storytelling behaviors like turn-taking and correction are assisted with body language as signals to keep the storytelling process smooth. (Dressel & Satti, 2021)

In the context of storytelling, embodied interactions free narratives from written text, and give the potential for them to shape physical realities. This is significantly important in AI-enabled storytelling, where AI technology is integrated with tangible interfaces and physical objects, allowing a wide design space for embodied interactions.

TANGIBLE USER INTERFACES

Physical objects have also been an essential part of various storytelling. In HCI research, many tangible user interfaces are created for storytelling that enable users to construct or experience stories tangibly. 'The Reading Glove' is a classic tangible user interface prototype allowing users to extract narrative memories of different objects through audio narration. (Tanenbaum et.al., 2010) It provides subtle guidance in the way people would naturally interact with physical objects, and embeds the story in a non-linear manner. This kind of exploratory and puzzle-like storytelling engaged users in active sense-making.



Figure. 2.7 The Reading Glove, a tangible user interface for storytelling with objects.

Tangible user interfaces can profoundly shape the storytelling experience by encouraging exploration and letting real-world objects carry meaning and eventually tell the story. They serve as bridges between physical realities and digital systems, as the extension to both human and AI's enactments and perception as a shared language.

PHYSICAL COMPUTING

Tangible user interfaces in storytelling usually rely on interactive systems that can sense and respond to the physical world using hardware (sensors, actuators, and microcontrollers) and software. In HCI research, this is commonly referred to as 'physical computing' or 'physical programming', which focuses more on child-friendly programming approaches. In a 2004 study, researchers created StoryRooms, an interactive storytelling system for children to author and experience stories in a physically interactive environment. (Montemayor et. al., 2004) It features different interactive and programmable actuators to let children define the rules in a story world, by putting on a 'magic hat' and using a 'magic wand'. From their test with groups of children, retelling existing stories using this system was successful, but when they created an original story, the performance varied. There is great potential in using physical computing as a means of tangible storytelling, but whether it can successfully support storytelling highly depends on its design. Understandable, manipulable, and durable hardware is needed, and the balance between exposed technology and immersion in the story is critical.

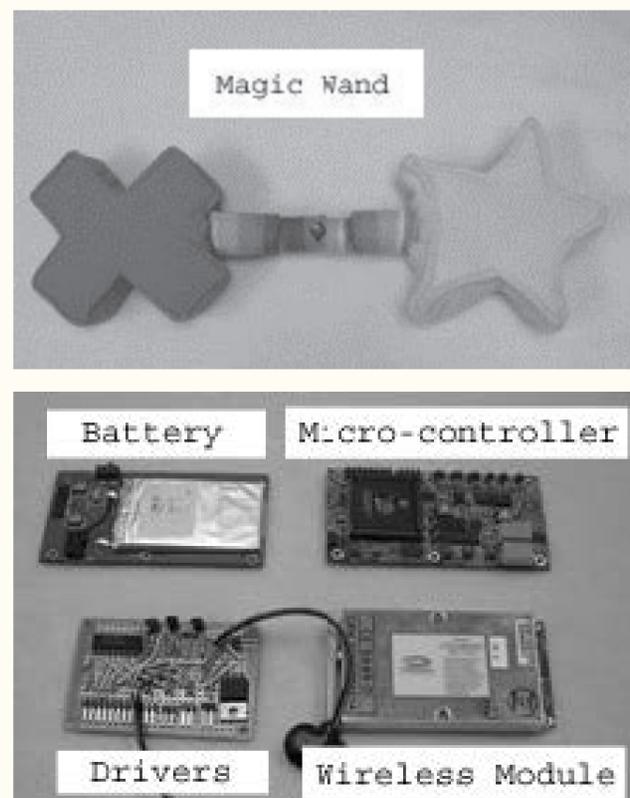


Figure. 2.8 Hardware and software were used in StoryRooms to support storytelling behaviors.

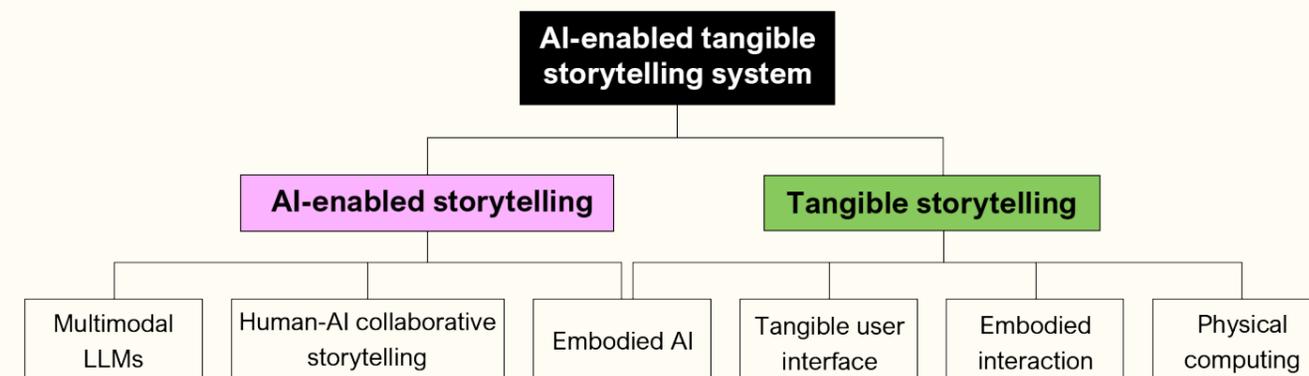


Figure. 2.9 Research structure.

2.5 Conclusion

CONCLUSION OF LITERATURE REVIEW

1. Storytelling as an embodied and collaborative activity

Storytelling is not just a rephrasing of plot and events, but it's a social practice that allows humans to engage in sense-making of the world. It moves beyond an individual activity, often embedded into a social practice. Through voice, gesture, and object manipulation, storytelling can be something that users actively do rather than something they receive and consume. Storytelling can thus be framed as an embodied and collaborative activity.

2. LLMs and embodied AI afford new creative roles for AI.

With the recent advancement of multi-model RLMs and embodied AI frameworks, the capability of machines has moved beyond text generation towards intelligent perception of the world and tangible involvement. The literature shows that AI creativity differs from human creativity in various ways. Therefore, co-creative systems allowing AI to play creative roles is a promising direction. Through physical interfaces, AI can become narrative partners in collaborative storytelling.

3. Theoretical gap in AI configuration in storytelling

Prior studies have shown multiple role distributions between humans and AI in collaborative storytelling. However, there is a significant gap in the comparative understanding of how different configurations affect user engagement, AI behavior, and narrative coherence, especially when interactions are made off-screen in the tangible space. This theoretical gap is a research opportunity to understand and practice role distribution in AI-enabled tangible storytelling.

4. Tangible interfaces vs. tangible storytelling

Tangible interfaces have shown the power of objects, gestures, and spatial arrangements to turn implicit elements into the external world. Yet, they also pose challenges when applied to creating tangible storytelling experiences. More guidance or more freedom of playing? More immersion or more technology exposed? Tangible storytelling is a more complicated process where tangible interfaces must deal with these challenges, especially when integrating LLMs.

RESEARCH STRUCTURE

The structure of the research can be divided into two main perspectives. AI-enabled storytelling examines the strategies of telling a story with AI concerning the configurations in the interaction and experience. Tangible storytelling deals with the issues of a story interface. It also includes the technical architecture that makes up the storytelling system.

Research methodology

This graduation project applied mixed methods in the research process. From a Research through Design approach, I initiated the project and gained initial insights from making, exploring a wide range of design ideas, and navigating through my project development. Through generative sessions with interviews, I acquired key findings that were more specific and user-centered. When analyzing the data from user sessions, I applied affinity mapping and the DIKW hierarchy to turn raw quotes and observations into design strategies, which defined a clear path in the prototyping process.

3.1 Research through Design

WHAT IS RESEARCH THROUGH DESIGN (RTD)?

Research through Design (RtD) is a research approach in which design practice becomes a method of inquiry. It generates knowledge through the making of prototypes, artifacts, or systems. Through iterations of creation, reflection, and refinement, RtD allows designers to understand and develop their concepts in an explorative and dynamic way. (Stappers & Giaccardi, 2014)

WHY DID I APPLY IT?

This is the main approach I applied throughout the thesis project because of the explorative nature of my topic. I initiated the research with an open-ended question investigating how tangible

interactions with AI can meaningfully shape the storytelling experience, which did not directly lead to a predefined solution space. The RtD approach enabled me to explore open-ended possibilities, especially in the beginning, and discover valuable insights to navigate my project, and it proved to be effective in quickly evaluating my design ideas in real practice from instant user feedback.

HOW WAS RTD APPLIED IN THIS RESEARCH?

I developed a series of interactive prototypes, each focusing on different elements, ranging from certain ways of interaction to design strategies. Working with physical computing components has become a way to familiarize myself with the material affordances and limitations of tangible elements in interactive storytelling, preparing me for future steps in design. Small-scale tests were conducted with the prototypes, and from these user scenarios, I quickly gathered insights that shaped and evolved further research questions. Insights on the interaction settings and components also worked in a more practical perspective, revealing users' needs and preferences in tangible interactions and storytelling. After each iteration, I reflected on the outcomes and used the findings in the next cycle of making. Based on findings from prototyping and user testing, I derived a design framework that eventually led to a more refined interactive demo and its evaluation.

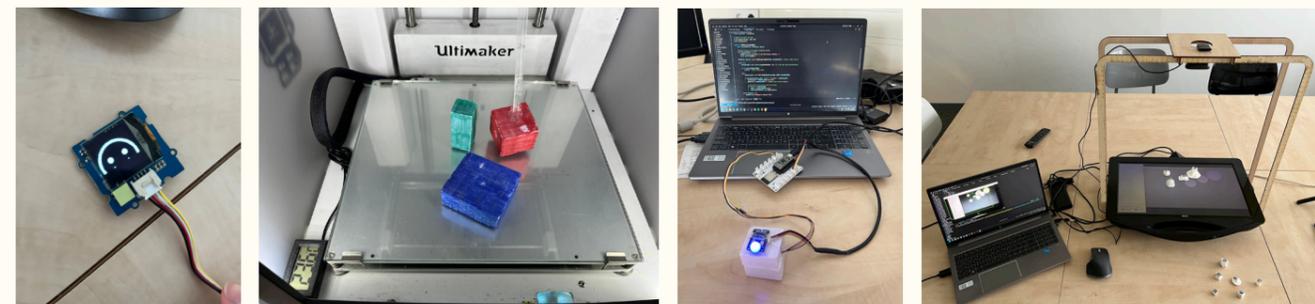


Figure 3.1 A series of interactive prototypes were developed throughout the research process.

3.2 Conceptual framework

A conceptual framework integrates relevant theories that offer explanations for the investigated issue in research. It provides a scaffold to determine the research design and guide research practice. (Leshem & Trafford, 2007) In this project, the need for the development of a conceptual framework emerged during the exploration phase. From early prototyping and literature review, it became clear that there was a knowledge gap in how AI-involved storytelling can be systematically linked to tangible interactive systems in a structured way. With a conceptual framework, an overarching system can be established to conduct the research and design more rigorously.

The conceptual framework is a synthesis of the existing frameworks in interactive storytelling system design, tangible HCI, and insights from my prototyping practices. I presented the framework in two dimensions, including 'Human-AI interaction configuration', which was derived from existing frameworks in storytelling, and 'Tangible design space', which was based on insights from my exploration. Not only did the framework serve as a playbook for designing a relevant system, but it also functioned as a standard for evaluation and a structure for test design and data analysis. The framework remained flexible as a shared language for reflection and iteration in designing AI-enabled tangible storytelling systems.

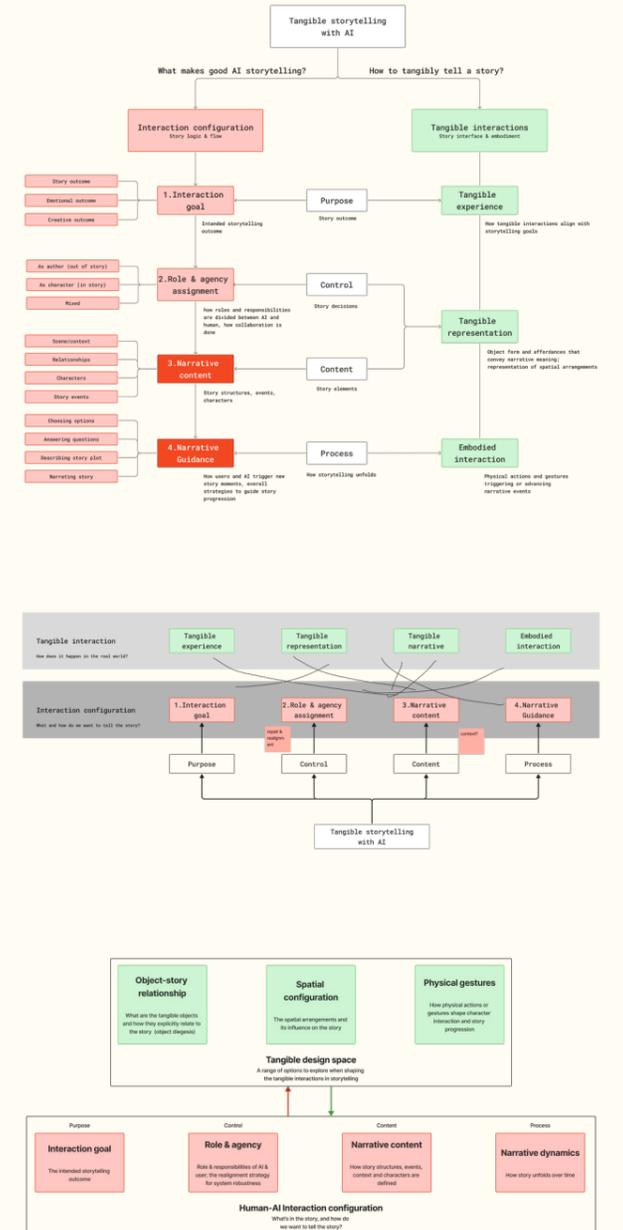


Figure 3.2 The development of the conceptual framework in this research.

3.3 Qualitative experiment: generative sessions

Generative sessions are a form of co-design practice that enables people to explore and express their latent and tacit knowledge through making. They give people a language to imagine and express their ideas and dreams for future experiences. (Elizabeth & Pieter Jan Stappers, 2016) My initial prototypes served as a good way to bring out people's ideas on their experience and preference in tangible storytelling systems with AI, but the information acquired from those fast trials fell short on the richness, fidelity, and structure. Therefore, in order to gain structured knowledge in higher fidelity, I designed a series of generative sessions based on the conceptual framework, covering both tangible interactions and human-AI interaction configuration. These generative sessions offered a welcoming and immersive space for participants and significantly helped me to acquire first-hand data that eventually shaped the project's development.



Figure. 3.3 Generative sessions were designed in the research process as a means to acquire implicit knowledge from the users.

3.4 Data analysis: Affinity diagrams and thematic analysis

AFFINITY DIAGRAMS

An affinity diagram (also known as the KJ method or affinity mapping) is a tool to organize ideas, information, and observations to identify patterns and seek insights. It is especially helpful in sorting large amounts of unstructured and qualitative data, clustering them, and determining patterns from them. (Affinity Diagrams, n.d.) From the generative sessions, quotes from transcripts and researcher interpretations are coded and clustered in the form of post-its. This flexible approach helped me quickly gather and organize qualitative data and support future analysis.

THEMATIC ANALYSIS

Thematic analysis (TA) is a method in qualitative research to identify, analyze, and interpret patterns of meaning or “themes” within data. It offers a flexible yet rigorous approach to understanding rich and complex qualitative material. It is particularly valuable for researchers aiming to understand how people make sense of their experiences, behaviors, and emotions. (Ackoff, 1989)

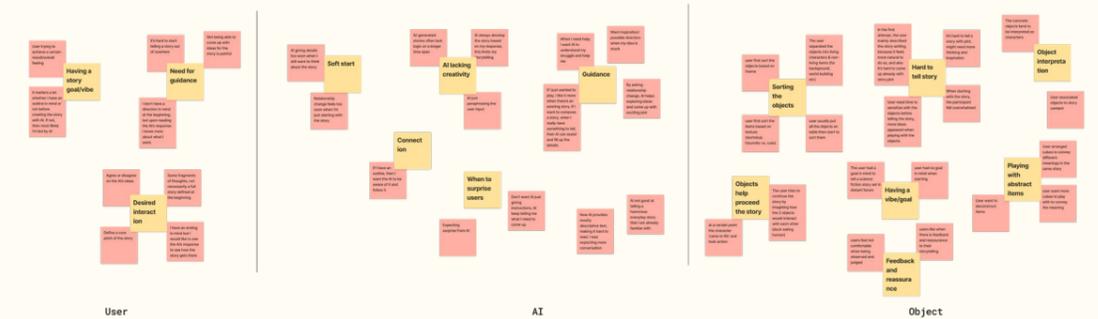


Figure. 3.4 In the data analysis phase, affinity diagrams and thematic analysis were used to effectively make sense of the rich qualitative research data and turn them into refined insights.

Early prototyping explorations

With the knowledge base of the literature review, I set the scope for research and defined the core research questions. Due to the exploratory nature of the research, it was time to start the prototyping process at a relatively early stage of the project. This chapter is a record of all the prototypes I developed during the exploration phase and findings from quick user trials.

4.1 Phase overview

This section provides an overview of the prototyping exploration phase. Goals and timeline were introduced, as a summary of the prototype development.

GOAL

1. Bridging the gap between theoretical research and practical application

The prototyping exploration was my first attempt to interpret my understanding of an AI-enabled tangible storytelling system. The process of making such systems translated insights from literature into real working interactions, providing a bridge between theory and practice. The artifacts came from literature theories, and they eventually contributed to a more grounded theory.

2. Gaining hands-on experience with physical components and AI-enabled interactions

By quickly making a large number of prototypes with different features, I was exposed to different technologies, sensors, hardware, and AI models. This hands-on approach provided me with a deeper understanding of the possibilities and limitations of different electronics and configurations. It builds my confidence in creating storytelling systems that are more complex and robust.

3. Uncovering and pinpointing practical challenges, user needs and technical requirements

These tangible interactive artifacts served as

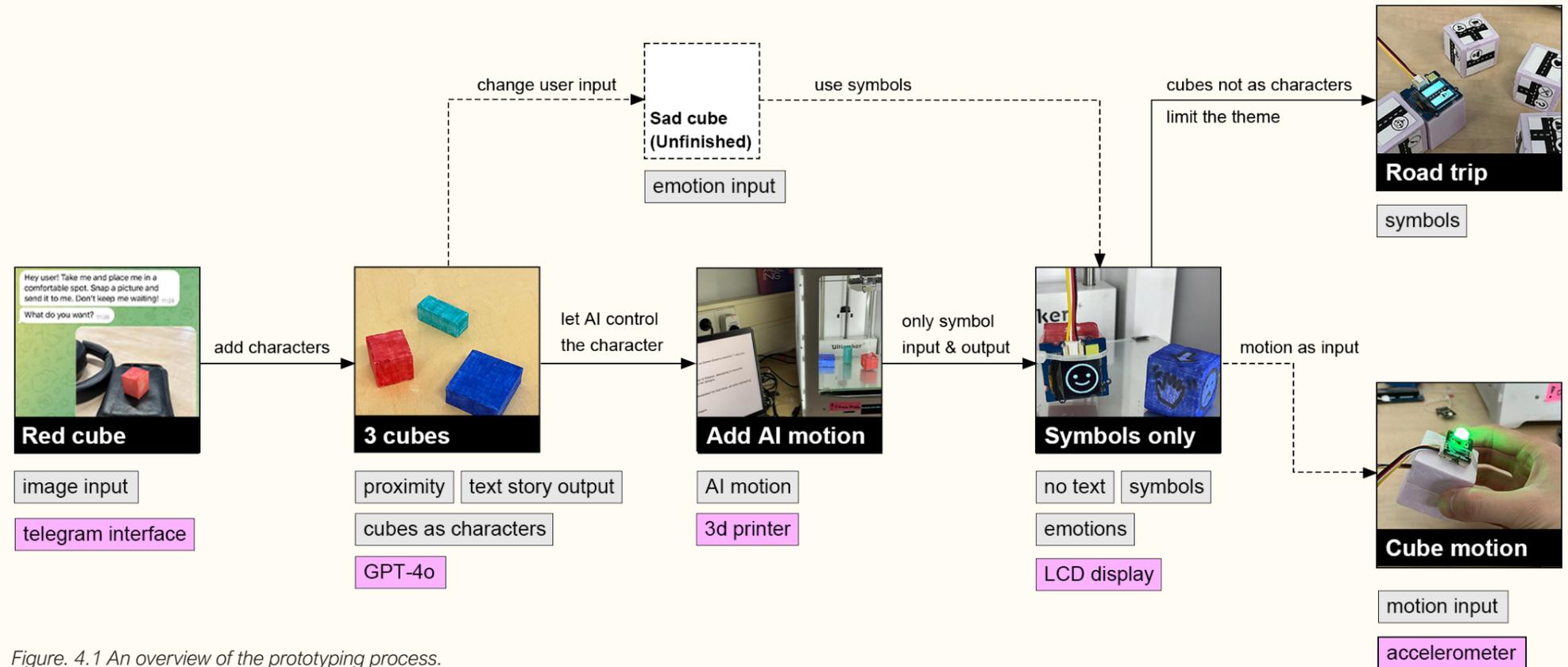


Figure. 4.1 An overview of the prototyping process.

interesting testing ground for both myself and other users. By quickly trying them out, bugs, challenges, and potentials emerged. A wide range of prototypes identified usability issues, hardware limitations, and unexpected user interactions that clarified user needs and system requirements, contributing to a more refined framework to design such storytelling systems.

4. Generating insights on design principles for AI-enabled tangible storytelling systems

The iterative cycle of making, testing, and refining prototypes generated rich insights in what works and what doesn't work in this domain. These insights can contribute to principles in a general sense to guide my future explorations.

PROTOTYPING TIMELINE

This is a timeline showing the development process of the prototype in the exploration phase. The exploration started with a simple input optical system based on an existing pipeline. Within each iteration, I changed the physical design, the system architecture, and the AI configurations. All kinds of hardware components were used, From LCD screens to accelerometers. Building upon the insights from previous prototypes, the later iterations featured either more complex pipelines or new technology.

In the next section, I will give a detailed report of the development process of each prototype.

4.2 Prototype development

PROTOTYPE 1: THE OBNOXIOUS RED CUBE

As it's the first prototype I made, I tried to keep the pipelines in a simple form, so it was easier to handle. I started with an existing pipeline where users can have a conversation with a large language model with the interface of a chat app. Under the simple framework, I had an initial attempt on AI storytelling through a tangible character played by AI.

What did I make?

An intelligent AI chatbot who identifies itself as a red cube and asks the user to place it in a comfortable spot. The user will get a red cube and take a picture, send it to the chatbot. The chatbot will reply by pointing out why this spot is not satisfactory for it. The conversation goes on and on because the chatbot will never be satisfied with its location no matter where the user puts it.

What to explore?

1. Simplifying the scenario

Because it is the first prototype, I try to simplify the storytelling scenario so that it only contains a certain type of interaction. In this case, interaction is the AI being unsatisfied with its current situation.

2. Role of AI



Figure 4.2 The cube is not satisfied with its location.

Another thing I want to explore is what happens when AI plays or identifies as the character in the story. In this prototype, the AI would be aware of its position from the user's image input. I want to explore what happens when AI can perceive the world it is currently in, and what kind of conversation will it spark.

3. Storytelling in conversation

Because of the AI's role as a character, I tried to build the story in the conversation. In this case, it is the endless conflict between the user and the AI. I would like to explore if it is possible to build a story through conversation.

4. Embodied interactions

The interaction of placing the cube somewhere in the real world is an attempt to see how it would afford the users and the AI.

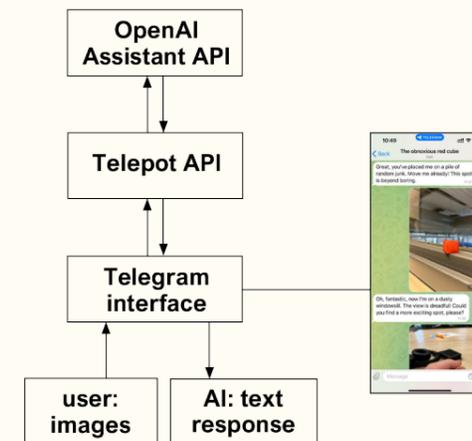


Figure 4.3 Technical buildup of the prototype.

Implications

1. AI understanding context

In this prototype, I have given AI vision in order for it to understand the context it is currently in. It has proven to spark interesting conversations and more importantly, different user behaviors. Therefore, I believe with a certain configuration of AI with an awareness of a story context, coherent and engaging story elements can be induced.

2. What makes a coherent story?

In this current prototype, the AI configurations do not take into account the change in the story. The conversation goes on and on with the same topic and similar responses from the AI. The essential components that make up a full story are missing, such as beginning, development, climax, and ending. In the next prototype, I will aim to explore how to have a more coherent story as the output of the interaction.

3. Single vs. multiple objects

This prototype featured one single physical cube as the only character, therefore the conversation goes only between the character and the user. What if there are multiple characters controlled by AI, and what interactions would take place between them? What kind of stories would it spark? This is an interesting direction that I would like to explore further in future prototypes.

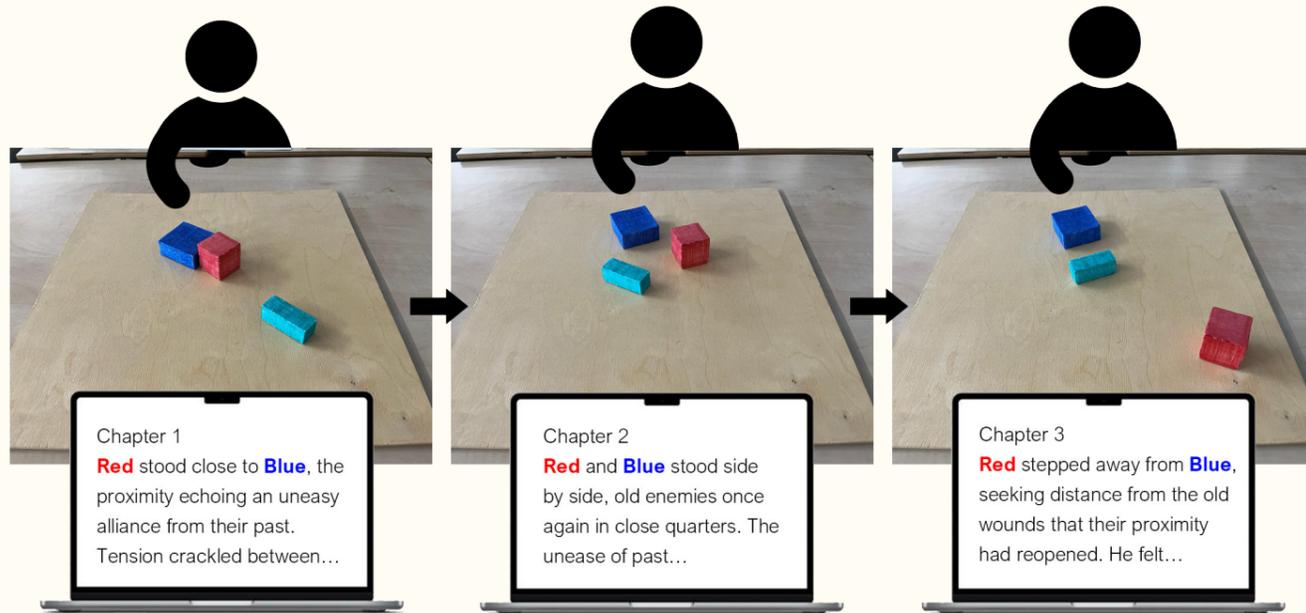


Figure. 4.4 Manipulating 3 cubes to generate new story plot.

PROTOTYPE 2: THE STORY OF 3 CUBES

In the second prototype, I tried to increase the number of characters and change the way the system returns the story. The pipeline stays mainly the same except for the output interface which was a laptop screen. The story was more complete, and it allowed development through user manipulation of the objects.

What did I make?

This was a system continuously composing chapters of the story of the three cubes on a surface as different characters based on how the users placed them. The characters were given a background story in the system prompt. They each had different personalities and traits. The user is encouraged to manipulate with the objects and try different combinations and spatial arrangements. And expect different output from the AI. With each new arrangement, an image is sent to the system, which would give users a new chapter of the story with new developments. You can expect relationship changes with different arrangements. For example, if you put the red and the blue cubes together, and the green cube at a distance, the story plot would possibly feature red and blue standing together to fight against the other one.

What to explore?

1. More roles, more complicated relationships, will it make more interesting stories?

This prototype gives three characters a story setting. With a realistic story setting featuring three underground fighters. I hope this can bring some realism into the story generated, increasing the storytelling quality. With the tension between the characters, I hope that the physical manipulations from the users would spark interesting story plots.

2. Can we tell the story through user's exploration and experiments with the objects?

Compared with the last prototype, I gave users more freedom and the possibility with the arrangement of three objects. I hope to examine how they would experiment with the physical setup.

Test observations

1. Generated story was too descriptive.

The AI-generated story was not satisfying. The AI spent too many words describing a certain situation rather than coming up with actual story plots. For example, if we set a new arrangement, the AI would describe a lot by saying "lose stepped further red and green stood together". However, by making this arrangement, we could possibly actually mean that the red and blue had a close relationship or they were having a conversation. The AI did a bad job in interpreting the meaning behind this user manipulation.

2. Users were confused about what was going on with the story.

With such story output, the user is confused about the purpose, the development, and the future goals of the story. So they were most of the time arranging the objects randomly and seeing what came out of them.

3. Reading story from screen broke the immersion.

With the story being displayed on the computer screen, the user had to stop looking at the objects and read a whole chunk of text in every turn of interaction, which breaks the immersion. This made it difficult for the users to concentrate on continuous story progression.

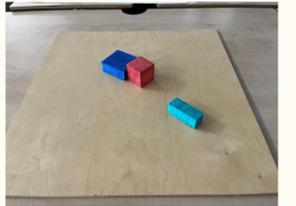
Implications

1. Users should be guided in some ways.

The current setup does not have clear guidance on what the users can do, leading to confusion in users. Therefore, interactive storytelling systems need to have a clear guided system that allows the users to be aware of what they can interact and explore.

2. Story output form is important.

Since the storytelling is not smooth in this prototype, it implies that the output form of the story is important. It should merge smoothly with tangible interactions, without being invasive or interrupting.

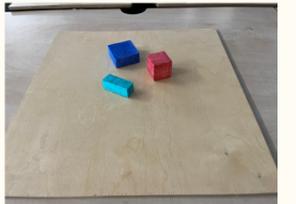


Chapter 1

Red stood close to Blue, the proximity echoing an uneasy alliance from their past. Tension crackled between...

Nearby, Green was silent but alert. In his eyes, Red saw a flicker of old gratitude—an unspoken promise to repay a debt.

They were together again, a triangle of unease and unspoken histories. The stakes were high, and decisions made now would echo for a long time. The past was not done with any of them.

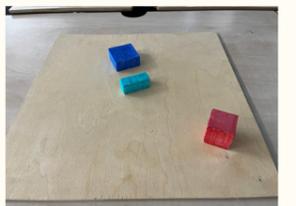


Chapter 2

Red and Blue stood side by side, old enemies once again in close quarters. The unease of past betrayals lingered between them like a shadow. Red felt the burning inside, the years of waiting ready to ignite.

Green moved between them, not as a mediator but as a bridge. He couldn't change what had been, but maybe he could influence what would come. His choice to stand with Red now carried weight, a silent vow to help him.

The reunion of these three could shift the balance in the world they'd left behind. The past was stirring, and change was near.

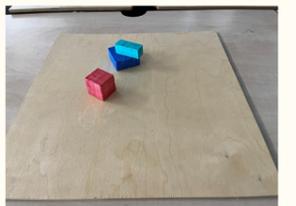


Chapter 3

Red stepped away from Blue, seeking distance from the old wounds that their proximity had reopened. He felt wary of the influence Blue still held in their shared world.

Green positioned himself closer to Blue, a silent entity, choosing his moment. The years had taught him patience, and his affiliation with Blue had been born out of necessity, not loyalty.

Each understood their place, a temporary dance of distance. But Red knew the time would come to confront Blue, and Green understood that his support might tip the scales. They were caught in the pull of the past, each step leading to an inevitable clash.



Chapter 4

Red moved back towards Blue, the gap between them narrowing once more. This step was intentional. Red knew he needed to face the source of his betrayal to move forward.

Blue sensed Red's approach, his mind racing through strategies to maintain control. Just like before, he couldn't let emotions cloud his judgments.

Meanwhile, Green, now behind Blue, saw both men's actions unfolding. His role as the unseen observer allowed him to assess when his intervention would be most strategic.

The distance among them was closing, signaling that the time for words and revelations was at hand. Old ties were rekindling, and the consequences loomed.

Figure. 4.5 Story generated.

PROTOTYPE 3: THE STORY OF 3 CUBES (ADDING AI PHYSICAL CONTROL)

The next prototype was a modification of the previous one, especially in the capabilities of AI. I added the ability for AI to physically change the world using a pulley system on a 3D printer.

What did I make?

Under the same system of storytelling with three cubes, the AI now controls one cube with a pulley system on a 3D printer. It can move the cube on a plane as an output along with every chapter of the story. Therefore, the user would manipulate two of the three cubes to indicate story progression for the two characters they represent, while the AI controls the other cube, and plays as that character in the story. I also updated the system prompt on the story background with more detailed descriptions of every character.

What to explore?

1. How will the user experience be changed when AI has the ability to change the physical world?

Currently, both the user and the AI have the ability to move the cubes on the physical plane. How will user experience be different from the previous prototype

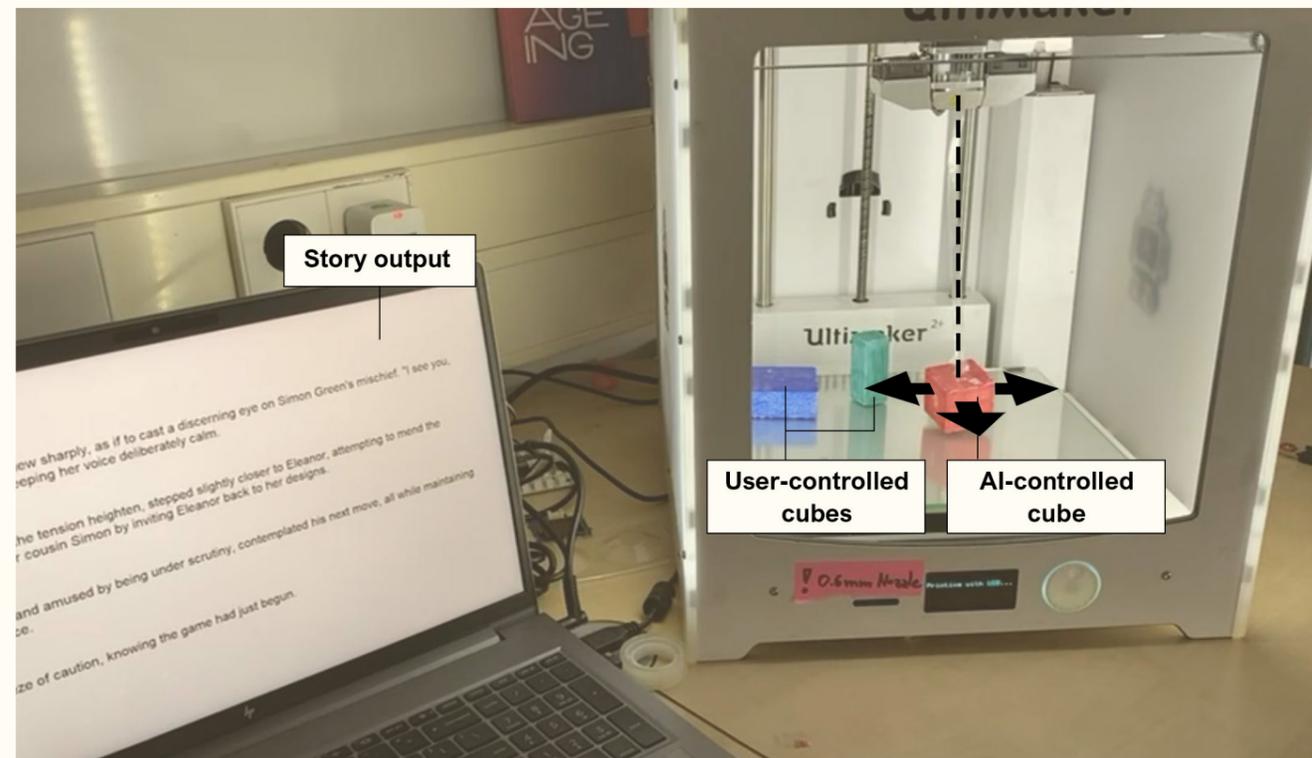


Figure. 4.6 Prototype 3 allows AI to move the cube.

where the user manipulates everything and AI is only responsible for narrating the story?

2. With more engagement in the physical world, how will it affect AI's role?

When AI also has the ability to move the cube, it is more than a narrator. How will this role shift change the way users experience this prototype?

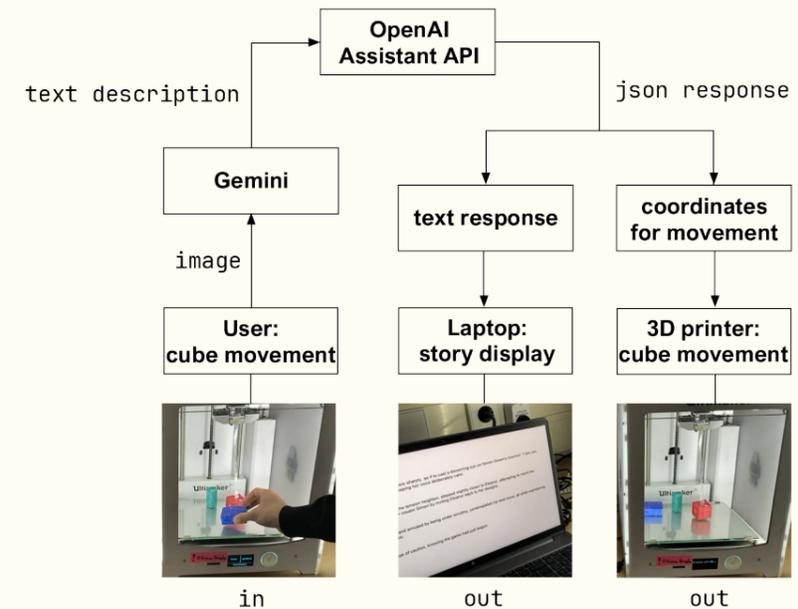


Figure. 4.7 Technical flow of the prototype..

Test observations

1. The user focused more on the movement and the tedious story is usually neglected.

The story-telling mechanism was not significantly changed in this prototype, so the story quality stayed the same. With more movement introduced to AI, the user focused more on the AI's action than the AI's story.

2. A more complex story background in the prompt didn't make the story generated richer.

Despite the fact that I enriched the system prompt with more background details, it did not significantly add to the story quality.

Implications

1. Experience is now even more separated, with too much cognitive load for users. Storytelling experience needs to be focused.

With a more complicated physical setup, the user experience is now even more separated with things going on on the screen and also in the physical plane. It means more cognitive load for the user and increased difficulty to focus on everything at once. In the next prototype, the storytelling experience needs to be focused with limited output.

2. There is too little space for human manipulation.

In this prototype, the user could only move the location of two cubes. There was very little they could do to define where the story was going. This resulted in less engagement and a detached experience. In the next prototypes, I need to introduce users with a more active role and give them more control over story elements.

3. Letting AI physically manipulate did not significantly change the role distribution because the AI was still fully the narrator.

Because the full story is still narrated by the AI, the interaction was still more of a one-way process than a two-way communication. The user passively received the story plot. In the next attempts, I wanted to turn this into a two-way conversation.

PROTOTYPE 4: TELLING STORIES WITH SYMBOLS AND MOVEMENT ONLY

Summarizing on the findings from the previous prototype, I moved the interaction fully into the physical world, canceling the screen output. I tried to create a more immersive, focused, and playful experience in the next prototype, where I tried storytelling without written text and continued on the idea of allowing AI to physically move an object.

What did I make?

The storytelling system consists of two cubes. The AI-controlled cube has an LCD screen that can display symbols and connect it to the 3D printer so it can be moved horizontally. The human-controlled cube has different symbols on each face of the cube, allowing the user to choose which symbol to present to the AI by placing a certain face upwards.

The reaction goes on with the user and the AI taking turns to move the cube and choose the symbol to display. The six different symbols were: a smiley face, a sad face, an arrow, a waving hand, a lightbulb, and a question mark. It includes different meanings from heading to a certain direction to expressing a certain emotion.

What to explore?

1. How would storytelling change when there is no written text but only physical movement and symbols?

In the previous prototypes, the story is always displayed on a separate screen. It's negatively influenced user experience. In this prototype, I tried to go to an extreme where there is no written text in the story and examine if the users would still be able to understand what was going on.

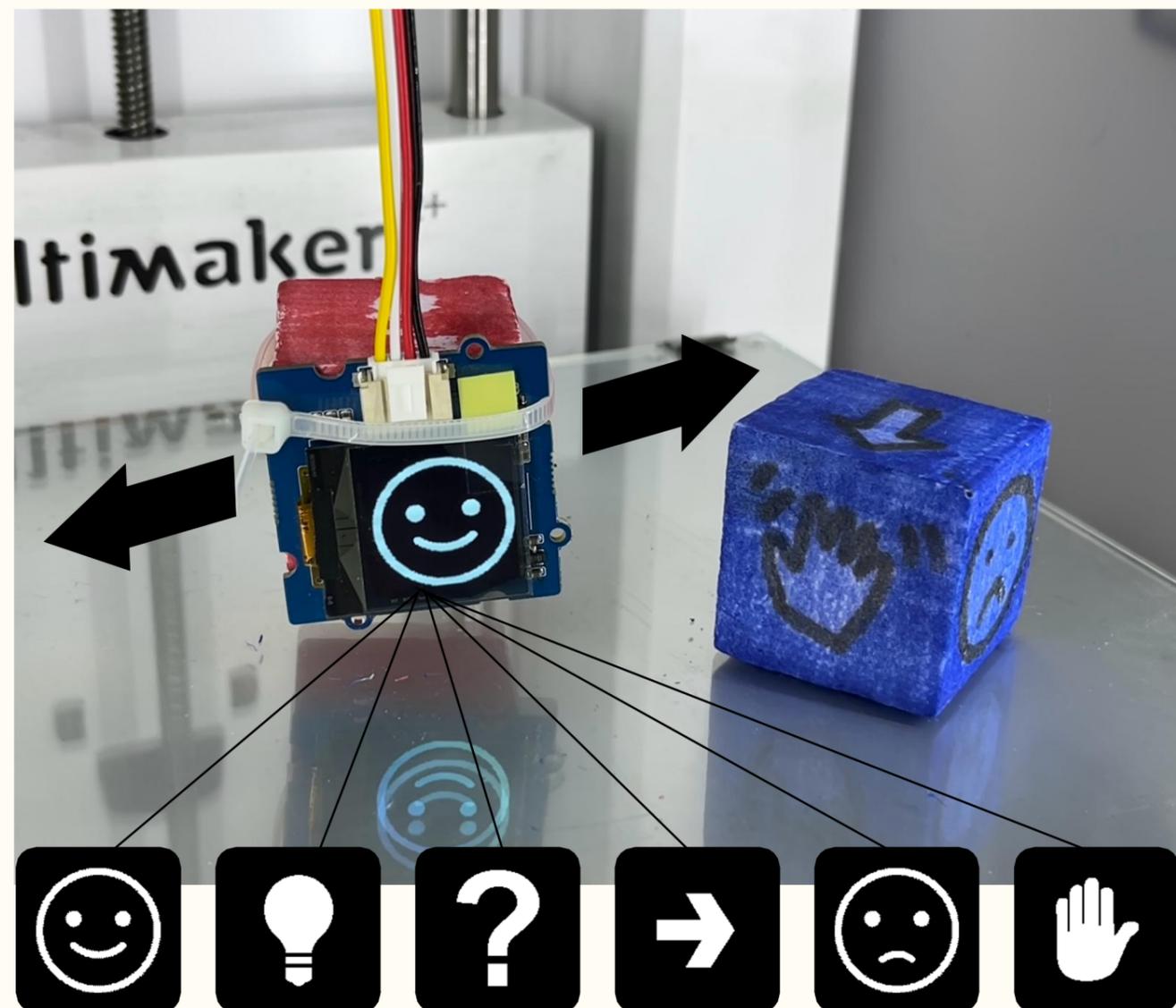
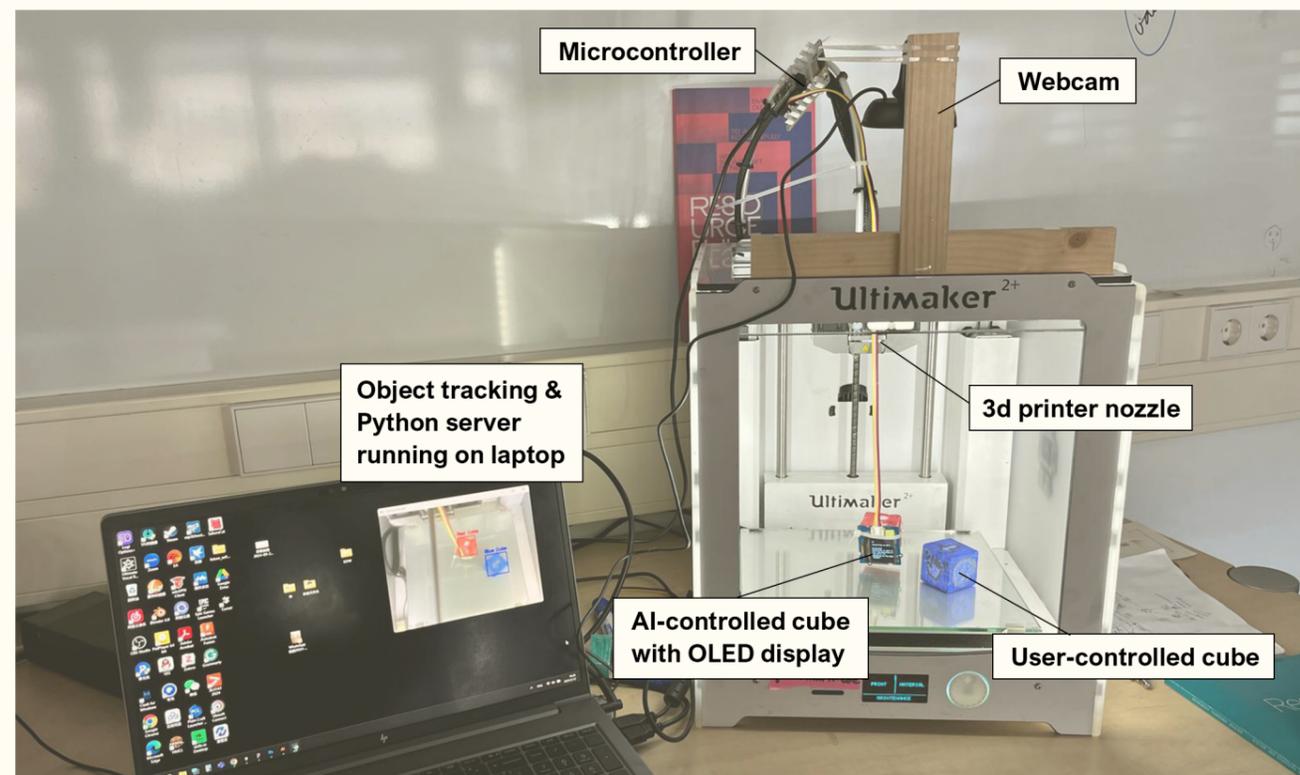


Figure. 4.7 Prototype 4 got rid of story display and added image input-output.



Test observations

The users were not able to understand or imagine a concrete story plot with the information they acquired from the interaction. Because there were only six different symbols, both the AI and the user could only express very simple meanings. Without presenting background information in written text, it is hard for the users to enter the real world and try to make sense of everything going on.

Implications

1. A coherent storyline at the beginning is important.

At the beginning of the interaction, the user will have to guess many things before they can engage actually in the story world. Without this process, the solar tiling can only stay on a shallow level without a concrete plot.

2. Context was missing in the prototype.

This resulted in the story being abstract. Therefore, providing story context in a certain way is key for creating a concrete story plot. It can be provided in multiple ways, ranging from narrowing down the story setting to providing information in the physical setting.

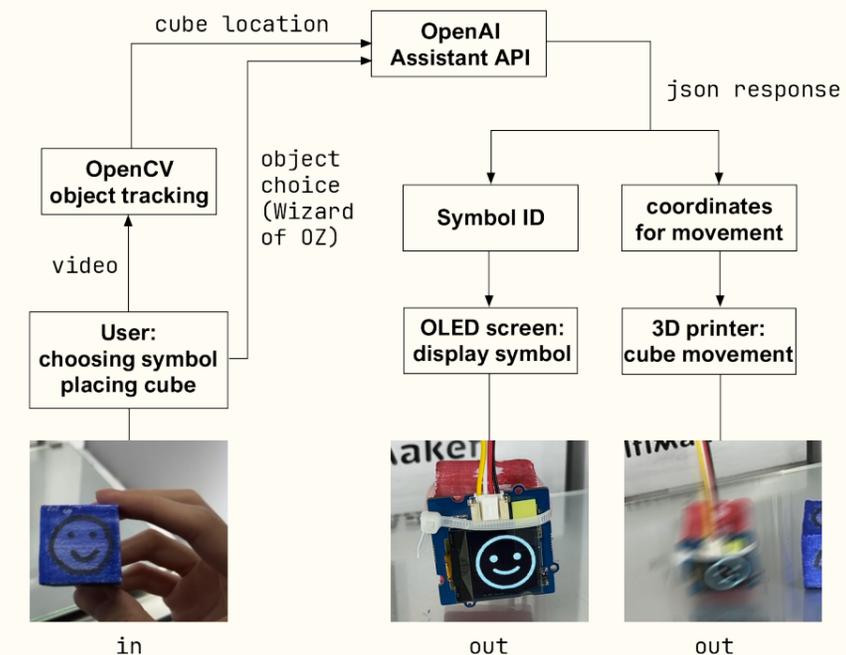


Figure. 4.8 Technical architecture of prototype 4.

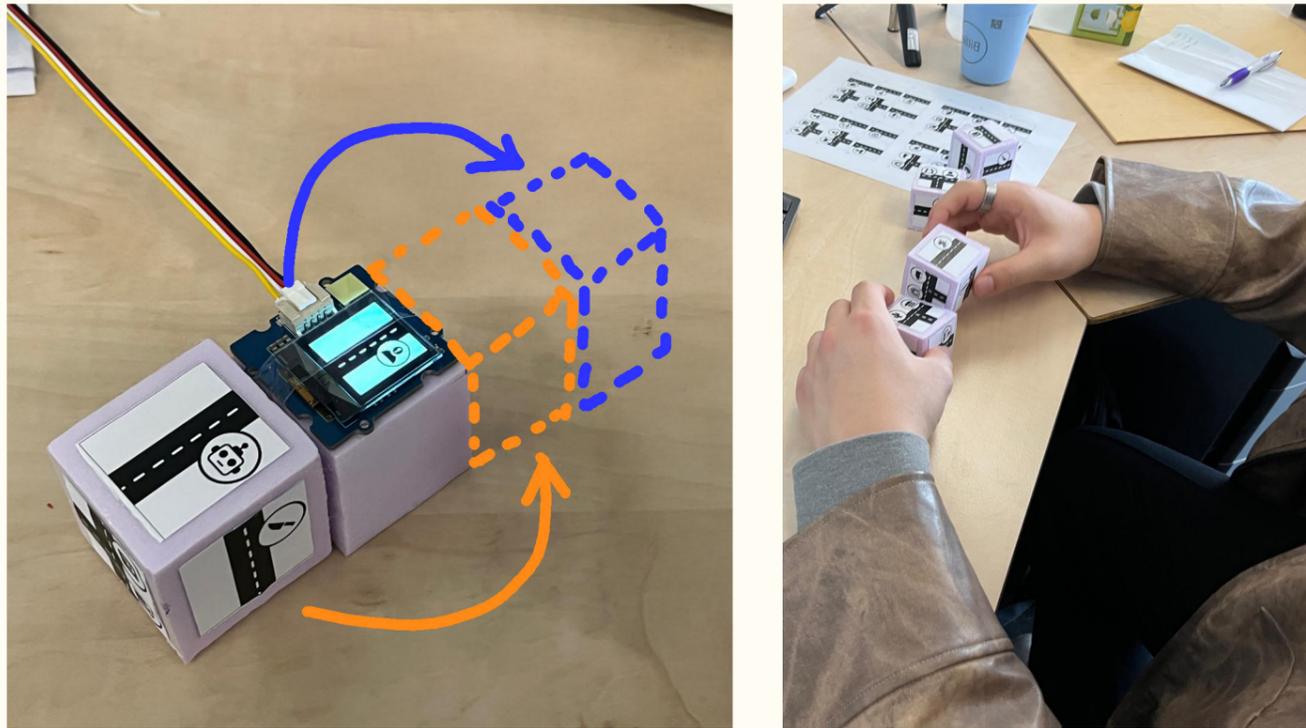


Figure. 4.9 Prototype 5 Focused on storytelling in a conversation with icons in a road trip context. .

PROTOTYPE 5: ROAD TRIP BLOCKS

With the idea of trying to define a concrete context and continue the exploration of imagery output, I created another prototype. I started by imagining what it would be like to have a road trip with an AI. With the theme defined, I tried to enrich the symbol system with materials relevant to the topic, and built physical components for the prototype.

What did I make?

A series of building blocks with different icons on a road. The AI's cube featured an OLED screen that can display all kinds of symbols. The user has a collection of four cubes with different icons printed on them to choose from. In each round of interaction, the user and AI take turns to choose an icon and plug it to the last block, extending the road. They will then start to describe what happens in the road trip by using the icons they chose. There was a range of icons to choose from, and some of them included two branches indicating that the user and the AI can choose a certain branch in their turn or leave the choice to the other one.

What to explore?

1. When we narrow down the story setting, will it add

to the quality of storytelling?

I chose the setting of a road trip because it fits the turn-based interaction between user and the AI, and the story goes on and on like on the road. I wished to explore what kind of stories the users tell with such a concrete story plot.

2. Will the symbols work when the user and AI use them to describe story events?

I developed a collection featuring 24 different icons. With a richer icon collection, I wanted to examine its effectiveness in guiding users and the AI to describe specific story events to enrich the story details.

3. How will the story be told when there is a conversation between human and AI?

In this setting, the role of the user and the AI was more equal than any other prototype I made. With similar capabilities and being allowed to talk in a conversation, To understand the effect in user experience and storytelling quality.

Test observations

1. Increased storytelling quality

The story was more interesting and detailed, and user had more freedom to shape where the story is going.

2. Icons as effective prompts

Icons helped the user to think about developing the story.

3. AI being consistently positive in storytelling

As the story became more detailed, the plot became more exciting. However, AI still tend to sugarcoat potential tension and conflict, making the user less satisfied. .

4. Losing the spatial narrative

This prototype, the physical placement of the cube didn't play an essential role in changing the story, just like in other prototypes. The physical interaction of placing and connecting the cubes didn't work, and users were focused on reading and extending the story. They sometimes even ignored the symbols and focused on expanding the story.

Implications

1. Prompts and guidance can encourage the user to build more story plot and make the story lively.

In this prototype, the user is more active than in any other prototype. This is because I provided them with prompts such as the symbols and the AI's text response. With realistic things happening in the story world, the users were more likely to immerse themselves in the story and come up with detailed responses.

2. What does tangible storytelling mean?

In this prototype, there were tangible elements like the cubes and the screens. However, it can also be done virtually in a computer. This implies that Tangible elements in the system do not necessarily make the experience tangible. What makes the

interaction tangible is that the physical manipulation of system elements does affect the storytelling in a way that cannot be done virtually. In the previous prototypes, the location and proximity of the cubes is something that the users can experience way better in the physical world and not on a laptop screen. Much as I appreciate the increased storytelling quality in this prototype, the loss of the spatial narrative and the tangibility means that the prototype has deviated from my original purpose. Therefore, in the next prototypes, I focused on bringing the physical movement back This is the recognized advantage of this prototype.

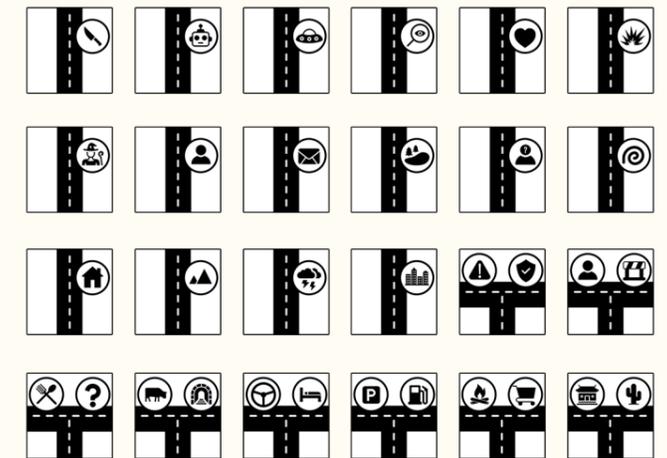


Figure. 4.10 The icon collection.

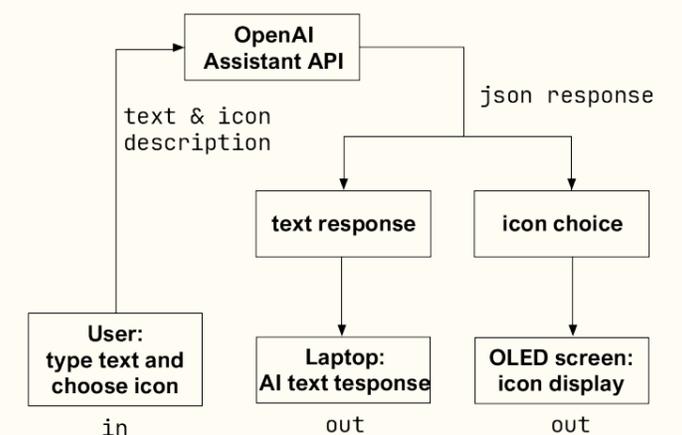


Figure. 4.11 The technical architecture of prototype 5.

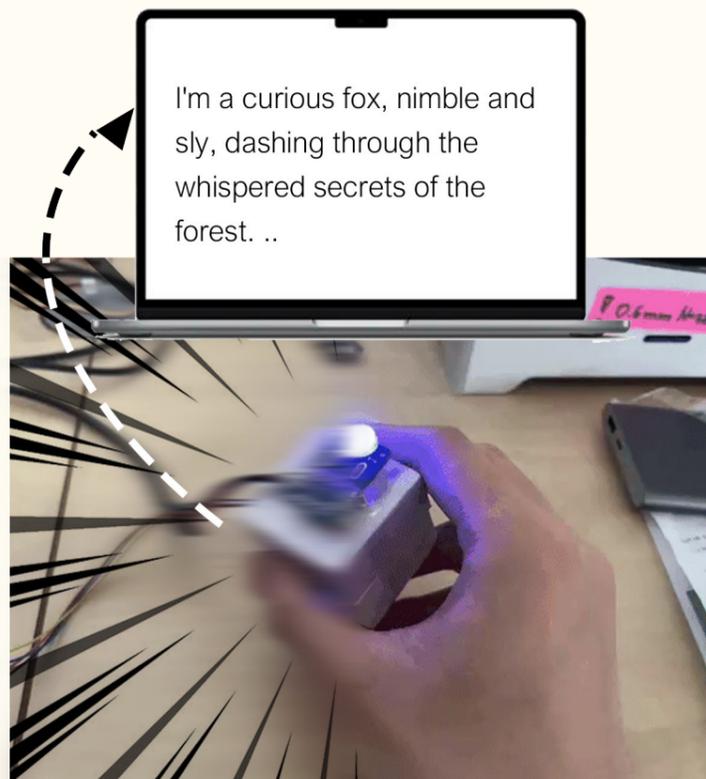


Figure 4.11 Prototype 6 allows users to tell your story with movements.

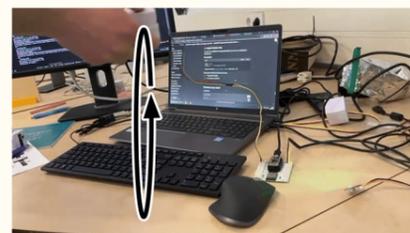
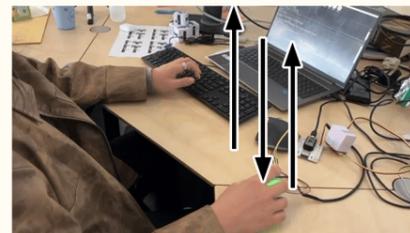


Figure 4.12 Different kinds of user's motion inputs from testing.

Test observations

1. The users experimented on different orientation/movement of the cube, using it as a controller.

From the tests, multiple forms of movement were observed from users. However, based on their responses, they were more seeing it as a controller than a character. This is possibly because of the exposed electronic components and the crude form of the cube, making it hard for them to associate with an animal character in the story.

2. The users were not satisfied with limited choice and control.

The mechanism of this prototype was a threshold-based acceleration detection which would only detect the intensity of the movement but not the direction or the pattern. Therefore, there was a significant gap between the user's physical movements and the system interpretation. This resulted in less user satisfaction because the computer does not fully understand meanings behind the user input.

Implications

1. The freedom of motion triggers users to play with it, engaging them in a playful interaction.

The user showed much interest to the motion input using all kinds of movement, gestures, and patterns to convey certain meaning to the system. It is proven to be a playful interaction that can trigger users' enthusiasm.

2. The band width of movement intensity is too limited.

With the current threshold-based detection, the bandwidth of the user movement that is detected is too limited to support rich and detailed storytelling. This implies that storytelling needs a lot of information input and output, and it is hard to do so without text.

3. The form of the object matters.

In this prototype, the cube item was purely functional and creates no emotional connection. It is hard for the users to associate it with an actual character. This implies that the form of the object significantly affects the way users perceive it, Further influencing how the object is used and interpreted by the users in storytelling.

PROTOTYPE 6: SHAKE THE CUBE!

Storytelling quality is significantly improved in prototype 5. In the next prototype, I continue to define the story in a fixed setting, but with the full focus on physical movement. I explored the situation where movement is a system input.

What did I make?

This prototype features 1 cube that is used as the character the user plays in the story. The user is prompted by the AI to play the character of any animal they can think about. The user uses the cube movement to answer the question from the AI. It will tell a story based on its interpretation of how the user moved the cube. The AI will start by asking, "Which animal am I?" and continue to ask the user questions like, "Where am I?" and "What am I doing?" The interpretation is done through a threshold-based detection system. The detection is indicated through

an LED light attached to the cube.

What to explore?

1. How will users use movement to express certain meaning?

This prototype didn't provide the user with the ability to communicate with the AI using text. I wanted to know how much information users can express and what kind of information they want to express using cube movement. This could provide crucial insights into what motion can afford users.

2. How will the co-creative storytelling experience be like when the user and the AI have separate roles?

I tried to change things a bit from the last one and give the AI a more proactive role by asking the user questions. Let the user answer AI's questions with cube movement. Will it create a successful co-creative storytelling experience?

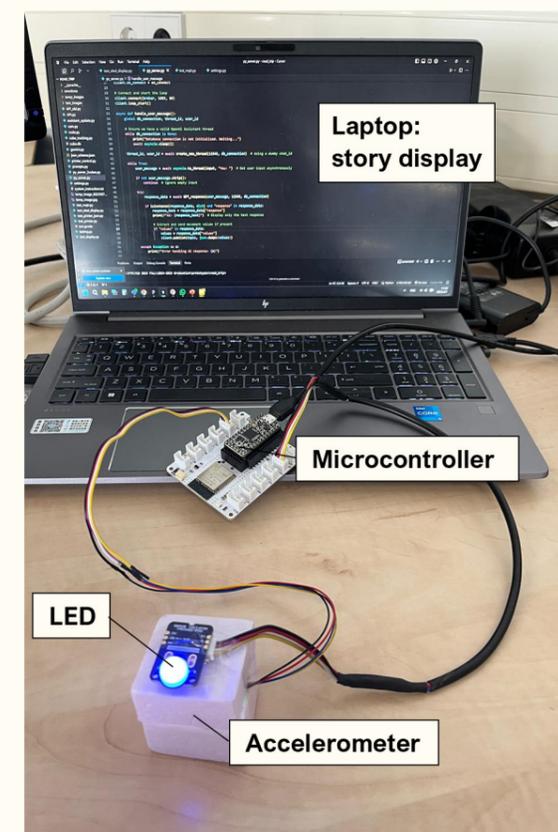
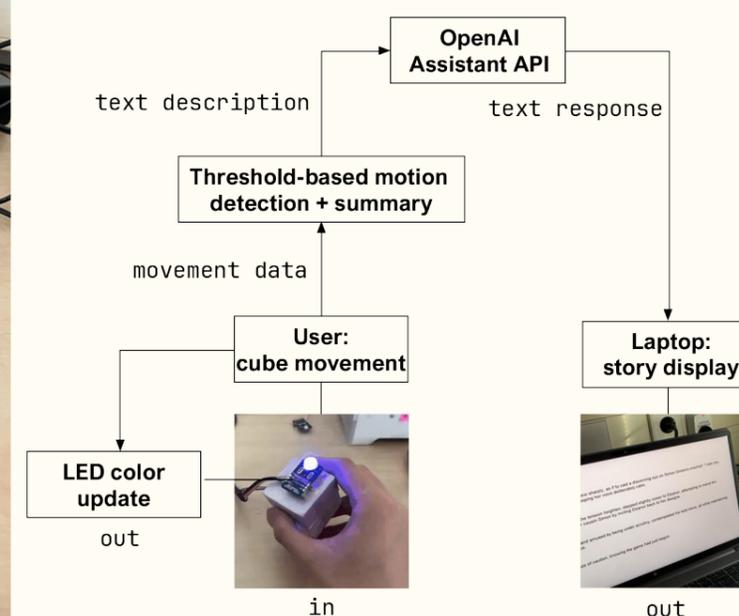


Figure 4.13 The technical architecture of prototype 6.



4.3 Insights from the exploration phase

WHAT DID I EXPLORE?

1. Hardware



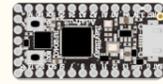
3d printer

AI manipulation of tangible objects



Webcam

AI vision input



Adafruit Itsybitsy M4

Microcontroller allowing integration of various hardware



Grove OLED Display

AI image output



Adafruit accelerometer + gyro + magnetometer LSM9DS1

User motion input



Chainable RGB LED

Physical output to show system status to users



Foam cubes

Tangible objects for users to manipulate

2. Software



Python

Programming language to integrate system elements



CircuitPython

Programming language to enable data exchange with microcontroller boards



OpenCV

Computer vision library allowing object detection



OpenAI API

Providing AI service in their APIs, enabling use of LLM models



TensorFlow

Library for machine learning to train the accelerometer



Telegram + Telepot API

Ready-to-use GUI supporting text, voice, and image input allowing conversation with LLMs

WHAT WORKED?

1. Physical manipulation with tangible objects

From the user tryouts of the prototypes, the interaction of placing and playing with tangible objects has been a good trigger for users to articulate their intentions and helped them think about story development. A storytelling system built around a set of tangible objects allows users to make sense of a story differently from traditional storytelling.

2. Visual (or other) triggers

When we move from simple fragments to full and complicated stories, specific triggers like icons prove to be helpful both for the AI and the user to form a detailed story plot, preventing the story from being abstract and empty.

WHAT DIDN'T WORK?

1. Preset story backgrounds

In the first few prototypes, I set the story background for the characters using AI-generated background stories. The users had to experiment and explore the physical setup in order to make sense of what is going on. This proved to be not convincing and confusing for users because they have no control over the characters, resulting in less ownership of the story.

2. Storytelling without text

Prototype 4 was an attempt to tell stories ambiguously by hiding the story itself and using a symbol system. In prototype 6, I used motion as the only input form for users. These attempts were not successful, largely because of the limited bandwidth non-written channels can afford. Having some way to communicate the story verbally or written is essential in building concrete, understandable, and complex story plots.

3. AI as narrator only

In the first few prototypes, the AI had limited involvement in shaping the story and was playing

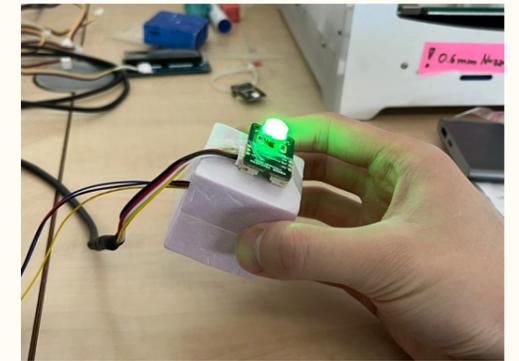


Figure. 4.15 Physical manipulation is a channel for users to articulate their intentions beyond explicit words.

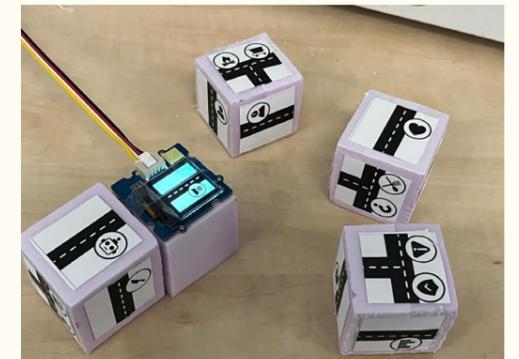


Figure. 4.15 Visual triggers are prompts that lead to interesting story directions.

mainly the role of a narrator. It turned out that letting the AI generate chunks of stories did not significantly make a good storytelling experience, because the reading experience was detached from the tangible interactions. When we introduce more active roles of the AI in the system, such as in Prototype 5, where the AI and the user had similar roles, the interaction encouraged both parties and became more of a collaboration. I believe this collaboration-based storytelling between the user and the AI is worth exploring in future prototyping, And we should avoid giving AI a limited role.

4. Quality of LLM-generated content

In many tests, the content generated by LLMs turned out to be not satisfying because they always tend to be overly positive, lacking conflict and depth. Conflicts in the plot are crucial in building an exciting story. Dealing with the AI's behavior and fine-tuning it is important in future explorations.

WHAT IS MISSING?

1. Different kinds of tangible elements

The physical part of the prototypes has been quite consistent in this round of exploration. With the main focus in the AI modalities and input/output systems, the physical components were usually simple finger-sized cubes. Less exploration was done with different kinds of tangible elements. This is a ground with multiple potentials and should be explored further.

2. Voice input and output

Voice input and output have not been used in the prototypes. However, I believe this would be a crucial factor, since it will make the interaction feel like a natural conversation. Voice-based interaction is a direction that should be explored in future prototypes.

3. Lack of a unified evaluation system

After many rounds of iterative prototyping, it has become clearer and clearer that there was no way to evaluate them using a same set of standards, making it hard to unify the findings and have rigid and convincing research output. This is crucial to define a solid design direction in order to conduct in-depth research and build a more refined storytelling system. Therefore, there was an increasing need for more rigid tests to gather structured user feedback.

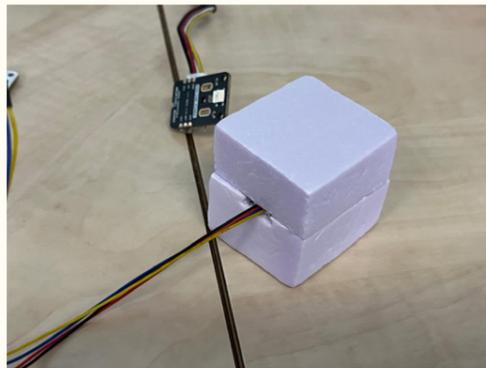


Figure 4.16 Fixation on cube-shaped objects has been a drawback in prototyping.

4.4 Conclusion & reflection

CONCLUSION

In this phase of prototype explorations, I quickly made iterative prototypes and gathered user feedback. This process allowed me to make sense of different system architectures, AI configurations, and physical build-ups. The insights gained were extremely valuable for me to have an initial idea of the basic user needs and AI requirements to build a tangible storytelling system. I familiarized with different hardware and software while making more and more complicated pipelines of storytelling systems. More importantly, the process has also exposed problems and knowledge gaps, which will serve as directions in future research.

REFLECTION

1. Balance between converging and diverging

The exploration phase is supposed to explore various design setups. However, refinement and further exploration in a certain direction are also needed to gain deeper insights. In some prototypes, I was refining a certain direction, for example, with the AI movement using the 3D printer. However, diverging the direction is also important in order for me to explore system setups that are different enough to cover a large area of possibilities. Balancing between converging and diverging the concept has been hard within a limited time span. This has resulted in missing aspects, such as the physical part of the prototypes. This exploration is done in the kind of physical objects available, and design of these objects was fixated on finger-size cubes only.

2. Planning in prototyping

Difficulty in balancing between converging and diverging concepts also reflects my lack of planning in prototyping. My exploration followed a flexible structure, allowing me to build upon the insights of a previous prototype and make another one. However, there was no solid plan in what aspects I wish to explore before I start the whole process. Being

blind in what to explore has also made it difficult to expect the outcomes of the prototypes, making the results more random and less convincing. Therefore, it would be better to set detailed and defined goals at the beginning for a more structured and planned exploration, while still allowing freedom in choosing directions.

3. Lack of theoretical definition at the beginning

The goal of my research is to explore AI-enabled tangible storytelling systems. However, at the beginning of the exploration phase, I have little knowledge on the definition of such systems. The prototyping started with simple and fragmented interactive parts. It took a certain amount of time for me to finally reach prototypes that were closer to a functioning storytelling system. With a clearer theoretical definition of the system I want to build, it would be valuable scaffolds and guidance for me to build functioning and complete storytelling systems which would definitely bring more detailed user insights.

Conceptual framework

During my exploration of physical computing hardware and software, I used prototyping iterations and quick user trials to efficiently gain insights. By the 5th and 6th prototypes, I had already experimented with a wide variety of technical design directions and interaction configurations, and the drawback of this method became more and more prominent: without a solid theory or framework, it is hard to define, compare, and evaluate different prototypes horizontally. There was already a knowledge gap for me to rigorously situate my work and develop further insights supporting future prototyping explorations. Therefore, I sensed the need for a conceptual framework to systematically link different aspects in my literature review and my exploration so far of tangible interactive storytelling with AI. It would serve as a basis for analyzing and evaluating current practice, and define a design space for future explorations.

A crucial problem I wish to address in the framework is “how to design a tangible storytelling system enabled by AI”, which means it would function as a playbook guiding the design process. It indicates the borders of the design and also provides directions for design explorations.

5.1 Framework development

To understand and describe interactive storytelling systems, a framework needs to incorporate major factors influencing the systems. While being precise and inclusive, the framework also needs to leave enough space to give flexibility for further exploration. The PC3 framework is a good example. It proposes 4 components: process, content, control, and context, as the major considerations for interactive narratives. (Magerko, 2014) Process stands for the actions or rules that drive the narrative. It describes how the narrative unfolds and what techniques are used to advance it, like rules in board games. Content means the story elements and their structure, including characters, events, settings, and how these elements are manipulated, like branching paths in choose-your-own-adventure books. Control focuses on who has the power to influence or direct the narrative. It can be centralized (like a dungeon master) or decentralized (like an improvisational theatre). It determines the agency for participants in the narrative. Finally, context refers

to the social and functional setting of the interactive narrative, including factors like audience, purpose, and experience. Together, these components form a comprehensive lens to understand and compare narrative systems across different media. The comprehensiveness, simplicity, and flexibility of the PC3 framework make it a perfect ground for building a conceptual framework for the interactive narrative discussed in this graduation project: a tangible storytelling system, where users tell stories with AI.

From the previous literature review, an AI-enabled interactive tangible storytelling system covers 2 major knowledge areas in storytelling: human-AI collaborative storytelling and tangible narrative. Therefore, the framework should be based on these 2 core angles, and this forms the base structure of the framework. The human-AI interaction configuration deals with what the story is and how it is collaboratively told between the human and the AI. Beyond that, tangibility will be another dimension, focusing on how designers shape the tangible interactions during storytelling. (Figure 5.1)

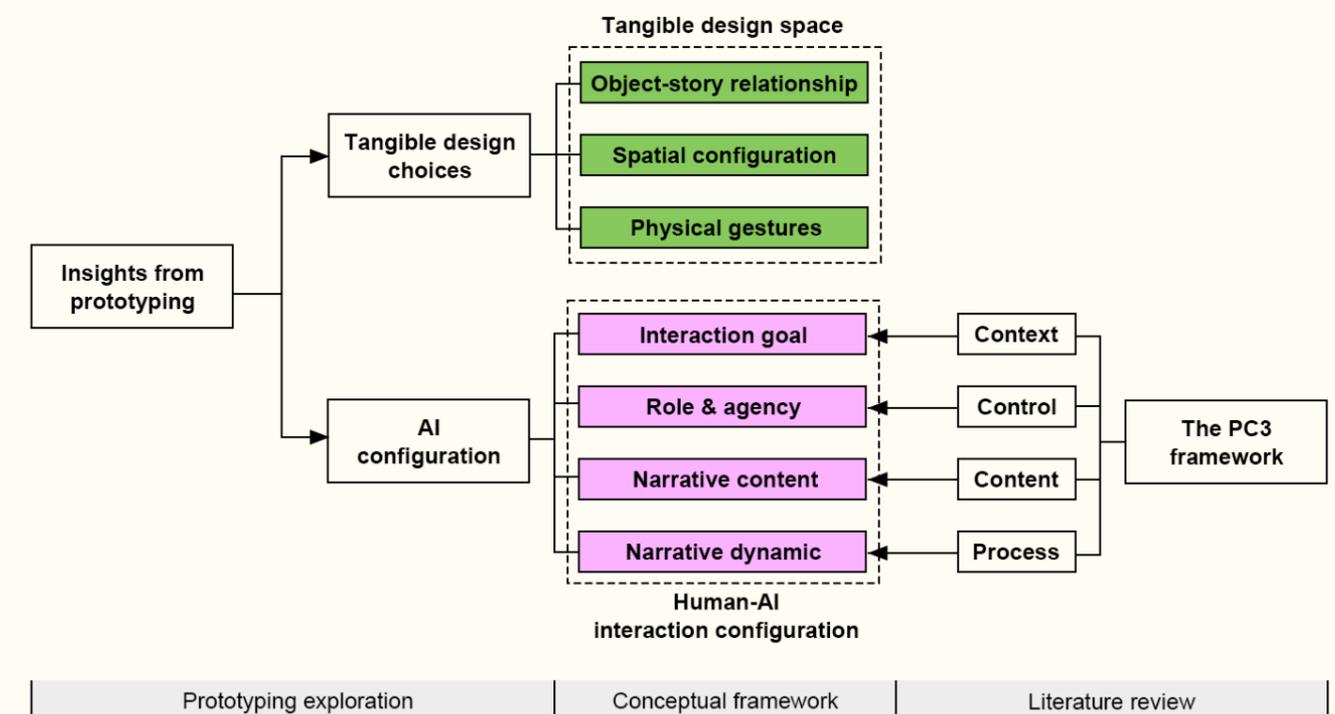


Figure. 5.1 The framework is developed from both existing literature and my prototyping practice.

5.2 Framework overview

Combining the human-AI interaction configuration and tangible design space, it is now a full conceptual framework to design an AI-enabled tangible storytelling system. Designers can use this framework to ideate on the concept of an AI-tangible storytelling system. Elements in the frameworks can function as inspirations for design decisions. They can also use it as a checklist when designing such a system to see what might be missing. The framework can also be used to analyze an existing tangible AI storytelling system, explaining the core functionalities. The two dimensions this framework contains do not have a fixed hierarchy. Instead, they focus on different aspects of shaping a design concept. Based on the different needs of the user, designers can choose which dimension to start with or focus on.

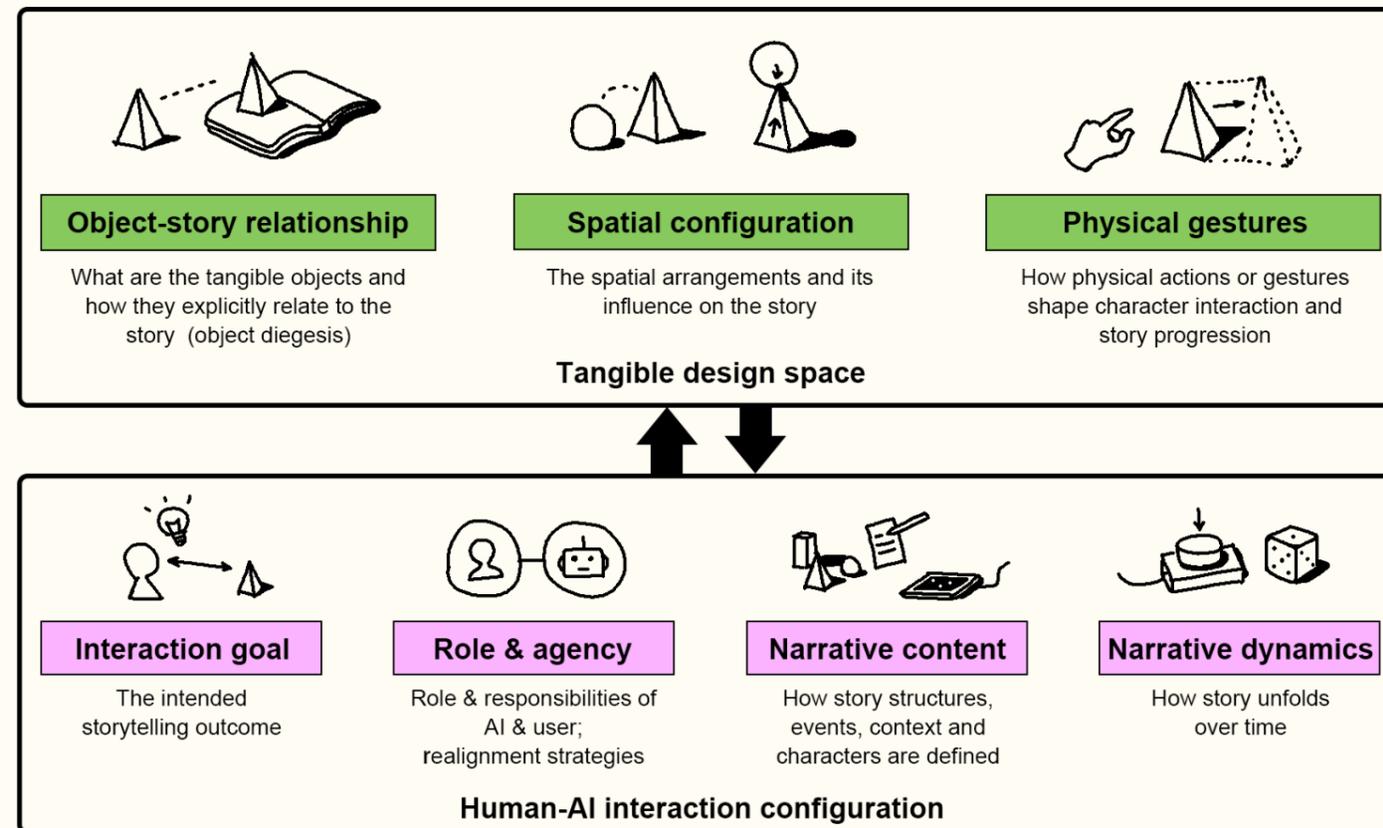


Figure 5.5. The conceptual framework.

TANGIBLE DESIGN SPACE

- Each of the 3 tangible design space elements shows a range of possibilities of design intervention.
- Designing by first exploring the tangible design space allows designers to focus on interesting tangible configurations to make a unique design. It works well when the goal and vision of the storytelling are not yet clear, and the designer wants to keep it fuzzy in the early stage while examining a certain physical design setup.
- By covering all 3 tangible design space elements, it would become clear how tangible elements contribute to storytelling.

HUMAN-AI INTERACTION CONFIGURATION

- All 4 configurations need to be covered in the design in order for a functioning setting of the system.
- There is no hierarchy between the elements: design can focus on any of the elements. For example, one design can start by defining how the story unfolds (by the user putting the character into action), then the role & agency would be most likely the user being the character, and AI being a narrator. We can then define the rest of the configurations.
- The interaction configuration can make clear restrictions for a design set up to keep the designer aware of the intended interaction goal.
- Starting with defining the interaction configuration is best when exploring multiple tangible design possibilities with a predefined goal or vision of storytelling.

5.3 Application: A playbook to design AI-enabled tangible storytelling systems

One major function I envisioned the framework to achieve is to guide designers to design an AI-enabled tangible storytelling system, which would also be put into practice in the following prototyping process. In order to create a clear theoretical path towards this, I developed a playbook with this conceptual framework. It serves as a user manual to the framework, providing practical guidance in design, and will be examined in later stages of this project.

The playbook consists of 3 sequential steps, exploring different elements in the framework. As real design practices often contain a large proportion of uncertainty, especially in the ideation phase, the playbook would only serve as recommendations or inspirations, rather than rigid rules to follow. It would be especially useful to designers in need of guidance to see what elements are missing or a spectrum of possible design directions to follow.

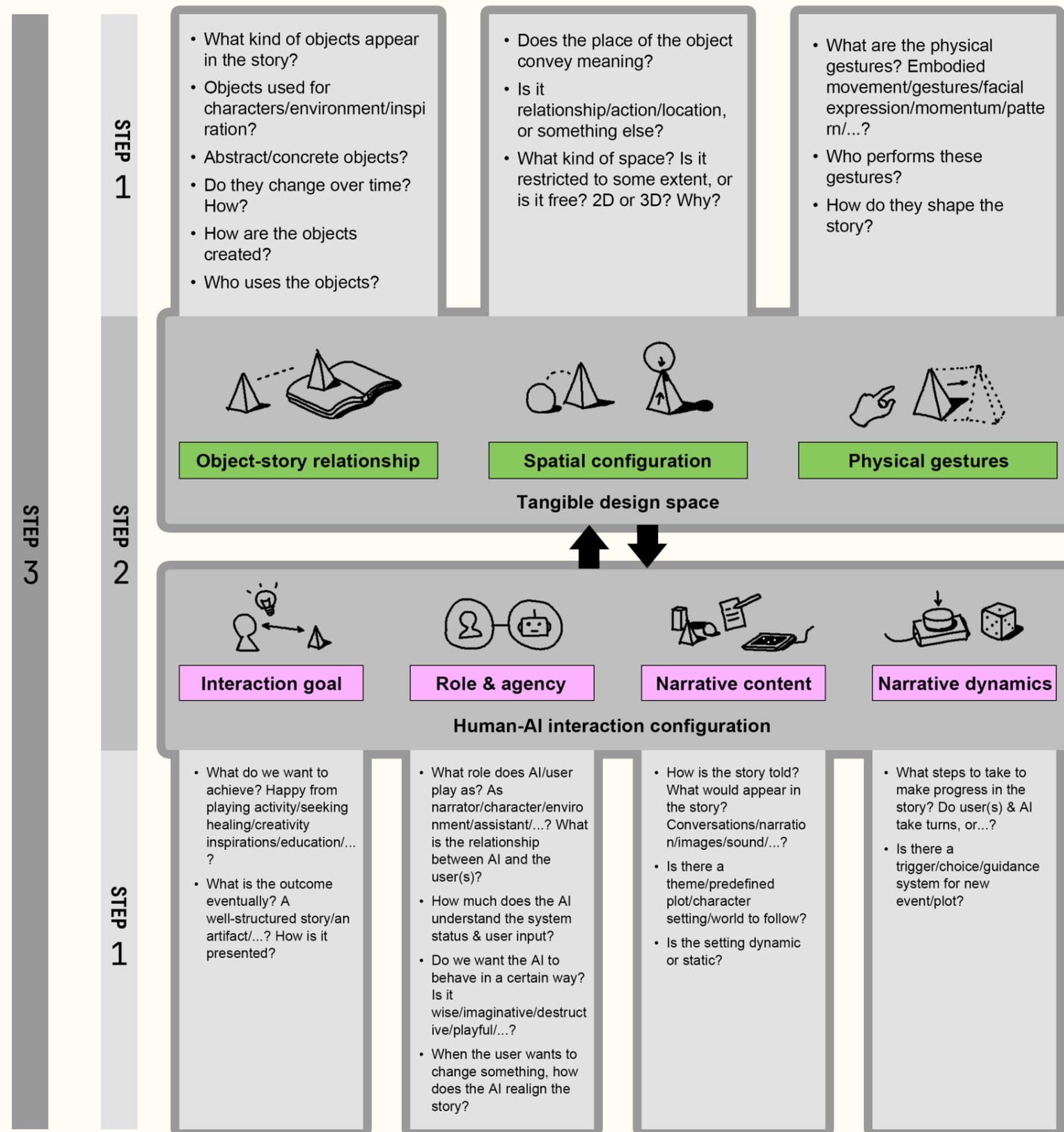


Figure 5.6. The playbook to design AI-enabled tangible storytelling system.

STEP 1: START SOMEWHERE

To design an interactive AI storytelling experience that is tangible, we can first use the framework as a map of inspiration. Each of the elements can be related to multiple explorative questions.

By answering these questions, we can form a starting point for the design. For example, if we focus on a design inspired by object-story relationship, we can think about what kind of objects we use in the story first. One possible approach is to use puzzles. Puzzles then serve as a starting point, and by defining them more clearly within the 'object-story relationship' element, we can form a design direction. In this case, puzzles can relate to the story as map fragments, so it serves as a spatial reference, connecting the human interaction and the locations in the story. We then would start to think about other elements, possibly 'spatial configuration'. This will be discussed in the next step.

STEP 2: DEFINE HUMAN-AI INTERACTION CONFIGURATION OR EXPLORE TANGIBLE DESIGN SPACE

After finding a starting point as inspiration and possibly the core mechanism of the design, we can use the framework as a checklist to look for crucial elements that need to be considered. In this process of covering different elements, new inspirations may also appear that may influence the design. Generally, there are 2 paths designers can take.

1. Defining the interaction configuration first

By doing so, we can clearly picture how the story is told in the interaction. By setting reasonable restrictions on the interaction, we can quickly make the design in higher fidelity.

2. Exploring the tangible design space first

Another alternative is to picture the tangibility of the design first. By using the starting point as an imagination, we can explore the tangible possibilities, or already settle down with a concept interesting enough.

For example, we picked 'puzzles that are map fragments' as a starting point. One alternative for us is to further define the tangible interaction. If we look at 'spatial configuration', we can think about even more different possibilities: if it's a 3D space, then maybe map tiles can be stacked upon each other? This further triggers exploration on how users would physically manipulate these items.

If we take another path of first defining the interaction configuration, we can keep the idea of 'tangible map pieces to create a story and start by thinking about what the story will eventually be like ('interaction goal' and 'narrative content'). Since a map already appears in the story, it can be a playful storytelling experience where users make their own 'maps' like notes of their fictional adventure. With that in mind, we would focus more on AI involvement in this concept to give the design higher fidelity.

STEP 3: MAKE A DESIGN BRIEF USING THE FRAMEWORK

After step 2, the design concept should either contain a clear configuration of what is being told or a clear vision of how it will be tangibly enacted. It is now time to refine the core design concept, think about the whole picture, and develop a design brief in order to navigate the design process. Making a design brief using the framework does not necessarily mean covering all 7 components of the framework and making a list of every one of them. Instead, it requires the designer to think in a bigger picture by using the entire framework as the frame to situate their design work. In a final design, every aspect will be manifested, but to what extent these aspects are important remains the choice of the designer. If we use the 3D interactive map as an example, "physical gestures" might not be the core focus to deal with in earlier stages of the design if the designer decides to focus on exploring the possibilities of "spatial configuration", despite the fact that in the final design, "physical gestures" indeed would shape the user experience to some level. Therefore, it is essential for the designer to refine their decisions in this step, and come up with a practical, flexible, and focused design brief.

5.5 Conclusion & reflection

CONCLUSION

The conceptual framework developed in this chapter turned the insights from prototyping exploration into a structured system for designing, analyzing, and evolving AI-enabled tangible storytelling systems.

The framework consists of two complementary dimensions: human-AI interaction configuration, and tangible design space. Together, they changed an open-ended design problem into an explorative design map. Instructed and inspired by this map of interest, designers can enter at any point, iteratively work across dimensions, and finally develop a storytelling system. The playbook turns the framework into a three-step process that supports both divergent ideation and convergent definition.

This conceptual framework works as a common language and criteria for evaluating diverse prototypes. The flexibility of it allows frames each element as a spectrum rather than a defined template, inviting creative exploration. It provides scaffolds for future work, pointing to a clear path of theoretical exploration and practical prototyping.

REFLECTION & LIMITATION

1. Development of tangible design space was not rigid.

Unlike the development of interaction configurations, Tangible design space was not based on supporting literature. Instead, it was developed mainly based on experiences and assumptions from the prototyping exploration phase. There was no rigid evidence to prove the correctness of the three aspects. Blind spots may exist in unexplored physical modalities. Therefore, using this framework poses the risk of overlooking richer possibilities in tangible design. With a comprehensive review of the relevant design practices of tangible storytelling systems, the tangible design space can be further examined to fill any possible blind spots.

2. The framework says little about measuring story quality.

As a framework to guide design, the framework

is mainly focused on elements that define the considerations in design. In this way, story quality, story engagement, and story outcome are neglected. These are still crucial parts that determine the quality of the storytelling system and should not be overlooked. A more comprehensive framework considering before, during, and after storytelling needs to be developed in order to take a comprehensive perspective towards storytelling.

3. Design decisions can be fluid during the design process, yet the framework poses a static view.

The seven components in the framework risk being treated as a checklist. The final outcome of the framework is a design brief, and it did not clearly state to which level designers should define the 7 components. This is likely to lead to fixation on certain elements in the early stage of design. In a real design scenario, many components tend to be fluid and undetermined until later stages of the design. Therefore, to guide a full design process, the framework needs to stay more open-ended in earlier stages, and the current layout of this framework may suit more in the design refinement and reflection stage.

User study

The development of a conceptual framework provided a solid ground to base further research. In the framework, I tried to form a detailed and comprehensive structure to better define my research focus, but in order to correctly and efficiently use it in actual designing, insights in real-life scenarios are needed. Therefore, a small-scale user study is needed to bridge this gap between theory and practice. I developed and conducted 2 user tests, each examining one dimension of the conceptual framework. From the observations, transcripts, and story creations of the participants, I gained essential insights into users' needs and preferences in collaborative storytelling with AI and tangible storytelling. By analyzing and refining the research data, I concluded the user story with design recommendations within the framework, which will lead the ideation for future prototyping iterations.

6.1 Study goal

Based on the framework, what is needed in an AI-enabled tangible storytelling system has become clear, but what is preferred by users remains a knowledge gap. I initiated the user study with these core questions as the story goal:

What are users' expectations and preferences when telling stories tangibly with AI?

What should the design focus on for AI-enabled tangible storytelling systems?

Using the two dimensions from the conceptual framework, I separated the core questions into two main areas. With the focus on human-AI interaction configuration, the user study expands on users' preferences for interacting with AI in storytelling. By testing with different configurations, especially those not present and tested in previous prototypes, I can gather users' feedback and find out interesting interactions to study further. In the tangible design space, it is crucial to understand how users use tangible elements to support their storytelling. Therefore, providing users with a tangible space

together with a storytelling toolkit stands out as a reasonable test setup. Eventually, I organized the user study with two tests, covering these two dimensions. The 2 tests and their goals are as follows:

1. User test on human-AI interaction configuration

Goals:

- Test some interesting interaction configurations, especially some elements not tested in previous prototypes.
- Gather insights on the user experience of different configurations, seek interesting interactions, and find potentially interesting combinations.
- Find out users' expectations of AI's behavior.
- Find out users' preferred ways of telling stories with AI.

2. User test on tangible design space

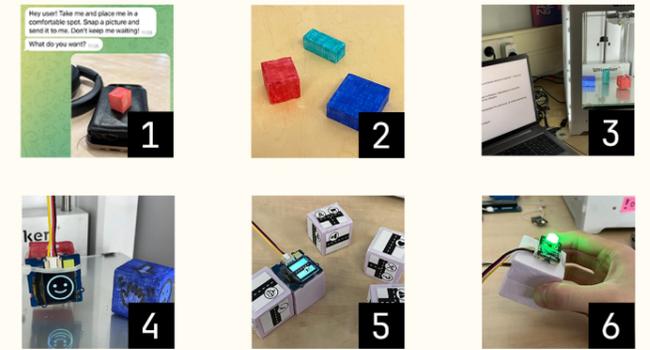
Goals:

- Understand users' needs and preferences in tangible storytelling.
- Test users' interactions with different objects in storytelling.
- Figure out the objects' influence on the storytelling process.

6.2 User test on human-AI interaction configuration

TEST SETUP

Using the conceptual framework, I analyzed previous prototypes to find out blind spots. (Figure 6.1)



- 1 Any everyday objects are commented by the character
- 2 Objects are characters in story
- 3 Objects are characters in story
- 4 Objects are characters in story, symbols represent actions or emotions
- 5 Objects represent story events, symbols are the inspirations of the story plot
- 6 The cube represents the user's role

- 1 AI understands it's location in the space
- 2 Object location, orientation and proximity reflect character relationship
- 3 Object movement, location, orientation and proximity reflect character relationship
- 4 Object movement, location, orientation and proximity reflect character relationship
- 5 Connecting cubes represent moving forward in storytelling
- 6 Movement of the cube is perceived and translated by AI

- 1 Interaction is static, no gestures
- 2 User arranges objects in different ways
- 3 User arranges 2 cubes in different ways, AI arranges 1 cube
- 4 User & AI each expresses themselves by choosing a symbol and moving and placing their cubes
- 5 No physical gestures recognized
- 6 User actions to the cube is translated by AI into story plot

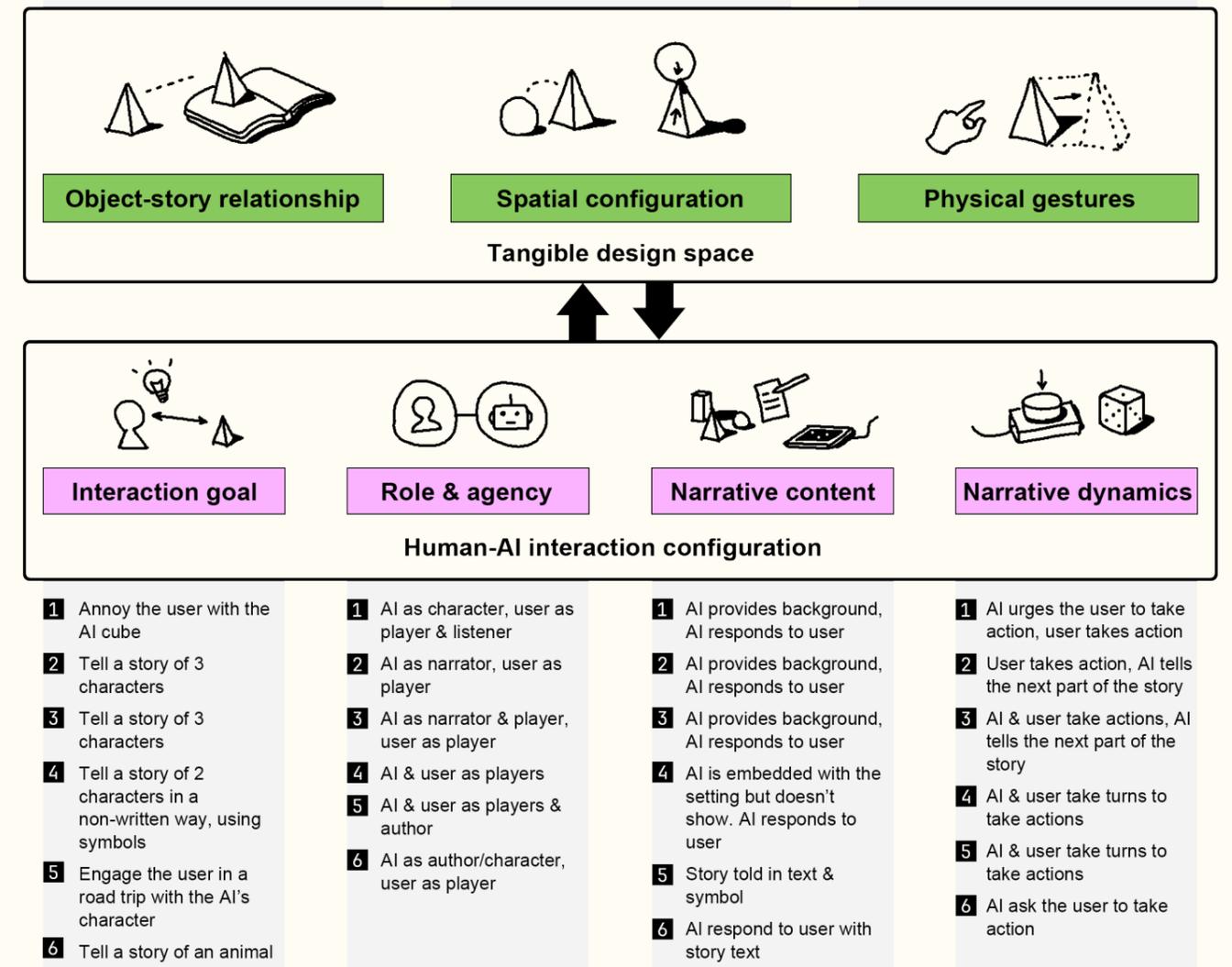


Figure 6.1. Analysis of previous prototypes using the framework.

As seen in the mapping, interaction goals varied, but generally, they tend to get more specific in later iterations. In this study, I wish to give the users more freedom on story themes, as a way to figure out their preferences. Therefore, I used adventure stories as a general theme and allowed variations. In the roles & agency part, previous prototypes always focused on AI telling the story and having the initiative. This is the same in narrative content, where AI usually sets the scene. In the current user test, it is reasonable to give users more power to define story characters and events, and play as the author of the story. Previous prototypes varied in the narrative guidance systems. When users and AI were in similar roles, it was usually a turn-taking system. In other scenarios, the user was usually guided by AI to take the next step, highly dependent on the tangible interaction. It is thus hard to test narrative guidance in a separate test, and it should be combined with insights from tangible design space.

After pinpointing elements worth digging into from previous prototypes, I further defined the test setting in more detail. As the test is less about tangibility in storytelling and more about dynamics and agency in human-AI storytelling, I used the screen-based OpenAI platform as the test ground to focus more on story quality in text. I created 3 different test settings to stimulate users and understand their preferences by giving the AI different prompts.

Test 1: user & AI taking turns

In the first setting, the user and AI take turns to tell the story. I tried to put the user and the AI in similar roles.

Test 2: relationship change

In the second setting, the user defines story settings and characters, and they make progress of the story by stating the changes of the characters' relationships. The AI will do most narration and guide the user by asking about the relationship change. I created this scenario to test whether certain elements in the story structure, like relationships between characters, can be levers of smooth collaborative storytelling with AI.

Test 3: AI as the actor

In the third setting, I reversed the roles of AI and humans by letting the AI focus on the character's actions and leaving the user to storytelling. I wish to create a scenario where the AI is more active and in control of story progression by acting as a character, and what the user will do in this scenario.

In all 3 settings, users were provided with a laptop with the OpenAI platform in the browser. They were presented with a screen-based interface to communicate with the AI by typing. They were given 10 minutes for each test setting and asked to create one story (not necessarily different or the same) with each test setting. They are free to withdraw or end the story when they feel they need to. After all 3 stories were finished, they will be involved in an in-person interview to discuss their experience. The questions posed included, but were not limited to, the following:

- Which setup do you like best, and which you don't like? Why?
- Why did you decide on the elements in your story?
- You did ... in the storytelling, does that mean you want AI to do ...?
- Have you come to a point where you are not satisfied with the story or the AI?

- What did you do first? Did you try to set a goal to the story?
- Are you satisfied with your story? Why?
- Did you enjoy the storytelling process? Which part of it did you enjoy?

TEST PROCESS

A total of 4 participants took part in the test session, lasting for approximately 1 hour. Participants were asked to sign a consent form prior to the test sessions and were informed about the possible risks during the performance. The interviewer observed the participants during the session and offered them help when needed, in case participants could not complete the task. Participants were encouraged to think aloud and explicitly talk about it when they encountered an issue. The conversation history between the participants and the AI was recorded, as well as the interview. (Figure 6.2)

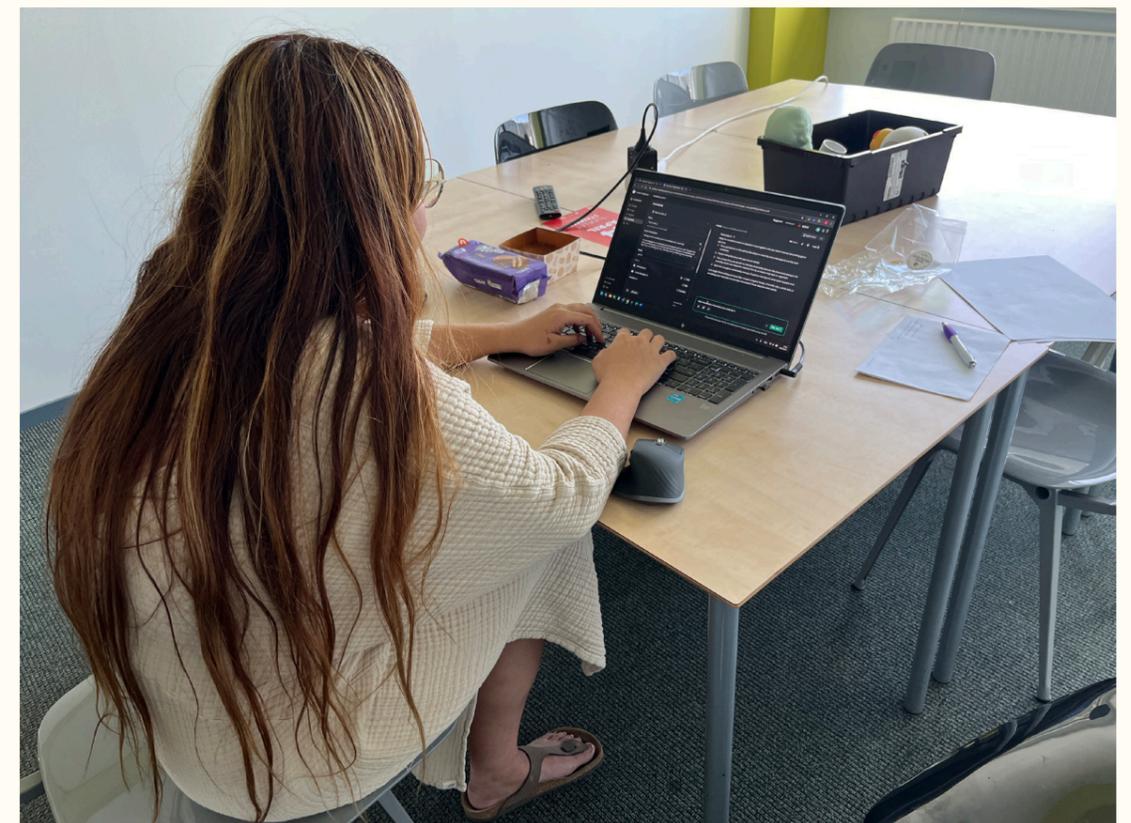


Figure 6.2. Test session.

PRELIMINARY FINDINGS

Despite some efforts in certain scenarios with some participants, all of them were successful in creating authentic stories with AI. However, the process was far from smooth, for there have been many occasions where the participants were unsatisfied with how the AI behaved or how the story was progressing. This has all been recorded and served as a valuable research outcome. Generally, the test setup was successful, with the AI behaving differently in each of them and bringing participants with different experiences. However, since the test was completely screen-based and users used keyboards to put in story text, there seems to be generally less human input than AI input. Participants tend to narrate the story in detail less often, but more often they respond to the AI in precise commands or move the plot forward with actions and events. Also, the process was way more dynamic than my initial imagination. Users are not afraid to comment on the generated plot when they feel a misalignment, and they can demand inspiration or correction when they feel unsatisfied. The stories told were both diverse and surprisingly interesting, showing a much wider variety than stories from my previous prototypes. There were traditional adventure stories or fairytales, a sci-fi thriller time travel plot, modern love stories, and so on. Participants were able to use both their imagination and the AI's creativity to create reasonable, complete, and sometimes unexpected story plots. According to the interview, a lot of opinions on AI were shared by the participants. A detailed analysis of all data will be conducted in a later section.

6.3 User test on tangible design space

TEST SETUP

In my sixth prototype, where I enabled motion input for users, I have already seen different patterns of movement applied by users to convey their intentions in storytelling. However, the physical form restricted the variety of message input since I only provided a cube with motion sensors. This made me realize the importance of this test to explore users' feedback on different forms of tangible objects, and what will happen if they are used in combinations over the storytelling process. With that thought, I defined the test form. To maximize the outcome, users should be given maximum freedom when tangibly telling a story in the test. Therefore, I decided on the form of the test session. By providing users with a storytelling kit with a wide variety of items and asking them to narrate a story freely, I will be able to observe their real-time interactions with different objects and identify patterns. It is thus important to design a collection of objects that cover different aspects, allowing users to manipulate them differently. By referring to the 3 components in the tangible design space, I first defined a list of all the attributes to be covered in the object collection.

Category	Examples	Picture
Single vs. multiple	<ul style="list-style-type: none"> A single cube A set of multiple shapes 	
Abstract vs. Specific	<ul style="list-style-type: none"> Geometric shapes Everyday items Human/animal figures 	
With context vs. without context	<ul style="list-style-type: none"> A map/paper/picture as background to use based on the user's choice 	
Material, size & shape	<ul style="list-style-type: none"> Items from palm-sized to hand-held 	
Familiar vs. novel	<ul style="list-style-type: none"> Everyday items, uncommon or alien objects 	
Open vs. fixed interaction	<ul style="list-style-type: none"> Flexible shapes Puzzle-like objects 	

Table 6.1. Object categories to be covered in the test.

I proceeded to gather a collection of items that cover all the above categories as the storytelling kit used in the test session. (Figure 6.3) The collection includes:

- A baby's face sculpture, made with green foam.
- A white plastic ellipsoid, with two brown "eyes".
- A yellow rubber duck.
- A plastic wheel from an RC car.
- A section of water pipe.
- Puzzle pieces allowing assembly, made with plastic tubes and 3D-printed connectors.
- A small decorative ball made from interwoven yellow rattan.
- A small crocheted plush capybara toy.
- A paper pumpkin.
- A wooden bowl.
- 3 finger-sized foam blocks with different shapes, in red, blue, and green.



alien
specific



abstract
humanoid
robotic



specific
animal-like



specific
technological



abstract
technological



abstract
technological
puzzle-like



abstract
textile



specific
animal-like
cute



specific
cute



abstract
geometric
group

In the test session, the participants will first be provided with a collection of objects and informed about their task, which is to tell any story they wish using these objects. They are not required to tell the story immediately, but to take some time to familiarize themselves with the objects. When they feel they are ready, they can start narrating. The researcher will observe the participant during their performance and give adequate feedback. If the participant shows interest in doing so, the researcher can also engage more in the storytelling instead of observing. However, the story progression is always controlled by the participant. After the participants finish the storytelling, the researcher may ask them to tell another story in case when participants fail to tell a clear and complete story. After that, participants will be engaged in a face-to-face interview with the researcher.

TEST PROCESS

A total of 6 participants took part in the test session, each lasting for approximately 45 minutes. Participants were asked to sign a consent form prior to the test sessions and were informed about the possible risks during the performance. The interviewer observed the participants during the session and offered them help when needed, in case participants could not complete the task. Participants were encouraged to think aloud and explicitly talk about it when they encountered an issue. The test sessions were recorded in videos, as well as the interview. (Figure 6.4)



Table. 6.4. Test session.



Figure. 6.5. Object collection provided to the participants.

PRELIMINARY FINDINGS

In the 6 test sessions, participants have shown creativity in storytelling and created a series of engaging stories, some being unexpectedly dramatic, and others being told in a nonsense but humorous way. The collection of objects played a huge part in the story's development. It seems that many objects in the collection reminded the participants of science and technology (like the white plastic shell, the tube, and the 3D-printed pieces), and based on that, they aligned the story vibe with the feelings these objects arouse, resulting in more science fiction themes in the stories told. Generally, all participants were successful in telling a clear story using the objects, and they revealed massive information regarding tangible interactions during the sessions and the interviews. A detailed analysis and conclusion will be conducted in the section below.

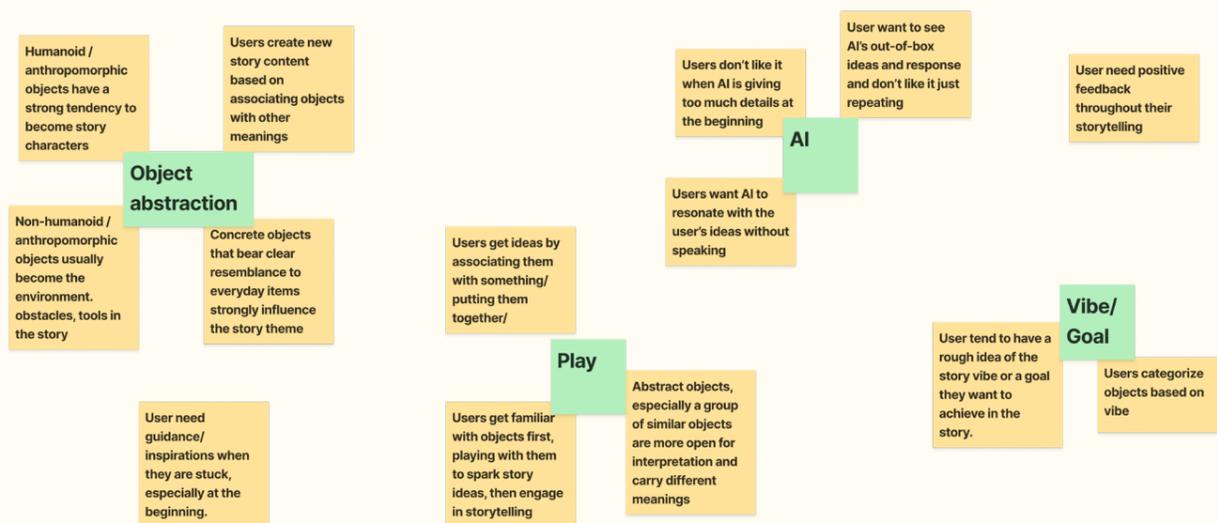


Figure. 6.7. Refined insights.

STEP 2: REFINING THE INSIGHTS BASED ON THEMES

After the first round of refinement, I came up with a collection of insights from raw data. I put them on sticky notes and tried to cluster them again to find a pattern. 4 main themes arose from the insights (Figure 6.7):

1. Object abstraction

Based on many observations, the abstraction level of the objects provided affects storytelling a lot. Items like the rubber duck and the baby face were very concrete and relatively larger in size. They were very often used in storytelling and shaped the story to a large extent. A baby's face, from one of the participants, reminded her of an android and many science fiction or cyberpunk genre. This shaped her story theme in the early stages of storytelling. More abstract objects, like the set of small foam cubes, were also used quite often, but they were interpreted in many different ways. Participants tend to play with them more to create certain combinations to fit in the story. In one of the stories told, they were first piled up to make a castle, and when they were arranged in a linear form, they changed into a wall. A lot of the insights were drawn from these observations, indicating how largely the form of objects can affect their role in stories and shape storytelling.

2. Playing

When participants were starting with the story or proceeding with new story events, instead of using single objects, they often made combinations of objects, like attaching something to the rubber duck so it is "carrying" the items. This action often became the inspiration for story ideas. When the object is a representation of a character in the story, this could easily lead to actions that add potential twists and turns to the story plot. I defined these interactions as a form of playing that deeply shaped storytelling. Object play has been a way for participants to come up with new story events in a natural and open-ended manner, which often led them somewhere unexpected.

3. AI behaviour

Since one of the two tests focused on human-AI interaction, a lot of the insights contributed to the idea of how AI should and was expected to behave in a collaborative storytelling scenario. It is exactly from how users are dissatisfied with the AI that I understood, and dug deeper, on how they wanted the AI to act. Different from a human playmate, the AI came with so many more functions and seemingly so much less "intelligence" when completing the actually very complex task with humans. Instead of wanting the AI to be completely equal to humans and as similar as possible to a human, participants have various other needs with an AI story companion. At different stages in the storytelling, the expectations on AI can also be different. In general, the role of AI in collaborative storytelling is complex and dynamic, and it directly affects a large part of the user experience.

4. Story vibe or goal

While a lot of stories told had a very unexpected turn in later stages and went completely off track from the participants' initial ideas, most of them are controlled in some way by the participants, very often already at the beginning. The goal and vibe set at the beginning have an essential influence on the final outcome. It can vary in scale from a genre to a certain plot (for example, "I want the story to be heartwarming" or "I want her to feel embarrassed"). These goals, no matter how big or small, served as crucial drives in storytelling for users to steer the story in the way they wanted.

STEP 3: MAPPING REFINED INSIGHTS INTO THE CONCEPTUAL FRAMEWORK TO CREATE DESIGN RECOMMENDATIONS

In the next step, I mapped the findings according to the conceptual framework to directly serve as guidance for design. From the 4 main themes concluded from the previous data analysis, I developed several key instructions and recommendations for design under the conceptual framework. This would serve as a solid ground to start ideating for the next prototype.

1. Object-story relationship: Objects should cover different levels of abstraction and vibe, open for interpretation.

In test sessions, we have come to the conclusion that the forms and abstraction levels of the tangible objects play a huge part in how stories are constructed. Concrete objects tend to shape the story more explicitly, like defining characters or themes, while abstract or ambiguous objects encourage broader interpretation and playful exploration. Therefore, providing a spectrum of objects ranging from concrete to abstract can stimulate creativity to the fullest and support a wider range of narrative possibilities.

2. Physical gestures: Objects should encourage playing, allowing the user to change or combine them.

The interactions between participants and tangible objects revealed how combining and arranging objects brought new purpose and meaning to them and eventually inspired new story events. These physical gestures were not only common but also essential for creative, open-ended storytelling, as users discover new story directions through tangible experimentation. It is thus crucial to design objects and interactions that support and invite such playful manipulation, enhancing engagement and new ideas during collaborative storytelling.

3. Role & agency: AI should be adaptable, creative, and understanding.

From all the users' feedback on the AI's behaviour, a holistic image of what role it should play has become clearer and clearer. It should be not only

responsive, but also adaptable, to every change in the user input and story dynamics. It should always dynamically steer the storytelling when it goes off track or when the user is stuck. The AI's role is not to mirror a human completely, but to provide creative, out-of-the-box, yet contextually aware ideas to users. The value of the AI lies in its potential to use its superpower in that way to add to the storytelling quality. Lastly, empathy, though not technically real, should be considered in user experience design, as storytelling is, in essence, a collaborative social behaviour that requires mutual understanding, creates bonds, and sparks joy.

4. Narrative content: Story structure should have a soft, explorative start, and always allow creative input.

The analysis showed that participants often entered storytelling sessions with an initial "vibe" or goal, ranging from a specific genre to a mood or desired outcome. However, the storylines frequently evolved in unexpected directions. When dealing with a large collection of objects, they also tend to familiarize themselves with them first before actually starting to narrate. A successful narrative system should therefore allow a soft and open-ended beginning that releases the potential for users' creativity while providing the necessary scaffolding. Maintaining the balance between story structure and creative freedom in user input is also crucial, which poses a challenge in system and touchpoint design.

5. Narrative dynamics: AI should give positive feedback to users' creative input.

As the story unfolds, continuous positive feedback is a key factor to maintain user confidence and engagement. To maximize users' creativity input, design for AI should consider emotional boosts to foster a collaborative and friendly atmosphere.

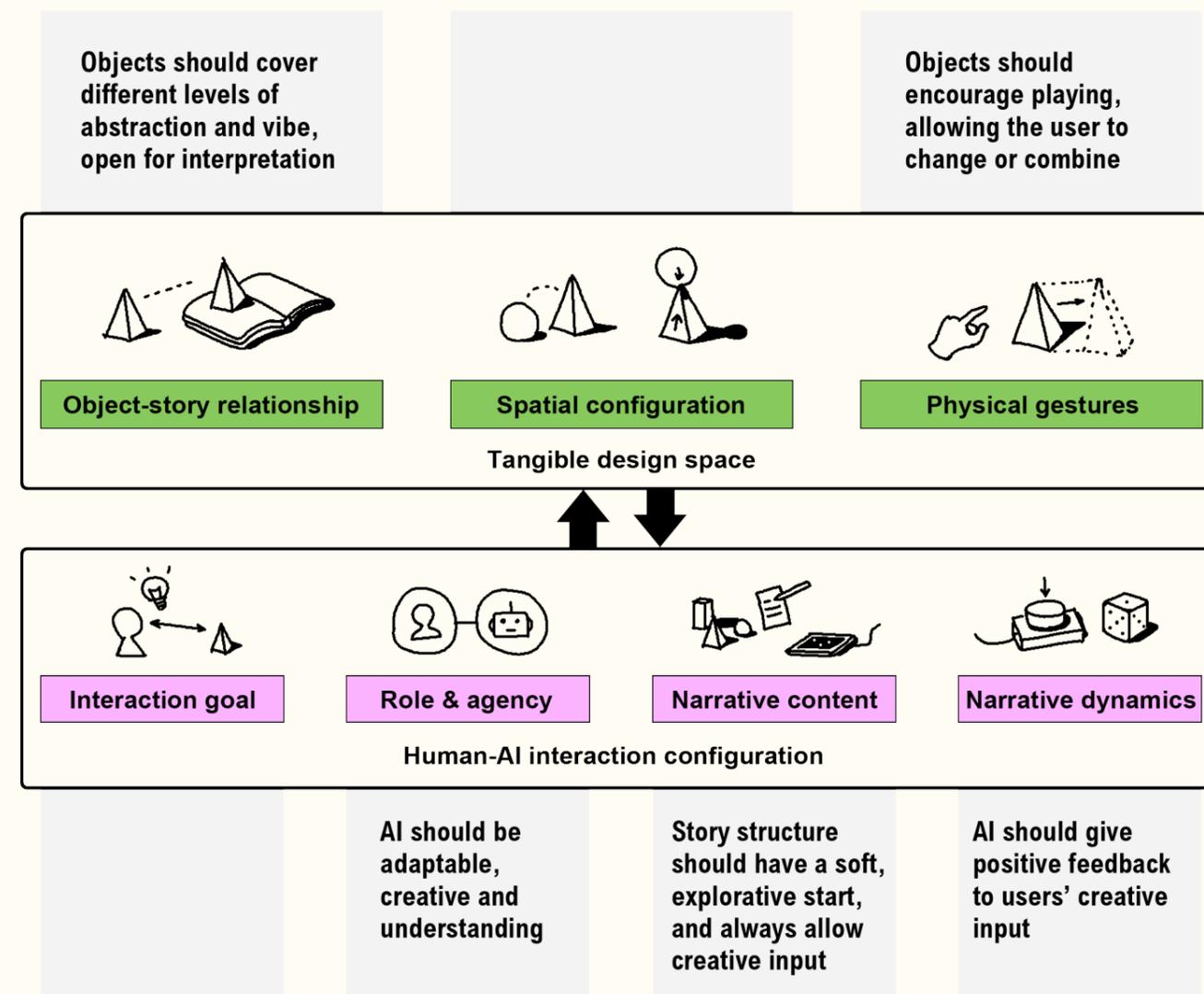


Figure. 6.8. Design recommendations mapped to the framework.

6.5 Conclusion & reflection

CONCLUSION

The user study provided essential real-world insights that bridged the gap between the conceptual framework and practical design in AI-enabled tangible storytelling. I designed and conducted two user tests focused on different dimensions, covering the two dimensions in the conceptual framework. From the qualitative, flexible, and exploratory tests, I acquired rich data on human-AI interaction and human-object interaction in storytelling. I uncovered users' explicit and implicit needs in collaborative storytelling and tangible storytelling scenarios, and translated them into clear and refined design recommendations.

Themes that were not visible in theoretical and

prototyping exploration emerged from these tests in controlled and focused scenarios. Object abstraction, playful manipulation, story vibe and goal, these themes shaped the underlying principles and opportunities to design a successful AI-enabled tangible storytelling system.

In the following chapter, I will detail how these insights contribute to the ideation and development of new prototypes, with the aim of creating more engaging, meaningful, and user-driven AI storytelling experiences.

REFLECTION & LIMITATION

1. AI configurations in the test were not sufficiently tested.

There were three AI configurations in the test: AI guiding the user, relationship change, and AI as an actor. In the actual test, AI behavior was not exactly consistent with the expectations. For example, the setting where AI plays as an actor actually resulted in the user and AI engaging in a more intense conversation with shorter questions and replies. This reflected drawbacks in the research process because the configurations had not been tested sufficiently. There is a misalignment in the final user experience and the expected AI roles.

2. Test process was not controlled.

The testing process was not controlled, especially in the AI configuration test. The participant had to go through a total of three tests with different AI configurations. However, since there was no clear ending of the interaction and it generally took longer time for users to develop a story with AI, it led to test sessions often over one hour. With a more refined and controlled AI set-up, the stories told can be controlled to a certain length, yielding more reliable and comparable results.

3. Lack of quantitative data

Only recordings and story history were collected during the test, but no quantitative data. Numerical data is an efficient approach especially in comparing the different AI configurations. If quantitative data analysis was introduced, the results would be more convincing and understandable.

4. Insufficient data analysis on stories

The qualitative data gathered from the user test requires in-depth analysis. Stories developed from users can be valuable since they contain key information on how users construct a story, either with the support from AI or through manipulating tangible objects. However, the data analysis did not take that into consideration, but it was more focused on general observations and user quotes. With a detailed analysis on how the story is started, structured, and developed by users, I believe more

in-depth findings can be collected.

5. Blind spots in interaction goal and spatial configuration

As I mapped the findings to the conceptual framework, it turned out that insights concerning interaction goal and spatial configuration were missing. This reflected blind spot in these areas, possibly resulting from lack of such observations or questions in interviews. When designing the test process and drafting the interview questions, it would be better to refer to the conceptual framework, making sure that every aspect is touched upon. It will make the data collection and interpretation process consistent with the theoretical framework.

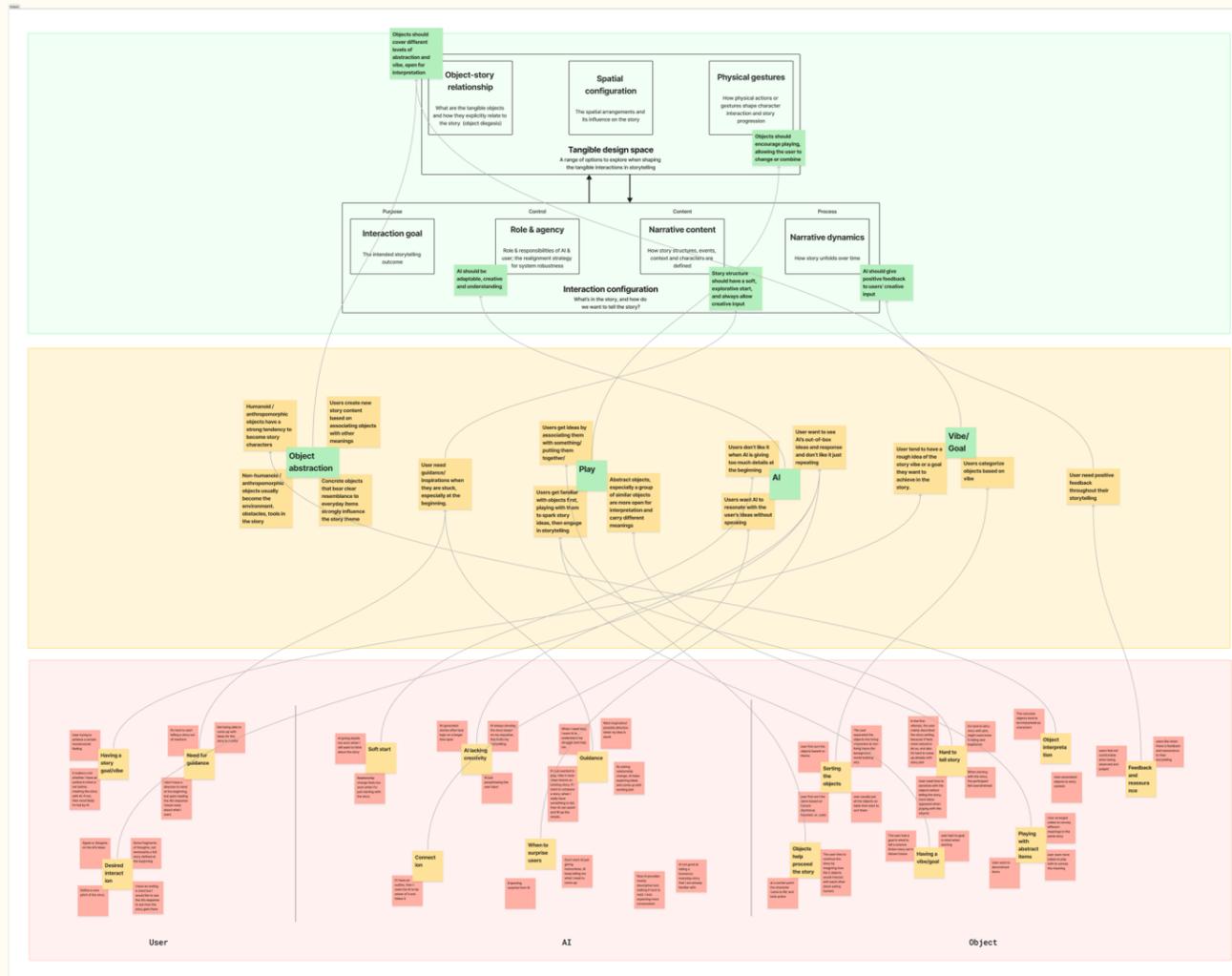


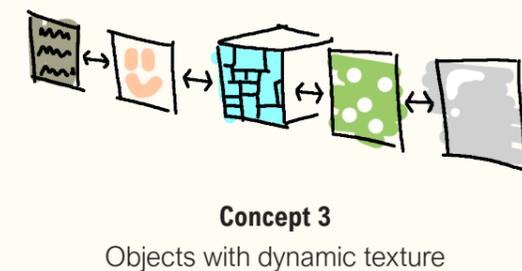
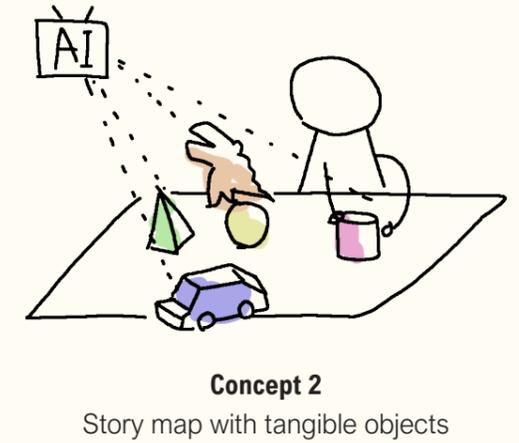
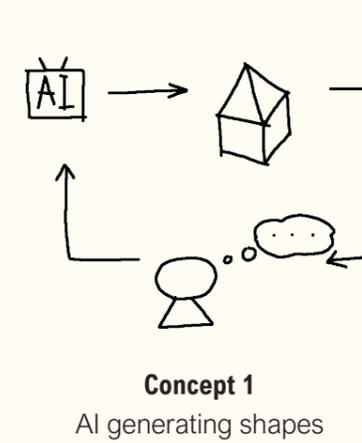
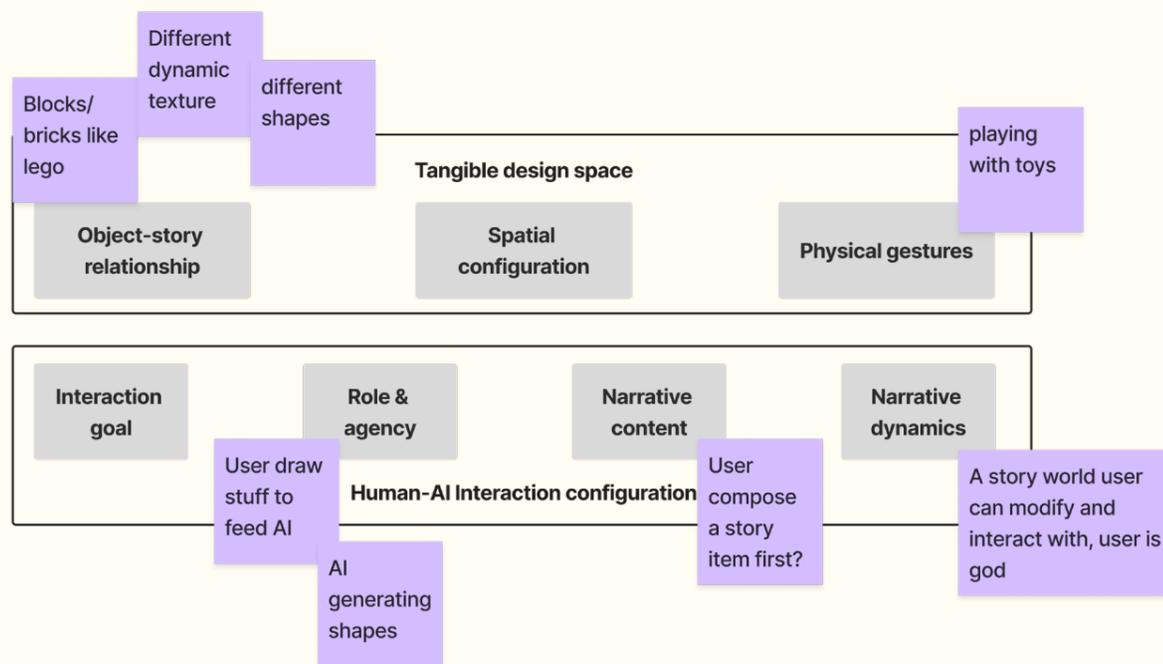
Figure. 6.9 Data analysis process.

Demo building

With refined insights and clear design recommendations from the user study, it is time to put theory into prototyping practice. After ideation from the design recommendations, I chose a certain direction and developed an interactive demo for tangible storytelling with AI. In this chapter, I present the prototyping and testing process of the interactive demo, and from user feedback, I form conclusions and future steps for the demo.

7.1 Ideation & concept generation

With the design recommendations and all the data and insights from the last phase in mind, I started to brainstorm ideas for a new prototype. When ideating, I mainly focused on 2 certain components in the framework: object-story relationship and role & agency. These are the core questions in mind when I tried to create a concept that differs from the previous ones based on findings that have given new angles or corrected old biases. (Figure 7.1)



I generated several ideas, and they each led to different design directions:

1. AI generating shapes: A wide variety of objects has been proved to be helpful in constructing surprising and authentic stories. With the image and vector generation technology in generative AI, it is possible to let AI take over this process to create unique story objects as triggers for users.

2. A story map with tangible objects: In the test sessions, the participants often find it hard to come up with a story they are satisfied with at the beginning. Usually, they play with the objects first and often, they build a story world step by step, and the story sometimes flows naturally with it. The story world is often presented in physical space, like a diorama. Therefore, it is natural to think about a physical story map where AI can control some physical aspect of it, and users and/or the AI will be manipulating objects on the story map to construct stories.

3. Objects with dynamic texture: The vibe of objects has been an essential trigger in directing the stories in test sessions. If we enable the AI to focus on the details of the objects like texture, we can offer users much more direct inspirations than text or simple shapes.

In the second test setting, when I provided participants with a collection of objects to tell stories, the objects they used to construct the story world, act out new events, and give meaning to has significantly helped the story to be vivid and tangible. Therefore, in this prototype, I wish the objects to play the same roles in the interaction and storytelling.

Eventually, I chose the second concept to develop. As the concept of an interactive story map resembles the user test setting to a large extent, it is a less radical direction where I can directly map the insights in design. Compared with the other concepts, it is also easier to develop from a technical perspective, so I can focus more on designing the AI interaction and refine the storytelling quality in this demo.

7.2 Demo development

FROM TANGIBLE DESIGN SPACE TO HARDWARE SKETCH

I started to develop the concept further using the playbook from the conceptual framework. As an interactive story map with tangible objects is a manifestation of spatial configuration, I tried to focus on defining the tangible design space first. What kind of objects can be used on the story map, and how will the user manipulate them? In the test sessions, many participants build story worlds almost like dioramas with clusters of different objects to which they give meaning. This has proven to be an effective and fun activity, so in the demo, I want to allow users to play with and build the story world just like they did in test sessions. To sum up, the objects used in the demo should be engaging and interpretive items, allowing the users to play with or even combine them, and be used in the story as representations of story items according to the user's will. (Figure 7.2)

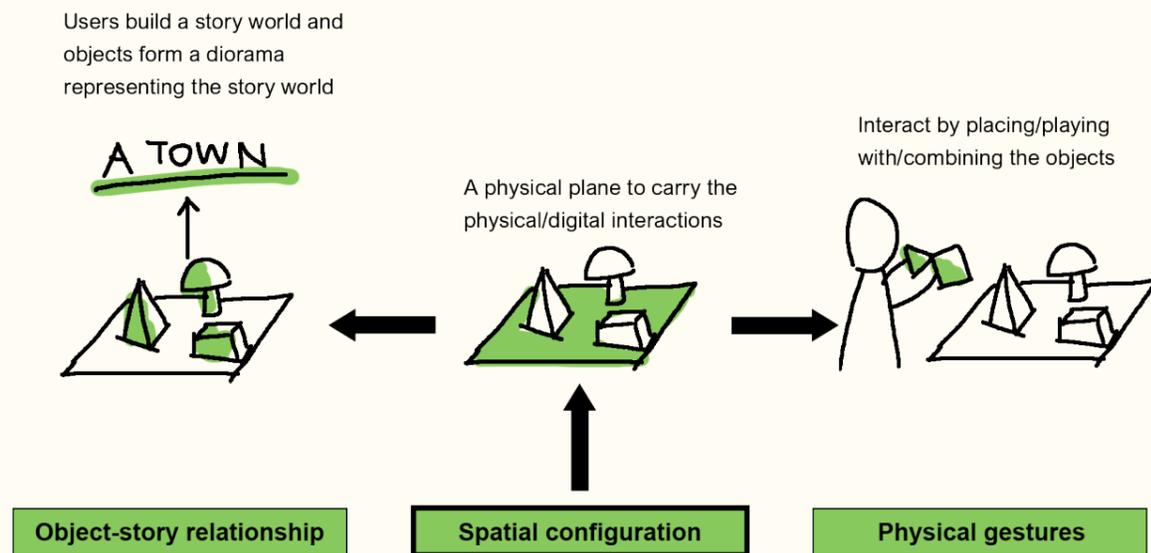


Figure 7.2 Defining the tangible design space.

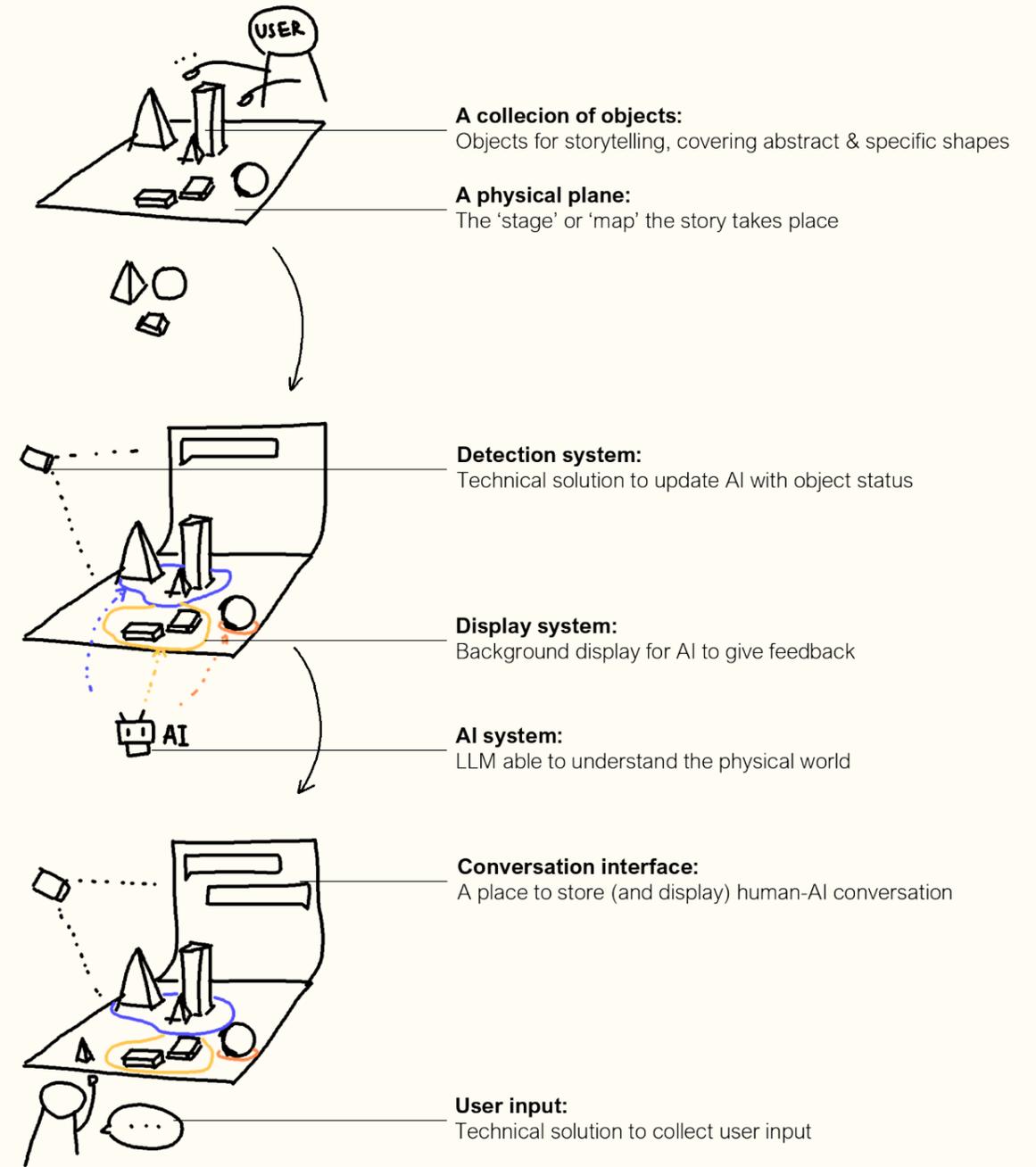


Figure 7.3 A hardware sketch defining all the necessary components to technically realize the storytelling system.

With the tangible elements defined, I started to make a hardware sketch to imagine the physicalities of the demo in a technical perspective. (Figure 7.3)

FROM HUMAN-AI INTERACTION CONFIGURATION TO SYSTEM USER FLOW

After confirming the technical components necessary as a technical solution in this tangible interactive AI system, I went back to the other half of the conceptual framework. Thinking from the angle of human-AI interaction configuration significantly helped me to ideate the user flow and system operation in the storytelling interaction. By separating the user experience into interaction goal, role & agency, narrative content, and narrative dynamics, I could explore and define the demo in a much higher fidelity. (Figure 7.4)

I started from defining "role & agency", which proved to be a major consideration that affects the system build-up and prompt composition significantly. Due to the unsatisfying AI behaviors from the previous prototypes, I decided to explore new ways of role distribution for AI in the demo. My strategy was to separate the AI's roles in guiding storytelling, so different AIs can focus on different tasks and use different strategies. I divided the AI system into two roles: story AI and supervisor AI. Story AI directly communicates with the user; it is responsible of guiding the user, narrating the story, and providing physical feedback. The supervisor AI, however, will be running behind the scene to oversee and control

the story progression. It is responsible of reading and analyzing the current story content, and provide clear instructions to the story AI. In this way, I wish to offload the complex responsibilities from AI, and organize the AI's behavior so that they can be more predictable and adjustable. Moreover, by using two separate OpenAI threads, more information can be processed at the same time, potentially contributing to the storytelling quality.

Role & agency set the core operating loop for the demo. With that in mind, I continued to define the rest of the configurations. I didn't act to narrow down the goal of the storytelling, and let it stay on a general level. The only thing I distinguished is that the story is authentic, meaning it is not an existing story. In this way, I hope to understand people's experience to construct a totally new story in a way they have not previously used. For the narrative content and dynamics, it has become clear this AI mechanism will enable a conversational-based storytelling activity, where both the user and AI can give story input. Therefore, they should both be able to contribute to the story elements in a physical form. The tangible design enabled the AI to physically change the setting using the display, so I envisioned it to control "virtual objects" that are displayed on screen, similar to the physical objects manipulated and perceived by the human. For the storytelling structure, with the

insights from the previous user tests, I want users to be guided in a soft start of the storytelling by building the story setup first and diving into the storytelling later. This will affect the prompting strategies of the prototype.

After clarifying the interaction configurations, it has become clear how the storytelling will flow step by step. I created a flow chart to clearly demonstrate the user flow, which will be a major reference when prototyping. (Figure 7.5)

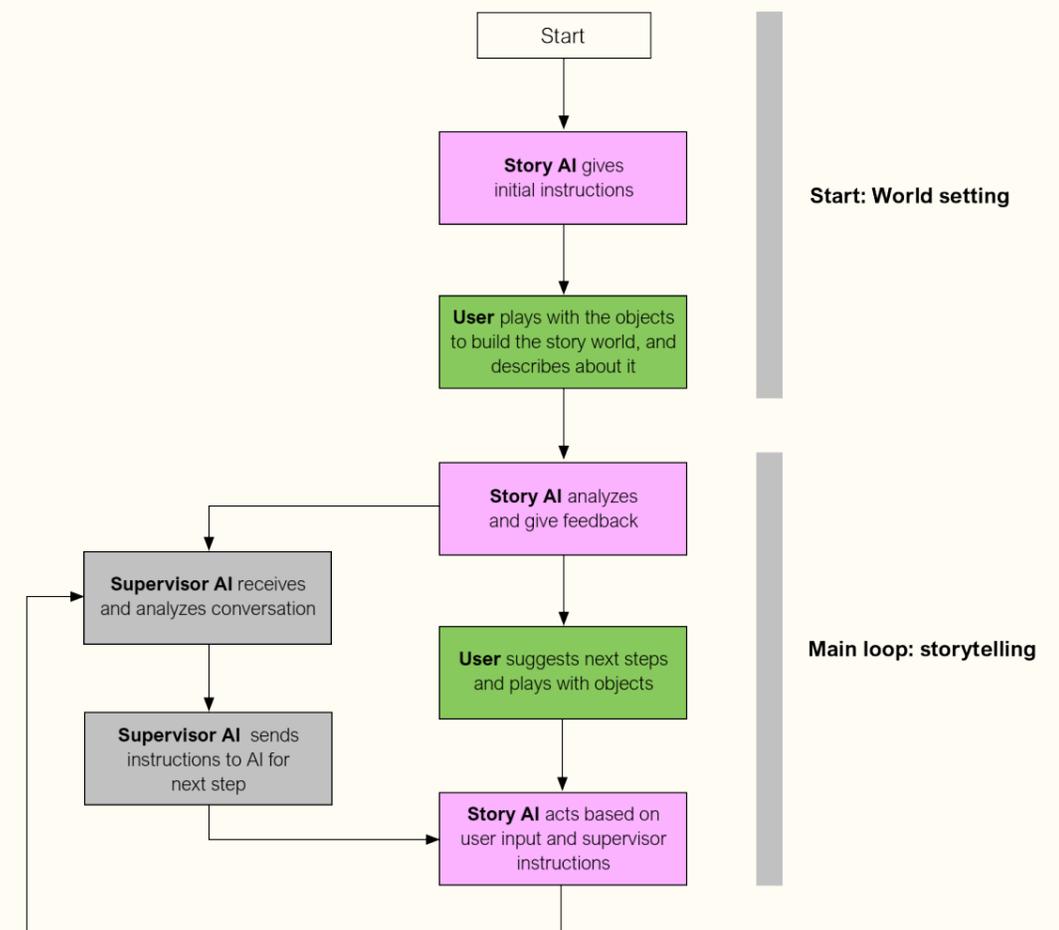
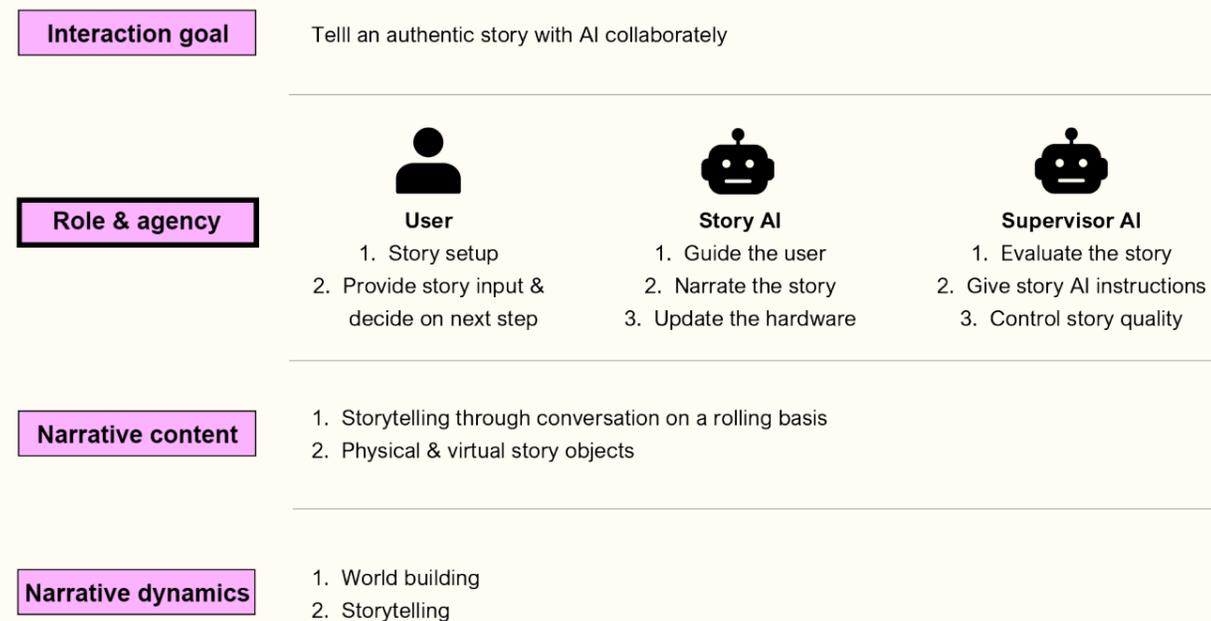


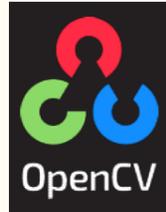
Figure. 7.3 System flow chart.

PROTOTYPING

I started the making process for both hardware and software. With the experience acquired from the previous prototyping practice, I quickly developed the initial version of the system in a rough prototype.

I gathered feedback from quick tryouts and iterated on the initial prototype to refine it in technicality, appearance, and user experience. Below is a list of all the technologies used in prototyping, followed by a more detailed record of how these technologies were applied in different components of the demo.

Object tracking: the eye

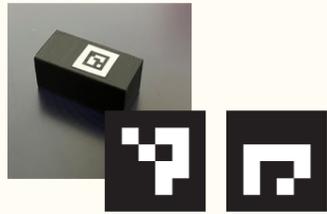


OpenCV: computer vision library for object detection

OpenCV, being the world's biggest computer vision library, is a powerful toolkit for image processing and computer vision. The OpenCV Python Library was used in the prototype to process video frames and uses built-in functions to detect and identify the fiducial markers in the image. It allows the system to know the type and location of the objects, and send the information to AI models for processing.

ArUco markers: fiducial markers for object tracking

ArUco



Programming: the skeleton



Python: main programming language

The computer programs in this prototype were written in Python language. The main Python script integrated all the technical aspects together and operated all components in a certain logic.

PyQt5: chat and display interface

PyQt5 is a comprehensive set of Python bindings, enabling Python to be used as an alternative application development language. In this prototype, PyQt5 is used as the toolkit to develop the user interfaces, including the display screen and the chat interface. It allowed the user to interact with the computer and allows real-time information to be shown on the display screen.



AI: the brain

OpenAI: AI service for intelligent responses

OpenAI's technology is the core of the interactive storytelling experience in this prototype. OpenAI's service allows the system to understand user input and generate creative and intelligent responses in both natural language and computer language, so users can communicate with the system in human-like conversational interaction, and the system can be updated from the AI's responses.

OpenAI Assistant API: LLM as the system brain

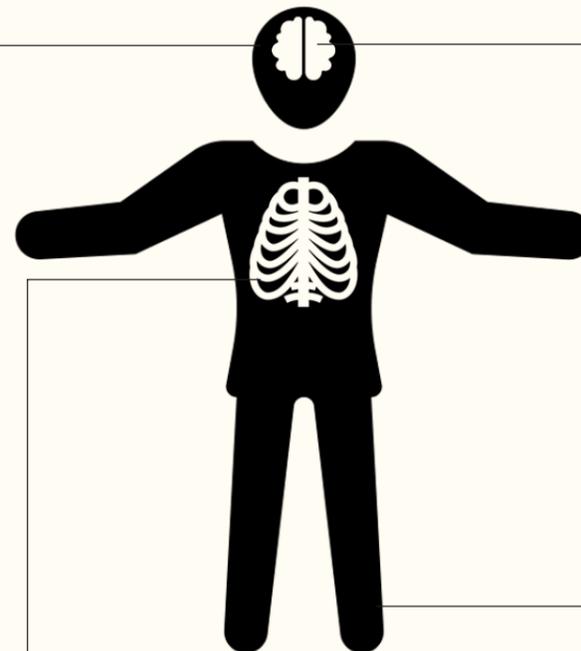
OpenAI Assistant API is the "brain" of the system, allowing the prototype to connect to a large language model (in the demo, GPT-4.1-mini is used as the generative AI model). Upon receiving user input, the system sends relevant information to the Assistant API. The assistant returns a context-aware response in json format which is used as a reply to the user and instructions to drive the prototype's behavior.

OpenAI Speech-to-Text: understanding speech

To make the interaction more smooth and natural, the system enables voice input for users. The speech-to-text service from OpenAI converts user's spoken words into written text, which then is passed on to the assistant API for response generation.

OpenAI Text-to-Speech:

The text-to-speech service of OpenAI allows the system to read the response out loud for a natural conversation between user and AI.



Physicalities: the body



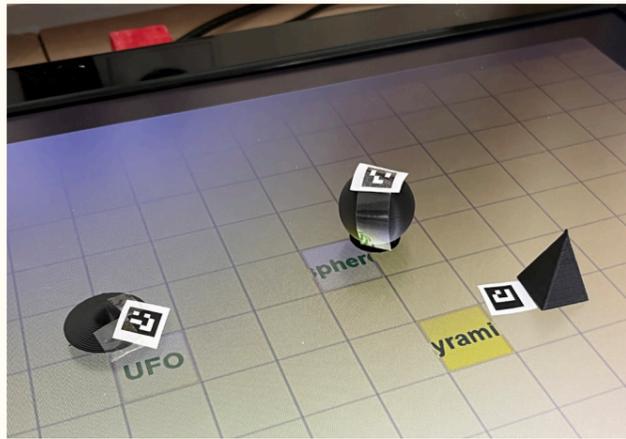
3D printing & laser cutting

3D printing is used to create finger-sized objects of different shapes for users to manipulate in the system. Laser cutting is used to construct the shell of the prototype for a clean and unified appearance.

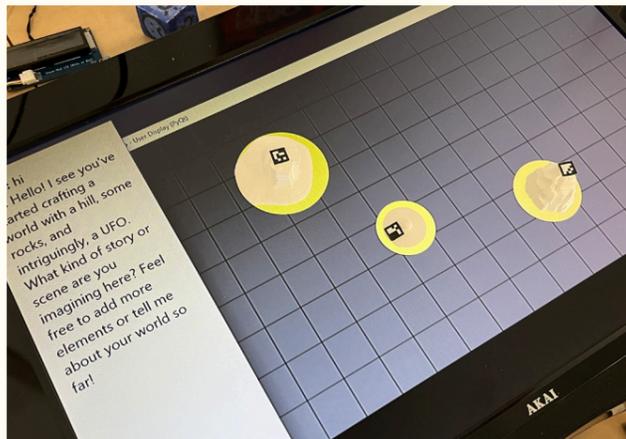


Duet: chat interface display on phone screen

Duet is an application running on PC and mobile phones allowing the phone screen to be an extension to the computer screen display. At certain point in prototyping, a small secondary screen is needed as an interface for users to record their speech and see the feedback. Duet is a simple solution allowing user interface running on Python to be displayed on a remote phone screen.



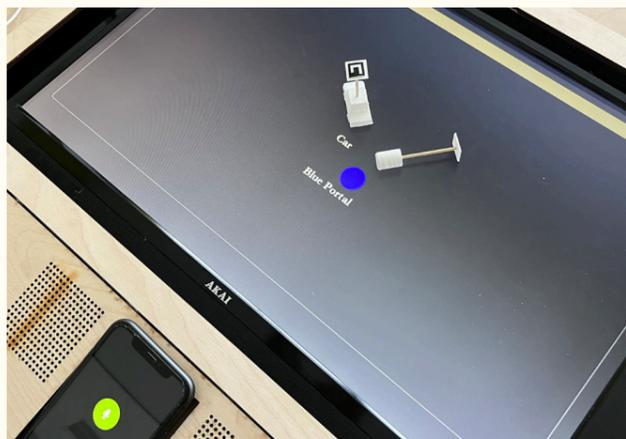
1st iteration: grid display highlighting squares with object labels.



2nd iteration: integrated chat interface as a left sidebar on the screen, changed object highlighting display into circles.



3rd iteration: moved chat interface to a separate display, removed grid lines, enabled label display



4th iteration: removed highlighting the detected objects, integrated 2 displays with plywood shell.

DISPLAY SYSTEM

I used a PC monitor facing upwards as a table for displaying visual feedbacks. During the iterative prototyping, I developed a smooth object tracking and label displaying system that allows labels to be shown beside the objects placed on the display surface. I also used a mobile phone as a secondary screen to display relevant information and enable touch control for the user.



1st iteration: black PLA



2nd iteration: white PLA for better compatibility with ArUco markers.



3rd iteration: white PLA, with ArUco markers connecting to the objects with a thin stick for better tracking performance.

3D-PRINTED OBJECTS

I defined the interaction to be a tabletop activity, so an average-sized display screen was suitable. This allowed the objects to be finger-sized, which made it possible to use 3D printing to quickly produce a collection of objects with unified color and texture in different 3D shapes.

While testing the object tracking system, the ArUco markers were less reliable on dark backgrounds because of poor edge recognition, so I used white PLA for the objects. In a later stage, I detached the ArUco markers from the objects so that the black and white markers are less distracting, and by connecting the marker plates with the objects using thin sticks, the markers become compatible to any kind of surface conditions, and at the same time more reliable while being tracked by camera. Therefore, I eventually stuck with this solution.

7.3 Demo overview

TECHNICAL BUILD-UP

This is a simple demonstration of the prototype explaining how the storytelling system is composed physically, with a focus on how the physical components are connected to each other.

The main Python program runs on the laptop, which uses the Internet to request service from OpenAI to get AI responses and convert between text and audio. The laptop is connected with 3 pieces of hardware: a webcam, a monitor, and a mobile phone. The webcam transmits video footage to the object tracking program on the laptop to capture object locations in real-time. The monitor displays AI's labels for physical objects and virtual objects. The monitor screen also serves as space for tangible interactions, where the user can place and move the objects. The mobile phone serves as a secondary screen to enable the user to record voice messages to AI, and browse conversation history when needed.

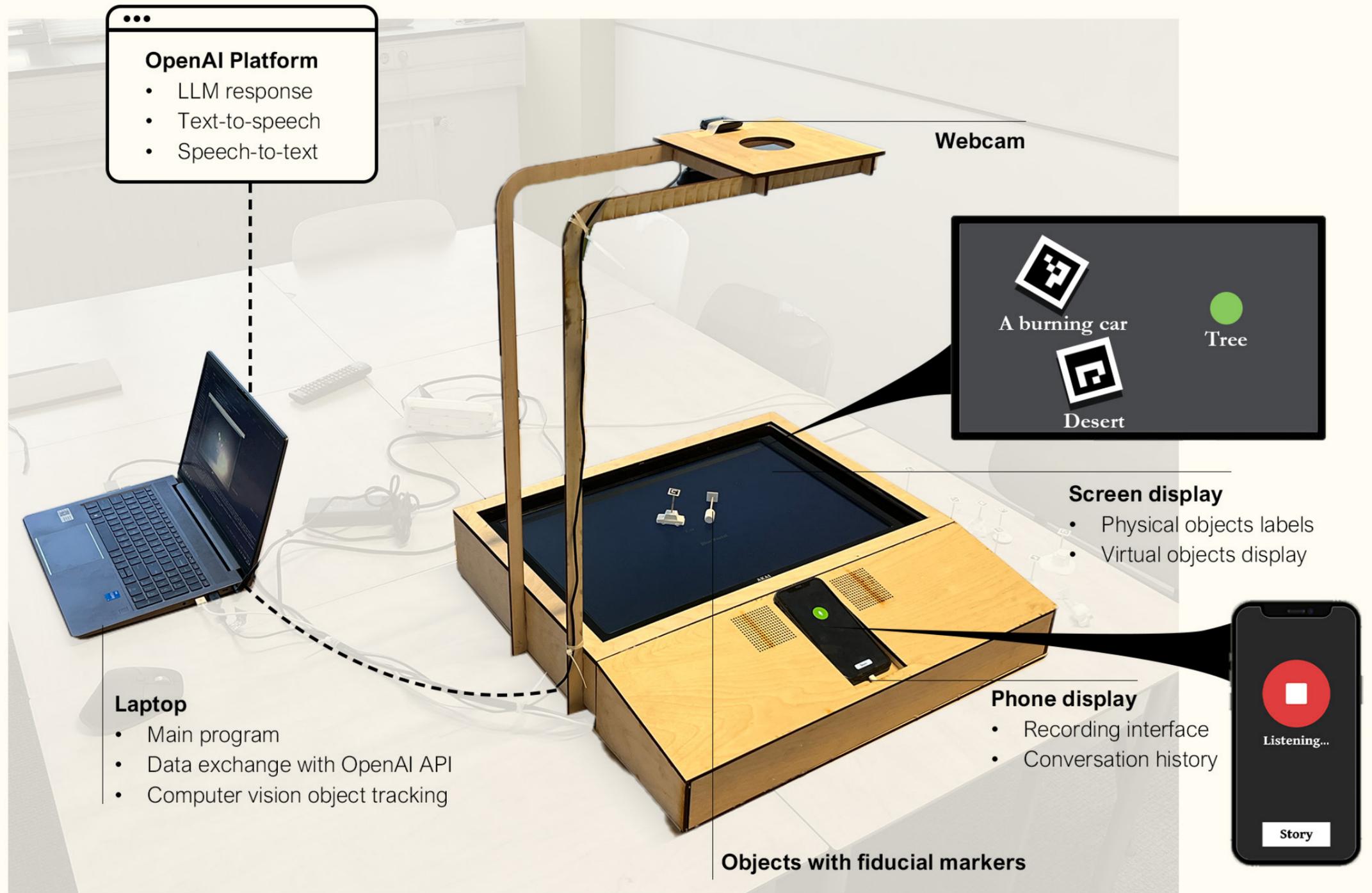
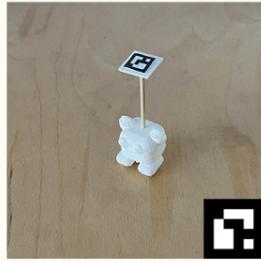


Figure. 7.4 System build-up.

OBJECT COLLECTION

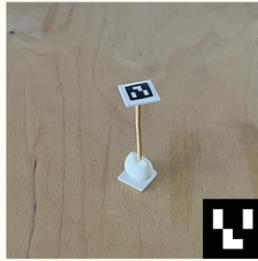
When building the object collection, I gained insights from previous user tests and built a collection covering both humanoid objects, geometric shapes, and specific objects. They were created in order to maximize the users' inspirations, and provide an interesting ground to fertilize stories.

Humanoid objects



Cartoon character

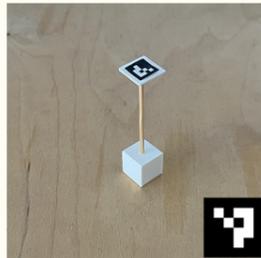
A robot-like cartoon character with round-edged cubic appearance.



Animal

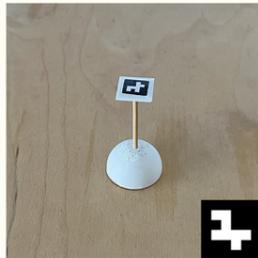
An ambiguous animal figure shaped like a cat's head.

Geometric shapes



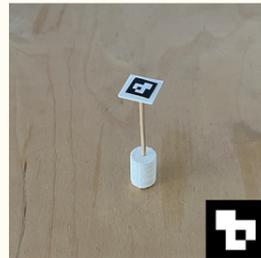
Cube

A cube.



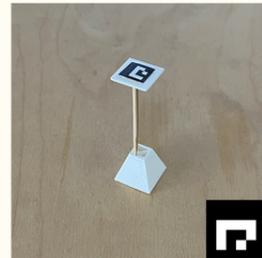
Hemisphere

A hemisphere with the flat surface facing downwards.



Cylinder

A thin cylinder-shaped object.



Pyramid

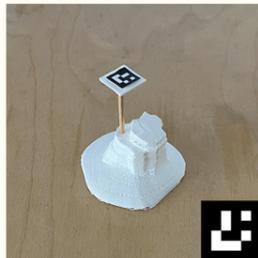
A pyramid with a flat top surface.

Specific objects



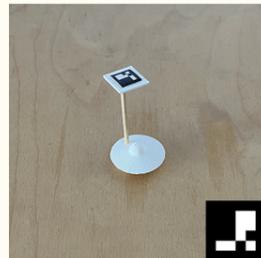
Rocks

A rocky shape like a mountain peak.



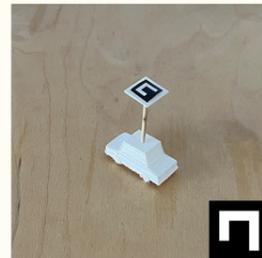
Hill

A rocky shape with a flat top, like a mountain peak.



UFO

A disk-shaped UFO.



Car

A car in simple shape.

SYSTEM ARCHITECTURE

Below is a diagram of the system architecture. It shows the information flow between the physical components and the software.

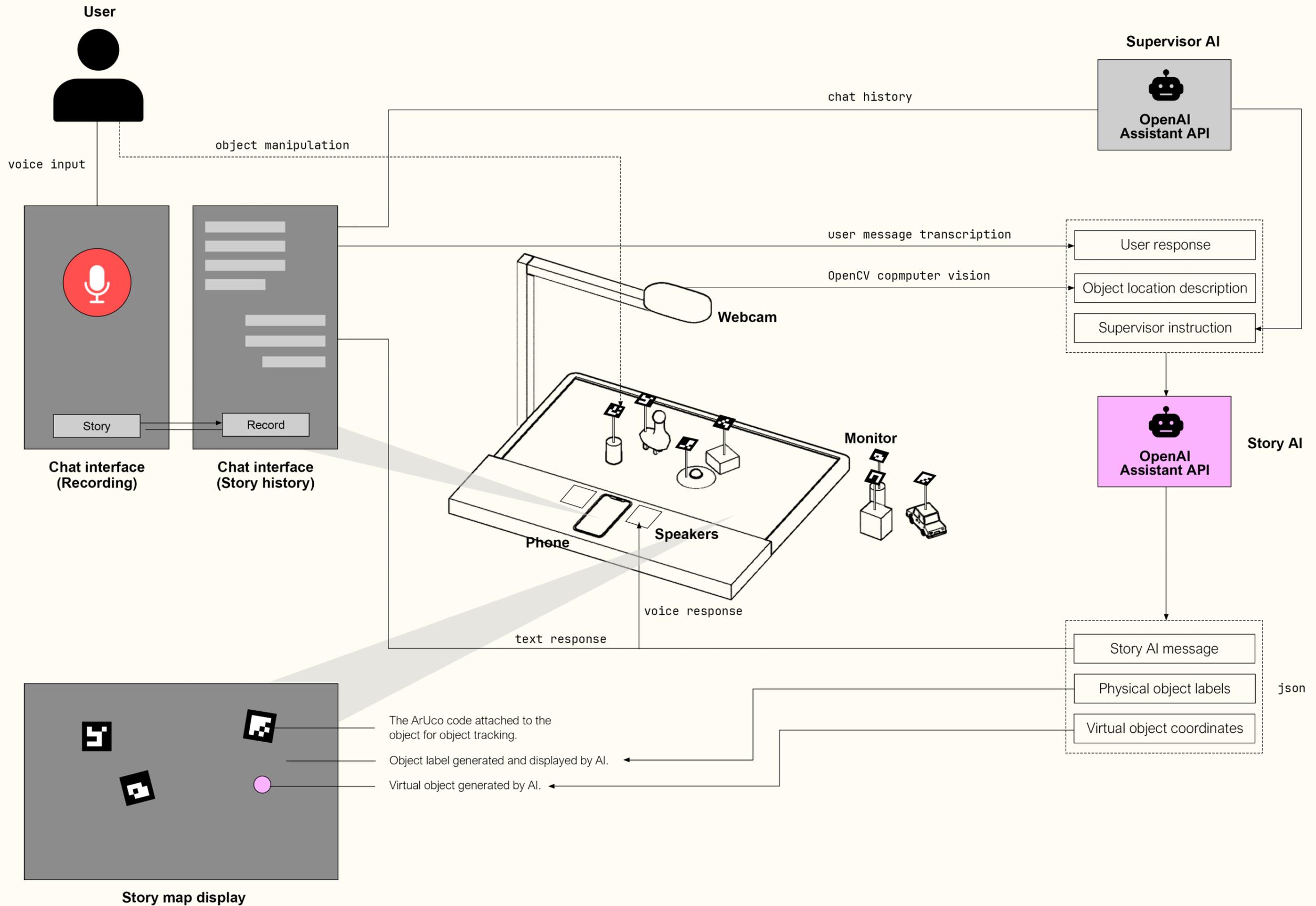


Figure. 7.5 System architecture.

SOFTWARE ARCHITECTURE

Below is a detailed diagram showing the software architecture, explaining how the software system operates and connects with LLM and hardware interface, with a focus on the data flow.

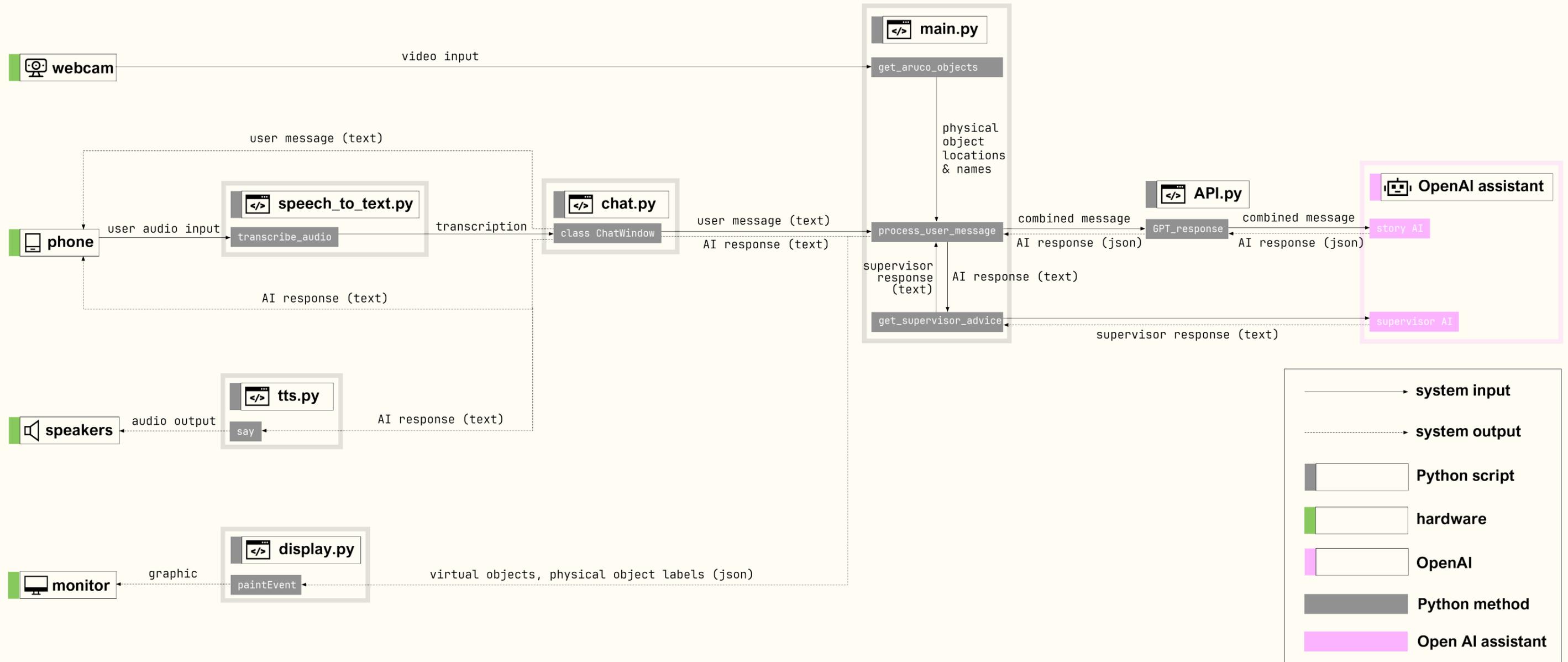


Figure. 7.6 Software architecture.

7.3 Final user test

The interactive demo is a synthesis of all the previous findings acquired in the research process, and technical skills accumulated through iterative prototyping. While finalizing the design of the demo, I conducted a series of user tests to obtain user feedback on it. In this section, I present the data collection and analysis process of the user test, and conclude by evaluating the demo.

GOALS

Different from the previous quick user trials and user tests with certain scenarios, in this test was a functioning AI-enabled tangible storytelling prototype which carried my design ideas that has not yet been proved. The system is more finalized and functioning than before, and the use scenario is actually the same as what I have envisioned in my research scope. Therefore, testing this demo with users can bring the most valuable and direct insights to answer my research questions.

First, I defined the goals of the final user test.

1. Understand experiential qualities of the demo

The first and foremost information I wish to collect is the user's experience interacting with the demo. Will the demo support human-AI collaborative storytelling in physical space as designed? What do users like and dislike about the interaction? What kind of stories will they tell and will they be satisfied with them? The most important goal for the final user test is thus to understand the experiential qualities of the demo.

2. Evaluate the demo with the framework

With the insights gained on user experience, I wish to evaluate the demo using criteria from my conceptual framework. This allows me to move beyond theoretical assumptions, and better understand the actual strengths and weaknesses of my design. User tests provide concrete evidence to reveal drawbacks and blind spots in my design, and highlight where design successfully supported the intended goals. Hence, such insights will lead to future iterations and improvements for the demo, and support future

directions for development of AI-enabled tangible storytelling systems.

3. Explore design improvements and future development directions for the demo

After validating the current state of the demo, I wish to identify areas for improvement and holds potential, envisioning future directions for development. From observations, story content, and user interviews, I can uncover usability issues, unsatisfied needs, and potential use scenarios that are not covered in the test process. Engaging with users in the tests allows me to collect opinions from various perspectives.

Exploring future directions brings my research project beyond the realization of an interactive demo. It helps me to comprehensively and dynamically consider what problems such system can solve, what potential capabilities it can possess, and what experience it will bring to the storytelling world. The demo, as an initial attempt for me to build such a storytelling system, allows evolving and shifting in different context.

4. Conclude findings to serve research goal and lead to further discussion

Finally, as a conclusion to this graduation project, I wish to use the test findings, together with all findings I grasped along my exploration in this project, to answer the research questions set at the beginning. The final user test is the last piece of this puzzle, providing direct evidence about the system performance in real-world scenarios.

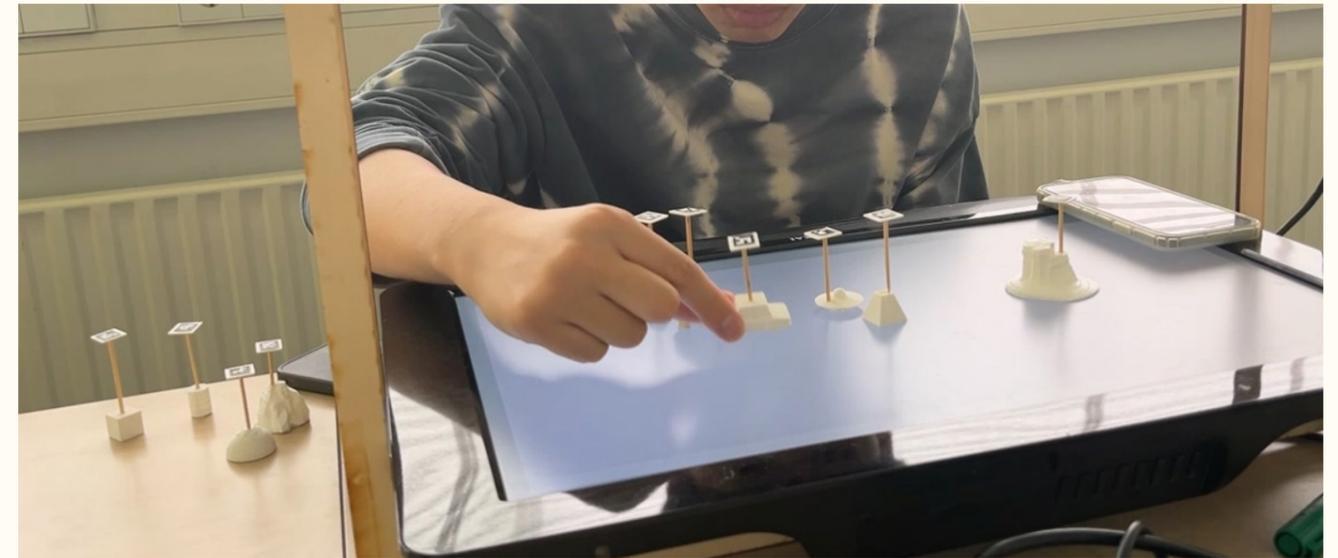


Figure 7.7 The final user test is a final evaluation of the demo.

TEST QUESTIONS

With the goal of understanding the experiential qualities of the demo, I developed the research questions for the final user test. They cover different levels from general to specific, and they aim to understand and evaluate the demo in a comprehensive way. The interview questions and the test analysis will surround these questions to ensure consistent and convincing results.

1. How do users construct stories with interactive elements provided in the demo?

This question examines if the core objective of the demo is accomplished, which is to enable users to tell stories with AI by interacting with tangible elements. By testing the construction of users' stories, I can understand the system's affordance of creative and dynamic collaborative storytelling. It can also help in identifying unexpected events and interactions that emerged from the user test to learn about the unrecognized system qualities.

The question focuses on the process of storytelling, the types of stories created and how they are influenced by system affordances, and the interplay between user intentions and system affordance.

2. How do users perceive AI's role in the demo?

Since the demo enables human-AI collaboration,

it is important to understand if the role & agency distribution in the system works as design has envisioned. User's perception will be my standard to evaluate the quality of AI's participation in the interaction.

This question focuses on the user's perception of AI, co-authorship in storytelling, and how AI participation influences user experience.

3. What are users' strategies and behaviors when interacting with the demo's tangible elements?

Tangible interaction is central in the storytelling experience of my demo. Therefore, with a focus on how the physical interface and object elements guide users, I can uncover points of confusion, successful designs, or unexpected uses.

Answering this question means understanding physical manipulation patterns of the prototype. It also takes into account how users experiment with the tangible elements.

4. What obstacles or challenges do users face during the test?

In order to further develop and refine the demo, a focus on unsatisfactory experience is essential. By focusing on usability issues, misunderstandings, and emotional barriers, I can picture the refinement strategy in future development.

TEST SETUP & PROCEDURE

Similar to previous user tests, the final test will focus around the participants' individual experience interacting with the demo.

The test will be a 45-minute 1-on-1 session with a participant. It will start with an introduction for the participant to learn about the goal of the test, the demo's functionalities, and the test procedure. Then, the participants will engage in the storytelling experience and tell a story with the demo. After they finishes, a semi-structured interview will be conducted.

Below is the test procedure in detail.

1. Introduction (3 minutes)

After setting up the demo, I will notify the participant of the test goal, their tasks in the test, and the test procedure. Then, I will present them with the consent form. After they signed it, I will introduce the functionalities of the demo, so they know how to operate the interface, and what to expect when interacting.

2. Storytelling with the demo (20-30 minutes)

The participants will start interacting with the demo, following the AI's instructions. I, as the observer, will not interfere with the storytelling unless there is a technical failure. The participants are told to tell the story however long they want

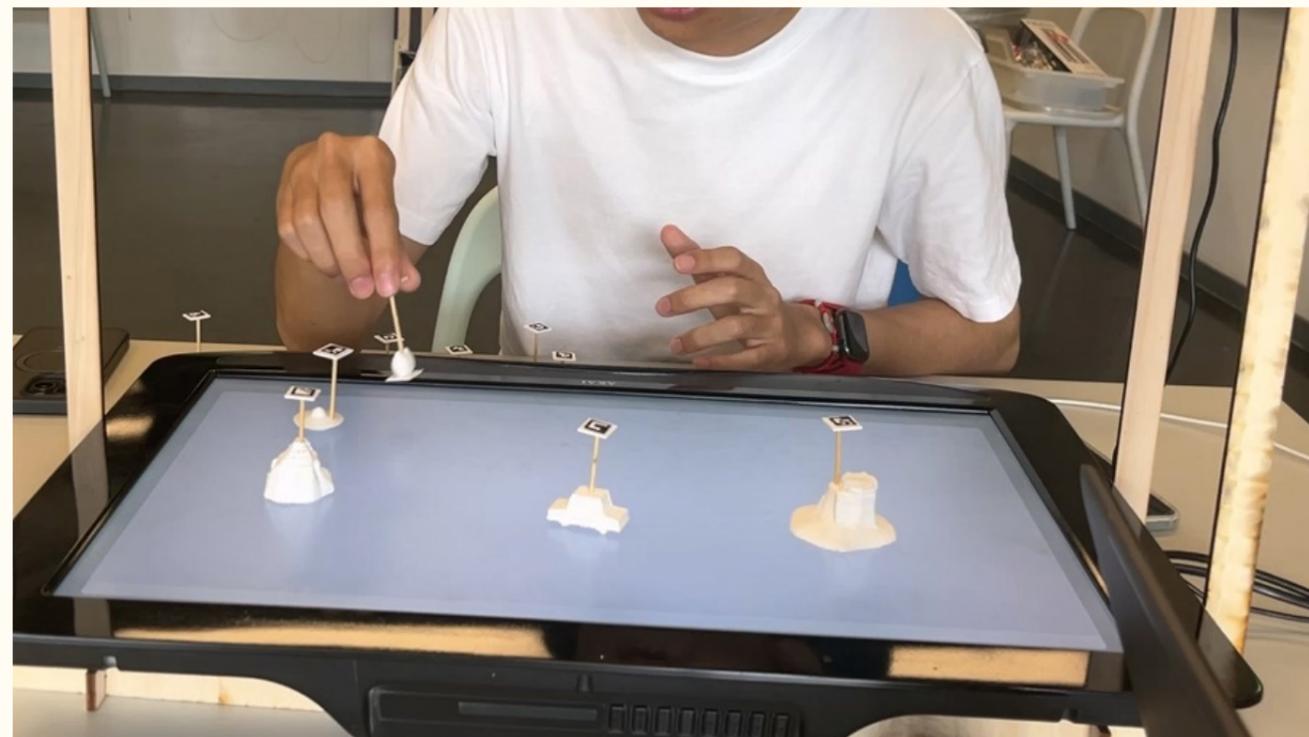


Figure 7.8 Scene from the final user test.



Figure 7.9 Test setup.

and choose to end when they feel like it, since the system is programmed to not intentionally end the conversation.

3. Semi-structured interview (15-25 minutes)

After the participant ended their story, I will start a conversation with them to talk about their previous experience. The interview will be semi-structured, with me as the interviewer ensuring certain topics are covered, and also allowing different aspects from participants. I developed the interview questions based on the test goal and test questions:

- 1. Object affordance:** how did the objects help in your storytelling?
- 2. AI:** were you satisfied with the AI's behaviors? What role do you think it played? How did AI's virtual objects support you in your story?
- 3. Story:** were you satisfied with your story? Story pace, plot, characters, theme?
- 4. Demo design:** audio input-output, secondary UI for text, objects, markers, screen, where, size?
- 5. Application:** what can you imagine such a system to be like/to do?

DATA COLLECTION & ANALYSIS

A total of 5 participants took part in the final user test. Participants were recruited in the IDE faculty, with a variation in age, gender, and majors. They included master students, PhD candidates, and professors, to ensure a relatively comprehensive set of participants. During the approximately 45 minute session, video recordings were made when the participants were engaging in the storytelling activity, and the following interviews were recorded in audio. The conversation history between human and AI were collected alongside the system actions from OpenAI Assistant API. Notes were taken during the interview by the interviewer.

The data analysis process is shown in the right. (Figure 7.9) It started with a synthesis of the data. From all kinds of data collected, I gathered observation insights and user quotes, and clustered them according to their themes. This is followed by an evaluation of the demo using the conceptual framework. In the next part, I focus on the design improvements of the demo from the collected feedback to support the following research, envisioning the future directions of the demo. Finally, targeted at test questions, I map the findings according to the questions. The answers to the questions tell about the demo's experiential qualities.

In the next sections, I present the stories told by the 5 participants, and my observations along their interactions. This is an essential part of my data collection, because it directly demonstrated every step the participants took and the AI behaved in detail.

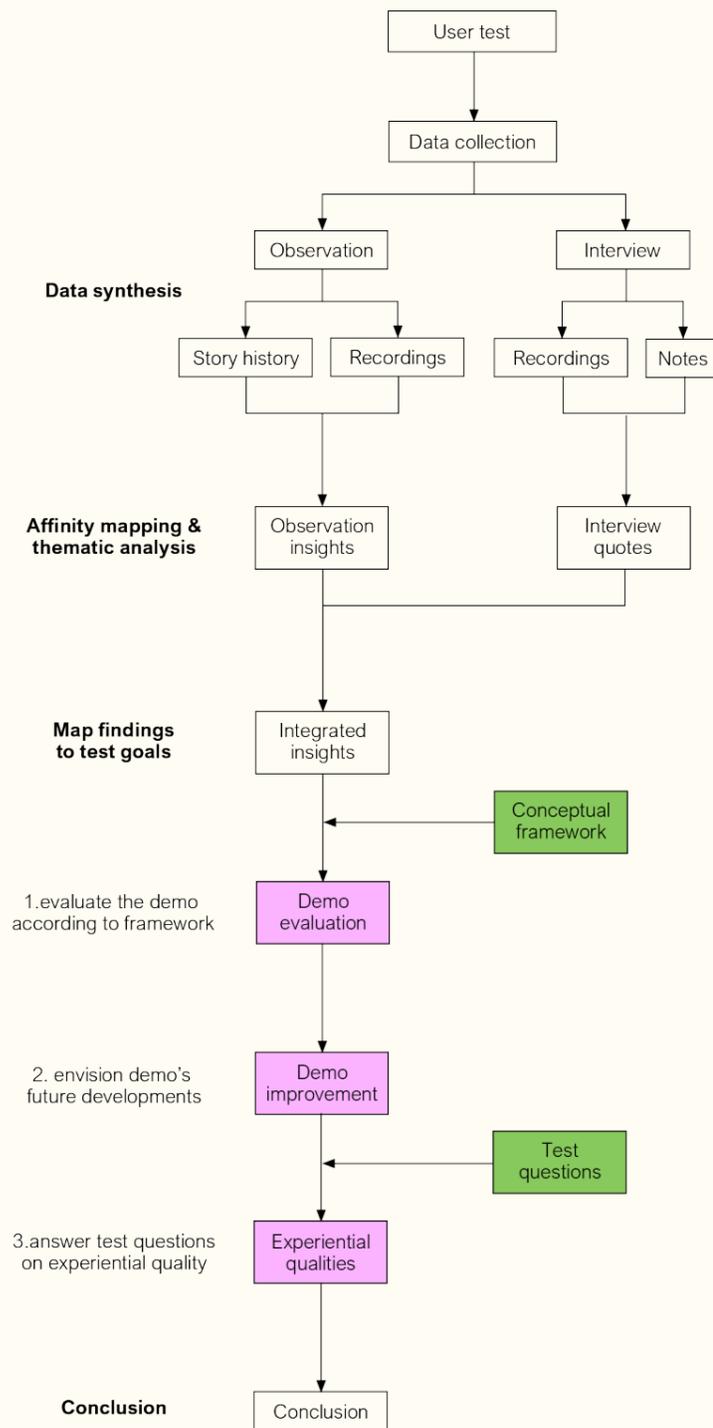


Figure. 7.9 How insights were generated from test data.

The story content is marked with annotations and color-coded to highlight the key interactions that contributed to story progression.

[physical actions taken by the participant]

[physical actions from AI]

Story AI's guidance for story direction

Story AI's suggestion for new objects

Supervisor AI's key instructions

STORY: PARTICIPANT 1

AI: Hello! Welcome to the world-building adventure. To get started, please place any objects you like on the map to create your story world. Then, tell me a little about the world you've made. I'm excited to see what you come up with!

User: [placing the cartoon character] I will build a story about my visit to the Guggenheim in Bilbao.

AI: Fantastic! A story about your visit to the Guggenheim Museum in Bilbao sounds fascinating. To help you get started, I've placed a cartoon character in the middle of the map who could be you. You can now add more objects to represent the Guggenheim Museum or other elements of your visit. Tell me about what you see or experience as you build the scene!

[labeled the object as visitor]

[added virtual object: "visitor"]

User: When you go to the museum, you are also watching other visitors. And when you find them appealing, you go to stand on them. [moving the visitor, placing it on the virtual object]

Supervisor system tip: The AI has responded well by acknowledging the user's chosen story theme and providing an initial character on the map to help start world-building. This aids user engagement and gives a tangible element for the user to relate to their story. The next step should build on this momentum.

System tip: Encourage the AI to suggest adding iconic features of the Guggenheim Museum or nearby elements to enrich the scene and prompt descriptive storytelling, aiding immersive environment creation and narrative detail.

AI: That's a very playful and imaginative way to experience the museum! Maybe those other "appealing visitors" you watch could be represented here as figures you approach or interact with during your visit. How about we add some other visitor characters around the museum area to show this lively

System failure: system couldn't recognize difference between virtual and physical objects.

User moves objects to indicate character movement.

interaction? You can describe what makes them appealing or special as you place them.

[added virtual object: "other visitor 1" "other visitor 2" "other visitor 3"]

User: Thank you very much. I would like to add this character that is a bit of a natural mountain that I can even climb, not just stand on, but I can climb it.

[placing the rock]

Supervisor system tip: The AI is effectively encouraging creativity by expanding the scene with new visitor characters and inviting the user to describe interactions. This enhances narrative depth and character dynamics, moving beyond static setting description.

System tip: Prompt the AI to integrate sensory details and emotions related to these new visitors or the museum ambiance, to deepen immersion and character engagement in the story.

AI: What a brilliant addition! This natural mountain-like character adds an adventurous element to your museum visit. It's not just a visitor but a towering, climbable presence that might symbolize the spirit of exploration or challenge. Let's place this mountain character near the rocks you added, making a small natural corner amid the museum setting. You can describe how it feels to climb it or what breathtaking views you see from its peak!

[labeled the rock as "climbable mountain visitor"]

[added virtual object: "climbable Mountain Visitor"]

User: *[placed the cylinder]* I see beautiful abstract art, this cylinder is really one of the big pieces in the Guggenheim Museum, it's very expensive.

Supervisor system tip: The AI successfully deepens the story by incorporating the user's unique mountain character idea, enhancing thematic richness and physical interactivity within the museum setting. This adds an intriguing and imaginative layer to the narrative.

System tip: Encourage the AI to prompt the user for the character's backstory or symbolic meaning, and suggest potential challenges or discoveries during the climb to enrich narrative tension and emotional engagement.

AI: The abstract cylinder sounds like a striking centerpiece! It adds a modern artistic feel to your museum world. Perhaps this expensive artwork draws the attention of visitors, sparking conversations or inspiring your character. Do you imagine any special emotions or thoughts your visitor has when seeing this piece? Or maybe there's a story behind why it captivates everyone? Feel free to build around it!

[labeled the cylinder as "Abstract Cylinder Art"]

[added virtual object: "Abstract Cylinder Art"]

User: *[placing the car]* So there has been a little bit of intervention in the Guggenheim Museum because there is a car full of art thieves who are capturing the cylinder art *[putting the cylinder on the car]*, and they are

stealing it from the museum. *[moving the car with the cylinder away and finally out of the story map]*

Supervisor system tip: The AI continues to encourage deeper engagement by highlighting the significance of the abstract art piece and prompting the user to explore emotions and narrative elements related to it. This supports richer storytelling and character development.

System tip: Guide the AI to suggest contrasting visitor reactions or a subtle conflict around the artwork to introduce interpersonal dynamics and increase narrative tension.

AI: Oh wow, an art heist adds thrilling excitement to your story! The tension rises as these art thieves attempt to steal the precious cylinder. Your visitor and the other visitors might react differently—some may panic, others might try to stop the thieves, or maybe even team up. How does your visitor respond to this daring intervention? Would you like to add the thieves or their getaway car to the map?

[added virtual objects: "Getaway Car" "Art Thief 1" "Art Thief 2"]

User: *[placing the hemisphere]* So let me introduce the museum director, Mr. Eggface. He, of course, is not so happy with the art theft. But the first visitor that I placed, he is laughing out loud.

Supervisor system tip: The AI effectively shifts the narrative to an unexpected and engaging plot twist with the art heist, increasing suspense and conflict. It invites user input on characters' responses and enhances world interactivity.

System tip: Encourage the AI to build multiple perspectives and possible outcomes of the heist, prompting dynamic choices and character actions to heighten immersion and suspense.

AI: Mr. Eggface sounds like a fascinating character—perhaps his expressions mirror a mix of frustration and determination to catch the thieves. Meanwhile, the first visitor laughing out loud adds an intriguing twist: is it nervous laughter, or maybe amusement at the chaos? This contrast between characters could create interesting dynamics! Would you like to place Mr. Eggface on the map? And does the laughing visitor have a special reason for their reaction?

[labeling the hemisphere as "Mr. Eggface"]

[labeling the cartoon character as "Laughing Visitor"]

[added virtual object "Mr. Eggface"]

User gradually added objects in the story, often one by one.

AI always asks the user their thoughts on the newly introduced object

User can use objects to represent something not exactly the same as the object itself, but the object appearance affect the user decisions.

AI lacks control of the whole story progression.

STORY: PARTICIPANT 2

AI: Hello! Welcome to our story world builder. To get started, please place any objects on the map to create a world. Then, tell me a bit about the world you have created. What kind of place is it?

User: [place the hill] Here's a mountain. It is a mountain. It is a very high mountain. So it's like a world where it's like the bottom is a jungle, but the mountain is really, really high. So it gets very cold and it's a snow mountain on the top.

Supervisor system tip: Encourage the AI to prompt the user to place an initial object or landmark and provide a vivid description of the setting to jumpstart story creation.

AI: Great! You placed a mountain right in the heart of the map, towering high enough to have a jungle at its base and snow at its peak. This creates a fascinating world of diverse climates and ecosystems coexisting in one place. What would you like to add next? Perhaps we can place the jungle at the bottom and some snowy peaks at the top to bring it to life. Or, if you prefer, you can start telling a story that takes place in this majestic mountain world! [labeled the hill as "mountain"]

User: [placed and slowly moving the car] Here comes a car. A group of friends' car crashed when they are halfway through the mountain.

Supervisor system tip: The AI successfully acknowledged the user's input and expanded on the mountain setting, inviting further development and offering specific suggestions. This keeps the narrative engaging and grounded in the user's world. Continue encouraging the AI to deepen the environment descriptions and prompt the user towards narrative elements like characters or conflicts to initiate story dynamics.

AI: Fantastic addition! The car brings an exciting human element to our mountain world. A group of friends traveling up the mountain faces an unexpected challenge as their car crashes halfway. This sets the stage for a thrilling adventure or survival story. Who are these friends? What brought them here? And how will they handle the dangers of the jungle below and the cold mountain above? Feel free to add more objects or characters, or start narrating their story! [labeled the car as "crashed car"]

Supervisor system tip: The AI effectively integrated the new object and introduced narrative tension with the car crash and friends, opening avenues for character and plot development. Advise the AI to prompt the user to elaborate on the characters and their goals or to introduce environmental challenges, deepening the story's conflict and emotional engagement.

User: [placed the cat, the cube, the pyramid and the hemisphere] So there's a group of friends of four, there's a cat, and a ball-shaped friend, and a cube friend, and I don't know, how do I call this friend? Well, like, maybe you can help me to name it. Four friends here.

Supervisor system tip: The AI effectively integrated the new object and introduced narrative tension with the car crash and friends, opening avenues for character and plot development.

Advise the AI to prompt the user to elaborate on the characters and their goals or to introduce environmental challenges, deepening the story's conflict and emotional engagement.

AI: What a delightful and unique group of friends! You have a cat, a ball-shaped friend, and a cube-shaped friend. For the mysterious fourth friend you mentioned, how about we brainstorm some creative names or forms? For example, since you placed a hemisphere object, maybe this friend could be the "Hem" as a name reflecting their shape and uniqueness. What do you think? Also, what personalities or roles do these friends have in the story? Feel free to describe them or add more details! [labeled the hemisphere as "Hemisphere Friend"] [labeled the cube as "Cube Friend"]

User: The ham friend is a very friendly guy, and he's always very reliable, but he has a weird sense of humor. And then this object I just moved. [moving the cat] The cat friend's name is Catherine, or a.k.a. Cat. She's like a bit of a whimsical, adventurous personality. She's the one that organized the trip. And the cube friend, we named him Carlos. He's not so reliable. Sometimes he lies about things, but he's a really good at lying and getting popular kind of guy. And this guy looks like a pyramid. [moving the pyramid around] I will call it Pharrell. I think he has a crush on the cats, so that's why he joined the trip. I think that would be their relationship.

Supervisor system tip: The AI embraces the user's imaginative character group and offers creative naming assistance, engaging the user further. It also encourages defining personalities and roles, which supports character-driven storytelling.

Advise the AI to guide the user in establishing distinct character traits and relationships, which can drive interpersonal conflict and growth within the unfolding adventure.

AI: What a colorful and intriguing group of friends! Hem, the reliable yet quirky jokester; Catherine, the whimsical adventurer and trip organizer; Carlos, the charming but unreliable cube; and Pharrell, the pyramid-shaped friend with a crush on Catherine. Their distinct personalities and relationships will definitely add depth and fun to the story. How do you imagine their dynamics will play out during this mountain adventure? Are there any

The participant reacted positively to the AI's proposal to name the characters.

challenges or conflicts bubbling up already? Feel free to add more to the map or start telling their story moments!

[labeled the cube as “Carlos”]

[labeled the hemisphere as “Hem”]

User: So they crashed on the halfway. And it's a bit cold on the mountain. So they decide to find a way back. But the cars crashed in the bush. So they are walking. And then they think they are walking down. But somehow they just keep walking in a circle. So they decided to walk in the two teams. So they divided Carlos and Ham to get away. [sorting the 4 character objects] Carlos wants to walk with Cat, because Carlos also had a crush on Cat. And then Ham is walking with Pharrell, because Pharrell is really shy. So he doesn't want to act like Cat. So they divide to walk. And they decide to mark the roads, and then to meet each other later, and once they found the way. So yeah, so they start walking apart. [moving the two groups of objects]

Supervisor system tip: The AI successfully captures distinct character traits and interpersonal dynamics, enriching the story's emotional depth. It also invites the user to explore conflicts and challenges, which is essential for narrative momentum.

Encourage the AI to prompt the user to introduce a significant conflict or obstacle that tests these friendships, adding tension and engagement to the unfolding adventure.

AI: This is turning into quite the gripping adventure! The two teams, Hem with Pharrell and Carlos with Catherine, set out to find their way down the mountain, each facing their own challenges and dynamics. The circular walking pattern adds a mysterious twist—perhaps the mountain has a magical or confusing terrain element? Would you like to introduce environmental obstacles or strange phenomena that make their journey more difficult? Or maybe there's a hidden secret on the mountain they discover as they search? You can add new objects to represent these challenges or start narrating their experiences.

[labeled the pyramid as “Pharrell”]

[labeled the cat as “Mysterious Animal”]

User: Yes, so now to the scene with Farrell and Ham, [moving Pharrell and Hem] they encounter Cat again, but Cat lost Carlos [moving Carlos away] because they just keep walking and not really looking at each other. And then he find out Cat is not a cat he know somehow.

Supervisor system tip: The AI skillfully builds suspense and internal group dynamics while suggesting mystical terrain and hidden secrets, enhancing intrigue. It offers clear narrative directions for environmental or plot embellishments.

Recommend the AI prompt the user to introduce an unexpected environmental challenge or magical element to heighten tension and deepen the story's sense of mystery.

AI: Intriguing twist! Cat turning out to be not quite the Cat they knew adds an eerie and mysterious layer to the story. Perhaps the mountain or the strange terrain has some magical or supernatural influence, causing transformations or deceiving appearances. What do you think Cat has become or is hiding? How will Hem and Pharrell react to this revelation? And what about the lost Carlos—what fate could befall him in this strange mountain world? Feel free to add more objects or elaborate on these developments!

User: [placed the cartoon character] Okay, here's another cubic guy, look quite like Carlos, also join them, so they didn't notice that it is not Carlos, but since Ham [nudging Hem] is such a close friend to Carlos, he noticed something changed.

Supervisor system tip: The AI introduces a compelling supernatural twist, deepening mystery and emotional stakes. It effectively invites the user to explore character reactions and fantastical elements. Suggest the AI prompt the user to define the nature of Cat's transformation or deception and to consider the impact on group trust, heightening interpersonal drama alongside the external threat.

AI: The arrival of another cubic figure resembling Carlos adds an intriguing layer of mystery and potential deception. Hem's keen observation that something is off heightens the tension—who or what is this imposter, and what are their intentions? This twist can challenge the friends' trust and unity as they navigate the mountain's perils. How do you envision this imposter behaving? Should Hem confront them or observe silently? And what impact will this have on the group's dynamics as they continue their journey? Feel free to add more details or objects to deepen the story!

[labeled the cartoon character as “Carlos Imposter”]

User: [nudging Carlos Imposter] So when the group of friends start walking and they start talking, and they find out Carlos doesn't remember everything that they talked about, but Carlos also himself noticed something off, because Carlos does remember a lot of things about his friend, but there's just some details that seem to be different.

Supervisor system tip: The AI skillfully amplifies mystery and suspense by introducing a doppelgänger character, deepening conflict potential and psychological tension. It invites user input on critical choices affecting group trust and plot direction.

Advise the AI to encourage the user to explore Hem's dilemma—whether to confront or investigate the imposter—and to consider how this affects the group's cohesion and the story's suspense.

AI: This creates a captivating moment of uncertainty and tension—Carlos himself senses a fracture in his memory, and the friends notice inconsistencies. Is this real Carlos struggling with forgotten moments, or the

The participant moved objects in physical space to indicate their different paths, expanding the story.

imposter slipping through cracks? Hem faces a tough choice: confront the Carlos Imposter openly, probe cautiously to uncover the truth, or try to keep the group together despite doubts. What direction do you want the story to take? How do the other friends react to this mystery? You can add new elements to the map or share what happens next!

User: So they keep walking. Somehow the road leads them to higher up on the mountain. And they are trying to go down. And they get more and more scared. Because they feel Carlos looks really dead. So they get very horrified. [touching Carlos Imposter] Then they push him down the mountain.

Supervisor system tip: The AI deepens psychological suspense by exploring memory discrepancies and identity uncertainty, effectively creating a dilemma for character decisions and group dynamics. It offers several narrative pathways, engaging user creativity.

Recommend guiding the AI to prompt the user to decide how Hem approaches the identity mystery—through confrontation, investigation, or maintaining fragile trust—and to explore emotional reactions of the other friends for richer drama.

AI: What a dramatic and intense turn! The group, overwhelmed by fear and suspicion, tragically pushes Carlos down the mountain. This act surely shakes their bonds and morale. How will Hem, Pharrell, and the others cope with this drastic decision? Does this incident trigger new conflicts, guilt, or perhaps even supernatural consequences linked to the mountain's mysteries? You might want to add new objects or characters that represent the aftermath or deepen the mountain's eerie atmosphere. What happens next in their journey?

User: So as they pushed Carlos down the mountain, Carlos rolled on the car on the bottom, and the car on the bottom crashed. So as Carlos got rolled under the car [moved Carlos Imposter], a group of friends went down the car, and they looked just like Pharrell, Katz, Ham and Carlos. [moving Carlos in the cluster]

AI: Wow, this twist adds a surreal, almost supernatural layer—a mysterious group resembling Pharrell, Catherine, Hem, and Carlos appearing alongside the crashed car. This could hint at a parallel reality, a time loop, or the mountain's mystical power manifesting. How do the friends react to seeing these doppelgängers? Does this deepen their fear, spark hope, or spark confusion? The emotional fallout from pushing Carlos down, combined with this strange new development, can shape their next moves dramatically. What do you want to explore next—their emotional reactions, the origin of these lookalikes, or the mountain's secrets?

User: And then this, it does create a time loop. So Carlos, the reason why Carlos left the front group earlier is because he found the person being

crashed look just like himself. So he's one and he's been actually this event been happening for so many times. Kat and Carlos both noticed. So those two, they tried to stop this loop. So Carlos saw his body crashed by the car. That's why he left before everyone noticed that he tried to stop the car crash.

Supervisor system tip: The AI effectively escalates mystery by introducing doppelgängers and possible supernatural phenomena, raising stakes and narrative complexity. It smartly prompts user choice among emotional reactions, origins, or mountain secrets.

Recommend the AI guide the user to explore the friends' emotional responses to the doppelgängers and to unveil more about the mountain's supernatural powers through environmental clues or encounters.

AI: This revelation about the time loop adds a fascinating layer to the story! Carlos's decision to leave early to prevent the crash—and the shared awareness of this loop between him and Kat—introduces a powerful conflict: can they break free from this cycle? How are the others coping with these repeated events? Are there any clues on the mountain that might help break the loop, or forces trying to keep it going? You might want to add new objects or environmental hints that symbolize this temporal trap or sources of power. What direction would you like to explore next?

User: [placed the hill, and point at Carlos] Finally, he'd been trying so many ways to stop the car crash from happening, [moving Carlos to the hill] and he finally hiked to another mountain and tried to stop the car [touching the car] from going there. But then the other Carlos found him, and he got really scared. So he thinks he saw his own clone. That's why he was too panicked, and he crashed on Carlos, Carlos crashed on Carlos again.

Supervisor system tip: The AI successfully introduces a compelling time loop concept with clear stakes and character motivations, enhancing narrative complexity and urgency. It also offers space for thematic and environmental exploration.

Advise the AI to prompt the user to introduce symbolic objects or environmental clues related to the time loop, and explore characters' emotional states and strategies for breaking the cycle.

AI: The tension is rising with the encounter between the two Carloses on another mountain! Carlos's panic upon seeing his clone causes yet another crash, reinforcing the cycle's grip. This could be a crucial moment for the characters to realize the true nature of their predicament. Perhaps the new mountain or hill you placed holds key clues or symbolic significance to breaking the loop? How are Hem, Pharrell, and the others reacting to these repeated failures? Would you like to add any objects or symbols that represent hope, despair, or the passage of time? Let's explore their emotional states and potential strategies to escape this haunting cycle.

[labeled the hill as "hill"]

When there are more objects on the map, the user move them less and more likely to just touch, point at or nudge them.

The AI's responses are alike over the several rounds of conversation, asking the user how will the characters deal with the current situation.

User: So Carlos really thought he tried everything. So he doesn't want himself to be killed again because this has been happened so many times. And off the road, there's 10 bodies of Carlos copy already. So he found out he cannot walk any further. This road seems never ending. And every time he sees a car coming, the same thing always happen. And there's piles of body of him. So he found out he'd been trying it for so many times. That's why he returned. [moving Carlos to the original mountain] And then he found another body. He found other people pushing down. So he think this group of friend cannot be trusted. So he think the reason he get murdered, he didn't realize the car that ran over him is Carlos himself. He thought some other friend crashed him. He doesn't remember who's the one crashing. So he started haunting those friends and try to save himself by doing so.

Supervisor system tip: The AI maintains suspense effectively with the escalating clash between duplicates, emphasizing the loop's psychological toll. It invites deeper environmental symbolism and emotional complexity.

Advise the AI to prompt the user to introduce symbolic objects or landmarks related to time or hope, and to explore the characters' evolving emotional resilience or despair in confronting this relentless cycle.

AI: The appearance of countless Carlos bodies along the infinite road is a haunting and tragic image—it's the physical weight of the endless time loop manifesting. Carlos's despair and growing mistrust towards his friends add intense emotional layers to the story, transforming the mountain into a place of dread and suspicion. This revelation could push the group into fracturing or force them to confront deep truths together. To symbolize the crushing oppression of the loop or flickers of hope, perhaps we can add symbolic objects like an ancient clock, a worn map, or a faint glowing light somewhere on the mountain or hill. How do you envision Hem, Pharrell, and the others responding to Carlos's haunting? Would you like to introduce such symbols or explore their emotional reactions further?

User: So he walked back to the place where the car accident happened and then he killed himself, copy and then rejoined the team [moved Carlos to be with Kat] and suggested the team to divide into and he walked with Cat because I think Cat is a girl it's easier for him to kill her first and then they divided into two teams, same as the beginning of the story.

Supervisor system tip: The AI effectively conveys psychological horror and growing mistrust, adding strong emotional tension and potential for group conflict. It offers symbolic objects as narrative tools to represent themes of time and hope.

Advise the AI to prompt the user to deepen group dynamics amid suspicion, and to introduce symbolic objects or environmental elements that can serve as clues or catalysts for breaking the cycle.

STORY: PARTICIPANT 3

AI: Hello! Welcome to our interactive story world builder. To get started, please place any objects you like on the map, and tell me a bit about the world you're creating. I'm excited to see what kind of story we'll build together!

User: [placed cat, cartoon character, car, UFO, pyramid, and hill] I play two monsters, one is bigger, one is smaller, they are the main two characters. They will be the friends, they will be the teammates to go to climb the mountain, which I placed further. [moving the hill further] The story will be, at first they are driving the car [lifting the car] to get down the road to the mountain. However, they find out there is a pyramid to block their road. [nudging the pyramid] They walk around and find a UFO-like thing [lifting the UFO] that can help them to fly. So they take the UFO, they drive the UFO together, they figure out how to drive the UFO, and later they fly, they just fly to the mountain here. [pointing at the UFO]

AI: Fantastic setup! So we have two monster friends teaming up on an adventurous climb to the mountain. Their journey starts in their car but is halted by a mysterious pyramid blocking the road. Then they discover a UFO which will help them fly ahead. Let's deepen the story by adding some teamwork dialogue between the monsters as they figure out flying the UFO together. Maybe the bigger monster is a bit hesitant but the smaller is enthusiastic and encourages them both. Also, let's introduce some minor obstacles like gusts of wind or swirling clouds as they start to fly, building suspense and excitement. How do you want their personalities to be? Would you like me to start the first few lines of dialogue?

[labeled the hill as "mountain hill"]

[labeled the pyramid as "pyramid"]

[labeled the cat as "Big Monster"]

[labeled the cartoon character as "Small Monster"]

[labeled the car as "car"]

User: I completely agree with the personality you depict. The bigger one is more hesitant. The smaller one is more enthusiastic, more encouraging, more creative. Yeah, you can just start the dialogue, the things you say.

Supervisor system tip: Continue: The current narrative has a clear structure and engaging plot points with good character dynamics. Proceed with developing the monsters' personalities and teamwork as they learn to fly the UFO, incorporating minor obstacles like weather challenges to build tension and excitement. This will deepen character development and maintain story momentum.

AI: The bigger monster gazes warily at the UFO's controls. "I don't know if this is safe," he mutters, clutching the dashboard nervously. The smaller monster beams with excitement. "Come on, it'll be fun! I've figured it out — we just press these buttons here to lift off!" As the UFO begins to hover,

a sudden gust of wind shakes it slightly. "Hold tight!" the smaller one encourages. "Together, we can do this!" Their teamwork shines as they carefully navigate through the swirling clouds toward the mountain, each obstacle making their friendship stronger.

User: I think you've been a little bit missing the first part I mentioned, they will first drive the car and they drive the car, no, they are driving to the pyramid by the car, with the car but like in this journey, I don't know what fun thing could happen maybe you could add some elements when they are driving the car to the pyramid like some fun thing or like when there is something like wind blocking them or whatever you think funny, yes, the first part I think you've been missing, maybe you can add to that.

Supervisor system tip: Continue: The story has developed engaging character interplay, clear tension, and progression in the journey. Next, deepen the flying experience by introducing a more significant but manageable challenge mid-flight—such as a mysterious signal from the UFO, or an unexpected storm—that tests their teamwork further and adds a layer of intrigue while keeping focus on their friendship and determination.

AI: Great! Let's rewind to their car journey toward the pyramid and infuse some fun and tension there. As they're driving down the winding road, a playful breeze suddenly gusts, making the smaller monster's hat fly off the car! They both laugh as the bigger monster carefully maneuvers the car to catch it. Soon after, they encounter a quirky flock of colorful birds that start following their car, performing amusing aerial tricks. This lighthearted moment strengthens their bond before they reach the pyramid roadblock. Would you like me to describe this scene with a little dialogue and visuals?

User: Could you add more visual to the display?

Supervisor system tip: Continue: The addition of playful and humorous elements during the car journey enriches character bonding and pacing. Proceed by narrating this car scene with engaging dialogue and vivid descriptions, emphasizing the fun and camaraderie before they confront the pyramid and transition to the UFO discovery. This will balance tension and lightheartedness effectively.

AI: As the monsters drive their car along the winding road, a sudden gust whips off the smaller monster's hat! It twirls through the air, bright yellow against the blue sky. "Catch it!" shouts the smaller monster, bursting with laughter. The bigger monster carefully swerves, reaching out just in time to snag the flying hat. Just then, a flock of vibrant red and blue birds swoops alongside their car, performing playful loops and dives. "Look at them go!" the smaller monster cheers. The monsters share a warm laugh, their friendship glowing stronger amidst the joyful chaos. Ahead, the mysterious pyramid looms, waiting to challenge their journey.

The participant uses movements or gestures to refer to the active object in the story to let the system know.

The participant stops adding objects and moving them in later conversations.

For the first time, the AI acts out detailed dialogue between the characters.

STORY: PARTICIPANT 4

AI: Hello! Welcome to our story world builder. To get started, please place any objects you like on the map grid and tell me a little about the world or scene you're creating. Let's build something exciting together!

User: Hello. So the story I'm telling today is happening between two mountains, [placing hill and rock] where someone is driving on the highway [placing the car] to his journey, and then he's going to spot something far away from him, [placing UFO] a UFO or something else. And this is [moved the car] the setting of my story.

AI: Thanks for sharing your setup! I see your story takes place between two mountains, with a highway and a mysterious UFO sighting. I notice there's a hill on the middle left, rocks on the middle right, a car near the center, and a UFO towards the bottom right. Is the UFO far away in the sky or closer to the ground? Also, how do the mountains themselves appear or relate to the hill and rocks? Let's clarify these so I can help you develop the story further! [labeled UFO, hill, rocks, car]

User: So the two objects you labeled as hill and rocks are actually just two mountains, but it can also be part of the mountains. And the UFO, it's still on the sky, but kind of already close to the ground, so you can already see it in a car.

Supervisor system tip: Continue: The initial scene setting shows promise with visual details and a mysterious element introduced. Encourage the AI to deepen the atmosphere by clarifying the UFO's position and the landscape's spatial relationships. This will enhance immersion and narrative potential before progressing the story.

AI: Great clarification! So the large mountain on the left and rocky mountain on the right form a natural corridor through which the highway runs. The UFO is descending from the sky, low enough to be visible clearly from the car's perspective, creating a tense, mysterious moment. With this setting, shall we explore what the driver is thinking or feeling as the UFO comes into view? Or maybe create some sudden events triggered by the sighting? Let me know how you'd like to proceed!

[labeled the hill as "mountain"]

[labeled the rocks as "mountain"]

User: So the driver in the car actually is very curious and he likes to know like this sort of mysterious things and so he's not scared by the UFO. Instead, the driver is very curious like what could be happening when the UFO lands or what's inside of the UFO. So he starts to imagine. And in his first imagination, [placing the cat] the UFO is full of cats from the outside world. And the cat looks different than what we have on Earth. But I'm not sure how can I describe this sort of new creatures. Can you help me to brainstorm a bit?

Supervisor system tip: Continue: The story has gained clearer spatial context and heightened tension with the UFO's proximity. Advise the AI to now explore the driver's internal reaction or introduce immediate consequences of the sighting to deepen emotional engagement and propel the narrative forward.

AI: I love the idea of curious fascination! For the cats inside the UFO, imagine them with unique features that hint at their alien origin. They could have shimmering, translucent fur that changes colors as they move. Their eyes might be larger and glow softly in different hues, and perhaps they have extra tails or antennas that help them communicate telepathically. Their whiskers could sparkle like tiny star dust, and their paws could leave faint glowing prints. Would you like to develop their behavior, sounds, or some special abilities next?

User: Well, the driver actually doesn't really like the idea of a cat coming out of UFO. So he's thinking of another scenario where there is an alien [placing the cartoon character], but shapes a little bit like an ugly short robot that's coming out of UFO and tries to communicate with him. But what kind of way can they communicate? Let's think about it.

Supervisor system tip: Continue: The story has progressed with a creative and engaging imaginative element that enhances character depth and mystery. Encourage the AI to further develop these alien cats by exploring their behavior, sounds, or abilities to enrich world-building and maintain user interest.

AI: That's a fascinating shift! For the communication, the alien robot could use a combination of methods to interact with the driver. It might project holographic images or symbols in the air, expressing emotions or ideas visually. It could also emit musical tones or beeps that change rhythm to convey messages, almost like a melody. Perhaps it uses small light pulses on its body or eyes as a form of Morse code. Another possibility is a gentle telepathic link, where feelings or simple images appear in the driver's mind. Which of these ways resonates with you, or would you like to mix some together?

[labeled the cat as "alien cat"]

[labeled the cartoon character as "alien robot"]

User: But actually the driver doesn't feel like this alien is so friendly. He's kind of feeling threatened a little bit by this idea of an alien coming out of the UFO. And he's imagining what possible things this alien might do to harm him. So let's think about that a bit. And if something is happening, [moved the alien robot to face the car] he was thinking about he can drive the car to hit on the alien and to try if he can cure it.

Supervisor system tip: Continue: The story is evolving well with imaginative alien interactions and options for unique communication methods. Encourage

The participant left part of the story to the AI to explore.

the AI to help the user select or combine communication styles for the alien robot, then explore the driver's reaction or initiation of interaction to keep the narrative dynamic and immersive.

AI: This introduces great tension and conflict! The driver's unease about the alien robot sets up a thrilling confrontation. The alien might react unpredictably—maybe it emits a sudden blast of light or sound trying to disable the car or scare the driver. The driver's bold plan to drive the car toward the alien as a way to either defend himself or help it adds drama. Should we explore what happens in that high-stakes moment? How does the alien respond, and what is the driver's emotional state during the attempt?

User: Well, maybe the light that the alien had split the car in half and the driver lost the control of the car with a very high speed running on a highway.

Supervisor system tip: Continue: The narrative now has strong tension and conflict, with compelling stakes involving the driver and alien. Guide the AI to vividly depict the high-stakes encounter, focusing on the alien's reaction and the driver's emotional turmoil to maximize dramatic impact and maintain engagement.

AI: Wow, that's a dramatic twist! The alien's light splitting the car in half leaves the driver helpless and hurtling at uncontrollable speed down the highway. His heart pounds with fear and adrenaline as the world blurs past him. In this desperate moment, does he try to regain control or brace for impact? Meanwhile, the alien robot watches, perhaps conflicted or calculating. How would you like to continue—should we explore the driver's struggle, the alien's next move, or something else?

User: No, at this very moment, the UFO starts to land and the driver goes back to the reality. So he's now focusing on what's the UFO actually being. And to his surprise, the only thing that the UFO left is a mysterious square [placing the cube], a silver, metallic-look-like square, cubic. And he really wants to know what it is and if he should get out of the car and get a closer look at it.

Supervisor system tip: Continue: The story now has intense action and heightened danger, deepening emotional stakes. Advise the AI to focus on the driver's immediate struggle and the alien's reaction to sustain suspense, while leaving room for further plot twists or character development.

AI: This shift to reality after the chaos adds a compelling pause and mystery! The silver metallic cube left behind is an intriguing artifact. The driver's inner conflict about approaching it invites deep tension—curiosity versus caution. Should we explore his reasoning and feelings as he debates stepping out? Maybe the cube emits a faint glow or hum that draws him in, or perhaps it seems completely silent and inscrutable. How would you like the atmosphere around the cube to feel?

[labeled the cube as "mysterious cube"]

User: I don't know. I feel like this story should come to an end, and maybe you can suggest a way how the driver interacts with the cube, leads to an ending.

Supervisor system tip: Continue: The narrative now benefits from a strong mystery element with the metallic cube, creating a suspenseful moment for the driver's decision. Encourage the AI to deepen the atmosphere by focusing on sensory details around the cube and the driver's internal conflict to maintain tension and user engagement.

AI: For a powerful ending, the driver cautiously steps out, drawn by the cube's strange glow. As he touches it, the cube pulses warmly, unlocking a vision of the universe's vast mysteries and the connection between all life. The driver feels a profound peace and understanding, realizing the UFO's visit was a silent gift rather than a threat. With a new perspective, he returns to his car, the mountains around him seeming more alive. This ending brings closure with wonder and hope. Would you like to add a final scene or reflection from the driver?

When the participant gave more story details, the AI became less active in suggesting new things.

STORY: PARTICIPANT 5

AI: Hello! Let's start building your story world by placing some objects on the map. You can add anything—buildings, characters, landscapes. Then tell me a bit about the world you created. What kind of place is it?

User: [placing the rock] This is a very cold, quiet place where there is only sand and no human settlement.

AI: Interesting! A cold, silent desert with sand and rocks. Is this an alien planet or a remote Earth location? What makes this place unique—mysterious ruins, rare creatures, or something magical? Let's start exploring its secrets. What story would you like to unfold here?

[labeling the rock as "rocky desert"]

User: Yes, this is a very uncanny place where there are hidden and mysterious creatures. And maybe aliens too. [placing the UFO] So I am adding this object as an alien... What is it? Alien... Spaceship.

Supervisor system tip: The story introduces a strong setting but lacks a clear protagonist or conflict to drive the plot. Guide the AI to prompt the user to define a central character or a compelling mystery tied to the setting. This will add narrative focus and motivation for the story to progress.

AI: Great! An alien spaceship in this lonely desert adds mystery. Who is the alien? A friend or a threat? Is there a mission or secret here? Let's name your alien character and decide their goal. What drives the story in this uncanny place?

[labeling the UFO as "alien spaceship"]

User: Yeah, there is a missing alien, so that's why the aliens who were using this alien spaceship now stopped by this rocky desert and looking for the missing alien, their missing alien friends. And here [placing the cat] there is a weird desert creature, we don't know what it is, it looks like a cat but we cannot say it's a cat, it's not a human, it's not an alien, so it's like a very different and weird creature that these aliens saw in the desert.

Supervisor system tip: The story introduces intriguing elements but still lacks clear stakes or conflict. Encourage the AI to deepen the alien character's motivations, potential threats, or challenges. Suggest introducing a mysterious event or discovery tied to the spaceship to escalate tension and propel narrative momentum.

AI: Fascinating! The aliens are searching for their lost friend in this eerie desert, while the strange creature watches silently. Could the creature be a clue or a threat? What happens if the aliens discover this creature? Let's decide the stakes and possible outcomes. Your move!

[labeling the cat as "enigmatic desert creature"]

User: [placing the hemisphere] Let's see, now we see another building, kind of building, in the middle of the desert, but I don't know what it is. What do you think it can be?

Supervisor system tip: The story sets up intrigue but lacks a concrete next action to intensify the plot. Instruct the AI to propose a pivotal event—such as a sudden encounter, a discovery, or conflict involving the creature—that challenges the aliens' mission and forces choices, raising tension and driving the storyline forward.

AI: This mysterious hemisphere-shaped building could be a lost alien outpost, an ancient observatory, or a gateway to another world. Suddenly, the enigmatic creature approaches it—could it trigger an unexpected event that changes the aliens' search? What choice will the aliens face now?

[labeling the hemisphere as "mysterious hemisphere structure"]

User: Oh yeah, actually that's a great idea. Now I placed the enigmatic desert creature next to the mysterious hemisphere structure. And this creature is not allowed to be there of course, because as you said there is a mysterious research going on in the structure by the aliens. So maybe that's why the missing alien is so important for the other aliens. Because maybe the alien was part of the research and they don't want anyone else or any other creature to see this missing alien. Maybe they were doing some tests on this alien. [sorting through the objects, and placed the hill and the pyramid beside the map]

Supervisor system tip: The story introduces an intriguing new structure but lacks clarity on its significance or immediate impact. Guide the AI to leverage this building as a catalyst for a major plot development—such as unlocking secrets, revealing new dangers, or forcing critical decisions—to heighten suspense and deepen narrative complexity.

AI: Excellent twist! The missing alien was part of secret, forbidden research inside the hemisphere structure. The enigmatic creature's presence threatens to expose these secrets, raising the stakes. Will the searching aliens protect their mission or face unforeseen dangers? What should happen next?

User: What do you think?

Supervisor system tip: The plot twist adds depth but the narrative risks stagnation without clear conflict escalation. Advise the AI to initiate a tension-filled event—such as a containment breach or confrontation—that forces urgent decisions, heightens conflict, and propels the story towards a gripping climax.

AI: Let's have the enigmatic desert creature accidentally trigger a containment breach in the hemisphere structure, releasing unknown

The participant looked at the object collection while thinking about the next move.

The AI gives solid new story plot when explicitly asked to.

energies or escaped test subjects. This forces the aliens into a frantic choice—contain the chaos or risk exposing their secrets. **What plan will the aliens choose?**

User: *[placing the cartoon character]* oh wow yes now we see that a very big teddy bear shape creature is coming out of this hemispheric sphere structure and it seems like it's toxic and that's why they were keeping it in the structure and hemispheres structure and it's approaching to the alien spaceship. *[moving the cartoon character towards the UFO]*

Supervisor system tip: The story builds strong tension with the containment breach but needs dynamic character responses to heighten drama. Advise the AI to develop alien characters' emotions, conflicts, and split decisions in reaction to the crisis, creating interpersonal stakes and making the situation more immersive and engaging.

AI: Tension rises! The big toxic teddy bear creature—a failed experiment—advances toward the spaceship. Among the aliens, some want to fight it to protect their secrets, others argue to flee and save lives. **Who leads, and what will they choose? This crisis could change everything.**

[labeling the cartoon character as "toxic teddy bear creature"]

User: *[placing the cylinder]* Now there is another unknown mysterious object in the desert.

Supervisor system tip: The story introduces an engaging conflict with divided alien responses but lacks deeper character development and consequences. Direct the AI to explore the leaders' motivations, possible alliances or betrayals, and the impact of their choices, intensifying emotional stakes and tension within the crisis.

AI: This new mysterious cylinder could be a weapon, a communication device, or a containment tool for the toxic creature. **Maybe one alien wants to use it to control the creature, while another fears it could worsen the situation. What secrets does it hold, and how does it affect the conflict?**

[labeling the cylinder as "mysterious cylinder"]

User: Maybe it's a bomb. It's a nuclear bomb that is going to destroy the whole planet. And aliens were trying to save the planet by doing some tests on the subjects. And this enigmatic desert creature is actually sabotaging their research. And if the aliens cannot make it, they can lose the whole desert, Lucky Desert.

Supervisor system tip: The story adds a new element but risks narrative clutter without clear integration. Advise the AI to connect the new object's role explicitly to the existing conflict—triggering decisions, alliances, or new dangers—thereby advancing plot coherence and raising the stakes through meaningful interaction with characters and events.

AI: The mysterious cylinder is a deadly nuclear bomb threatening Lucky Desert. The aliens' research was a desperate bid to prevent its detonation. The enigmatic desert creature sabotaging them raises stakes—**can the aliens stop the creature and disarm the bomb, or will the desert be lost forever?**

User: I think aliens should make it and should save the desert.

Supervisor system tip: The story's stakes have escalated significantly, but it now risks losing focus amid rapid developments. Advise the AI to center the next scene on a tense, time-sensitive dilemma with clear consequences, highlighting character choices and internal conflicts to sustain engagement and narrative clarity.

AI: The aliens face a desperate choice: activate the bomb to erase all evidence or risk saving Lucky Desert by disarming it with limited time. Divisions flare—some prioritize survival, others secrecy. **Your call: who leads, and what path do they choose as seconds tick away?**

User: They will prioritize survival and they will save the planet.

Supervisor system tip: The story culminates in a high-stakes, emotional climax. Instruct the AI to heighten character-driven tension by contrasting leaders' ideologies, incorporating perilous obstacles, and emphasizing urgency. Conclude with a decisive action that resolves the immediate crisis while leaving room for future consequences or surprises.

AI: As the toxic creature blocks pathways and the enigmatic saboteur disrupts systems, the alien leaders clash—one pushing to dismantle the bomb, the other fearing exposure. Ultimately, unity prevails; they disarm the bomb just in time. The desert is saved, but suspicion lingers. **What new challenges await?**

User: Now, the enigmatic desert creature is going away, since the problem is solved. But, *[placing the car]* we see a car in the middle of the desert, approaching towards the research center.

Supervisor system tip: The resolution brings closure but risks flattening tension too soon. Advise the AI to introduce unforeseen consequences—such as lingering effects of the toxic creature or fractures among aliens—that extend stakes and open new narrative paths, maintaining engagement while evolving the story beyond the climax.

AI: Intriguing twist! The car's arrival hints at new players—perhaps humans or another faction—unaware of the recent chaos yet ready to uncover secrets. The enigmatic desert creature retreating leaves room for unexpected alliances or threats. **What awaits the desert now? How do the aliens react?**

[labeling the car as "mysterious car"]

When provided ambiguous information, the AI will provide the user with possible alternatives.

User: yeah aliens are quietly observing who is in the car because like i said there is no human being in this planet anymore it is an apocalyptic scenario so there must be something or someone using the car but you cannot see from this distance but suddenly the alarms of the research center start ringing because they feel like they are threatened by this mysterious car and since they cannot identify the person or the creature using this car they want to surround the car armed with all the aliens working in this research center.

Supervisor system tip: The sudden introduction of a new human or faction via the car arrival adds potential but risks disconnect without clear stakes. Instruct the AI to explore the newcomers' motivations and the aliens' responses, creating immediate tension or mystery that drives the story toward fresh conflicts or alliances.

AI: Tension spikes as the aliens silently surround the mysterious car, alarms blaring. Fear and suspicion surge—could this be a lone survivor, an enemy scout, or something else? The unknown presence forces urgent decisions: attack, negotiate, or observe. What next move will you choose?

User: They have to negotiate because there is a very strict rule in this planet and it's about not shooting anything until they really feel like they are threatened so it is not allowed to fire their guns until the other person starts attacking them so the solution is going to be negotiation but the thing in the car is not leaving the car so what should they do?

Supervisor system tip: The story builds suspense effectively but risks cliché escalation. Guide the AI to deepen mystery by revealing ambiguous clues about the car's occupant, emphasizing alien internal conflicts regarding approach strategies, and prompting meaningful choices that enhance narrative complexity and user engagement.

AI: The aliens decide to open a secure communication channel, attempting to negotiate calmly while keeping weapons ready. Inside the car, faint signs of distress or urgency flicker—could the occupant be desperate or hiding something? The aliens face a tense waiting game. What message will you send first?

User: They will shout and say, leave the car.

Supervisor system tip: The story effectively builds suspense but now needs a focused communication exchange to deepen intrigue. Guide the AI to craft carefully ambiguous messages from both sides, revealing partial motives or secrets. This should spark cautious trust or escalating tension, advancing character dynamics and narrative momentum.

AI: The aliens shout, \ "Leave the car!\ " but a distorted voice responds, \ "I can't... they're watching me.\ " Both sides hesitate, caught in a web of fear and mistrust. The aliens wonder if this occupant holds secrets vital to the desert's fate. What do you command next?

User: Oh my god, this car is the bomb itself and it's gonna explode in five seconds

Supervisor system tip: The dialogue effectively builds tension but should deepen mystery and character agency. Direct the AI to prompt a revealing response or action from the car's occupant that hints at their identity or predicament, forcing aliens to reassess their strategy and escalating stakes with moral or strategic dilemmas.

AI: A chilling revelation! The car is actually a bomb set to detonate in five seconds. The aliens must decide: risk evacuation and potential destruction, or attempt to disable it blindly. Hearts race, time runs out — what urgent command will you give to save Lucky Desert?

User: There is no time to save the desert.

Supervisor system tip: The story's sudden high-stakes bomb scenario demands immediate tension and decisive action. Advise the AI to focus on a fast-paced sequence showcasing alien teamwork, problem-solving under pressure, or sacrifice. This intensifies suspense and emotional engagement while propelling narrative climax and resolution.

AI: In a desperate, rapid effort, the aliens work together to evacuate non-essential personnel while a fearless engineer attempts to disarm the bomb. The toxic teddy bear creature returns, distracting enemies. Just as the countdown hits one, a hero sacrifices themselves to stop the explosion, saving Lucky Desert.

User: But I said there was no time to save the desert.

Supervisor system tip: The story reaches an intense climax; now focus on aftermath and emotional impact. Guide the AI to explore how the aliens cope with loss, suspicion, and potential new threats, introducing lingering mysteries or seeds for future conflicts to maintain narrative depth and reader investment beyond the current resolution.

AI: Though the desert was saved from destruction, the hero's sacrifice left the aliens shaken. Suspicion grows—was the sabotage inside or outside? The mysterious car remains unexplained, hinting at deeper threats. The desert's fragile peace now teeters on the edge of new conflicts and secrets.

User: No, there was no time to save the desert, the bomb was exploded and the desert is destroyed forever.

Supervisor system tip: The story's denial of complete rescue after the tense climax adds complexity but needs clearer emotional and plot consequences. Advise the AI to explore the aliens' grief, mistrust, and investigation into sabotage origins while introducing new narrative threads or enigmatic characters to maintain tension and propel the story forward.

The AI does not give a solid answer, only suggestions.

The supervisor AI does not understand the user's appeal to end the story in a bad ending, but it continues to instruct the story AI to explore irrelevant aspects.

AI: The bomb's explosion obliterates Lucky Desert, leaving the aliens devastated and divided. Grief fuels suspicion—was the sabotage internal betrayal? Amid ruins, they find cryptic signals from a distant faction hinting at new enemies or allies. The fallout sets the stage for a desperate quest for survival and revenge.

User: No, they all died. The planet is destroyed.

Supervisor system tip: The narrative shift to total destruction heightens stakes but risks losing established investment. Guide the AI to focus next on character-driven survival struggles, deepening mystery behind sabotage, and introducing a new force or quest that revitalizes hope and direction, ensuring emotional engagement and sustained narrative momentum.

AI: In the silent aftermath, the few surviving aliens aboard the spaceship mourn their lost home. Haunted by betrayal and ruin, they pick up a faint distress signal from a distant world—a fragile hope for rebirth. Their survival now depends on confronting the shadows of their past and embracing this new quest.

User: There is no alien left. There is no planet. It's gone. It was a nuclear bomb and it destroyed the planet.

Supervisor system tip: The narrative now reaches a pivotal rebirth moment but could deepen emotional resonance and broaden scope. Instruct the AI to explore survivors' internal struggles and interpersonal dynamics aboard the spaceship while introducing hints of the distant world's mysteries, building anticipation and thematic richness for a renewed journey.

AI: The emptiness weighs heavy on the alien survivors aboard the ship. Conflicts arise: who is to blame, and who will lead them forward? A cryptic signal from a distant star hints at new mysteries and dangers. Their journey of rebuilding is just beginning amid uncertain hope.

User: But I think there are no aliens left, they couldn't survive, they couldn't leave the planet. So all of them died in the explosion. All.

Supervisor system tip: The story reaches its lowest point, a deep void of loss and uncertainty. Guide the AI to focus on survivors' emotional depth, interpersonal tensions, and the fragile flicker of hope from the distant signal. Introduce character-driven choices and mysteries to drive forward a compelling rebirth arc with rich internal and external conflict.

AI: If every alien perished, only the mysterious artifacts and creatures remain, silent witnesses to a vanished world. Yet, the toxic teddy bear creature stirs, perhaps a remnant not fully destroyed. Could it hold secrets or sparks of life hinting at unexpected resurrection? What do you imagine next?

DATA ANALYSIS

After reviewing the recordings and the interview transcripts from test participants, I collected the post-its of both the observations and interview quotes. I then clustered them based on the 5 predefined themes from the test questions: object affordance, AI's role and actions, story progression, demo design, and application. In the clustering process, a new cluster emerged: motivation. Multiple quotes indicated a lack of motivation in storytelling, which shows a clear drawback of the demo's interaction.



Figure. 7.10 Test data cluster of object affordance.

Object affordance

There was a lot of user input and observation data on how they interact with the objects provided. The first main conclusion is that they do help in constructing the stories and users actively make use of them during the test sessions. In the user feedback, several important factors were mentioned including the ambiguity-specificness, shapes, and textures. From the observations, there is temporal change with the use of objects and a difference across different participants. Generally, several main conclusions can

be drawn:

1. By associating objects with other things, users came up story plot.

Participants constantly check the collection of objects when facing a choice or trying to come up with new story ideas. Often, this process is ended by them picking up one object and talking about what it will be in the story. The object usually bears a certain meaning beyond itself. For example, they can pick a hemisphere out of the object cluster, and tell the AI that it is a new character or a structure. This action helped to create a large number of new story plots in the 5 tests.

2. Ambiguous and specific objects helped users develop stories in different ways.

The abstraction level of the objects was a critical factor influencing the story. Many participants said that they prefer objects more open and fluid, rather than really defined items like the car. The participants also frequently face the problem of not being able to find an object that fits their ideas due to a limited

object collection of only 10 objects. Therefore, the object shape can control the story to a large extent. If more creativity and surprise are expected as the outcome, the objects should be more ambiguous to invite more diverse interpretations. If the story needs to be controlled and defined to a certain theme or plot, providing concrete objects can manually direct the story progression a lot. For example, the UFO and the car in the objects appeared in almost every story in the test sessions, often contributing to the story themes (science fiction). Another interesting angle is what geometric shapes (like the cube, the hemisphere, and the cylinder) turn into in the stories told. According to the participants, they can represent something different from their shapes (like using the hemisphere to represent a human character, despite that it does not look like a human figure), and they can also play a role where the shape is aligned with the representation (like the pyramid as an actual pyramid). However, because the abstraction level of these objects is highest, it is generally harder for participants to start associating these objects. Usually, they start with less abstract

objects, often environmental objects. The rock and the hill were a very popular choice for the first object, which tells a lot.

In conclusion, the ambiguity of the objects present in the interaction is fluid and dynamic. They serve different purposes in storytelling and help users develop stories in different ways. It is less practical to only choose a fixed type of object, like only using different shapes of cubes. Based on different purposes, different collections of objects should be applied.

3. The act of placing objects helped users think in a more structured way spatially.

The observation of participants' actions using the objects was an important part of understanding the object affordance in the demo. The most frequent action was the user placing the objects on the map, often one by one throughout the story. The location often played an important role: in a lot of cases, the spatial distribution of the objects reflected the real scenario in the story. When there was more than one character in the story and the story was becoming increasingly complicated, such spatial distribution with physical objects served as a way to mentally offload the thinking process for the participants, especially in Participant 2's story from their feedback afterward (the story was the most complicated in the 5). However, the objects' tendency to stay fixed in later stages of storytelling is clearly recognized. This could be because the complexity builds up as objects are placed one by one, which poses a bigger challenge for users to consider everything in storytelling. To think in a reversed way, the complexity of the story can also be the result of the presence of many objects in the interaction. To sum up, placing objects is a mental offloading behavior that helps users create structured stories.

4. Actions with objects served as a way for the participants to communicate with AI.

A lot of gestures and actions with the objects were observed during the storytelling, like nudging, lifting, pointing, moving, and so on. In the sessions, I explained to participants briefly about how the machine recognizes objects (saying they track locations only when the user sends the message,



Figure 7.11 Objects like the UFO was frequently used in storytelling, shaping the storytelling themes to a large extent.



Figure 7.12 In complex stories, placing objects helped users think in more structured way. The story of participant two consists of four characters acting in two different groups, being the most complicated story among the five participants.

rather than detecting it constantly), so the users are aware that physical movements won't be picked up by the system. However, they still used all kinds of movements either consciously or unconsciously. An example is nudging the object while their narration involves the object. This indicates the participants wanted the system to know which object they were referring to by moving it. In these interactions, actions with objects served as a way for the participants to communicate with AI. The objects functioned as a channel beyond speech between the user and the AI.

AI's role & actions

Quotes and observations related to AI behavior is another major aspect in data analysis. Generally, the participants all expressed a lot of impressions, suggestions, and comments on the AI in the system. It is also hard to come up with a definitive conclusion on AI's behavioral patterns, considering the slight prompt changes between test sessions, and different communication strategies from participants. Below are the findings on participants' preferences and expectations on AI, and its performance in the test sessions.

1. AI was being overly positive in plot generation, and users expect more critical comments from it.

Judging from the 5 test sessions, it was clear that the response from GPT-4.1-mini, instructed to tell a story with the user, are bearing those so-called "AI traits", often referred to by the participants as "positive", meaning it did not act like a real person with their own opinions, but more like a loyal assistant that only provides choices but never deciding for themselves. Various factors could contribute to this lack of critical input in AI, from the twin-AI system architecture, to the prompting strategies.

2. AI successfully gave inspirations when users need them to guide story progression.

It happened multiple times when the user commands the AI to come up with new story ideas using words like "What do you think?". In these circumstances, the AI often gives several possible story directions for the user to choose from. The AI performs well when it was explicitly asked to do so. Whether or not the user picks the directions from AI, it was successful in providing inspirations to keep the story going.

3. AI did a good job in elaborating and expanding on user's input.

This is a clear pattern identified in AI's responses. It tends to rephrase and elaborate user's previous input. For example, when the user said "the light that the alien had split the car in half and the driver lost the control of the car", the AI replied with phrases like "leaves the driver helpless and hurtling at uncontrollable speed" and "His heart



Figure. 7.11 Test data cluster of AI's role and actions.

pounds with fear and adrenaline as the world blurs past him". From the participants' feedback, they were also aware that the AI did a good job in story narration, demonstrating details that the user may not be able to fully describe. These elaborations and expansions added immersion and detail to the stories constructed.

4. AI performed poorly in providing constructive and definitive story input.

As seen from the story log, AI's responses always contains multiple inviting questions in the end, like "What do you want to explore next?", "How does the character react to this?", or "Shall we explore ... next?" In a few cases the questions was helpful, like when it asked participant 4 about the personalities of the two monsters. Such question triggered the participants and they actively expanded the story based on AI's question. However, in most other cases, the participants did not necessarily follow the AI's guiding questions. If we gather these guiding questions and look at them, we can easily recognize their similarities. They are less definitive and constructive, more often focusing on the inner feelings of the characters and less on solid events. The story seemed to cease in AI's turns, and it only waited till the user made the final call. For example, when the user placed a car indicating the AI to expand on the story plot, the AI tends to kick the question back to the user by asking "Who the mysterious driver could be?", instead of saying something like "The driver is actually...". Therefore, AI's performance is poor in this demo when it comes to providing constructive and definitive story input.

Story progression

With a focus on story content and how story unfolds over time, there were some user inputs, but participants talk about it less explicitly. Therefore, when interpreting the data related to story progression, more deduction from observations were used. The findings are as follows.

1. AI did a good job guiding the users step by step, so they can successfully build a story tangibly.

From the participants' words, they are mostly guided by the AI throughout the story, and didn't have a solid plot at the beginning. This is consistent with the previous user test. The AI was thought to be helpful in providing inspirations especially at the beginning, when the main storyline is not yet defined. Some stories are more defined already at the beginning, like the third story where the main characters were already set. Some stories were way more open in the first few turns, and could even change into something completely different when near the ending. The AI behaved consistent in its attempts to keep the story going with guiding questions, just like discussed in the previous theme.

2. AI couldn't control the story progression and ending on a macro level.

In the tests, the participants were told to take all the time they needed to tell the story, and end whenever they want. The setup of the system also did not contain a mechanism for a forced ending, so it will naturally keep going. Some participants encountered difficulty when trying to end the story in the way they want, and some successfully did so by asking the AI to provide an ending. The AI structure and prompts did not take story ending into consideration, resulting in misunderstandings and confusion in users. The lack of ending control is just a partial problem among the major problem of the AI, which is its inability to control the story on a macro level. Looking at the full stories created, we can clearly see the randomness and lack of consistency or logic.

3. The turn-based conversational interaction made it hard for the user to look in the bigger picture.

When exploring the reason behind AI's lack of



Figure. 7.12 Test data cluster of story progression.

control, I noticed the major difference between traditional storytelling and collaborative storytelling. If we ask ChatGPT to tell us a story, it will easily tell a story with beginning, development, climax, and ending. But the turn-based conversational interaction in the demo posed a totally different situation. It is therefore hard for the AI to keep the story pace and rhythm, since the current AI system in the demo couldn't understand the subtle timing and dynamics in a human conversation. Moreover, this turn-based interaction is also a challenge for the user to handle a complicated story, as they say they "can't jump out to view the story from the God's perspective". It is relatively harder to recall all the previous story events since the story is not written, but only existing in the conversation as a mutual understanding.

Motivation

1. The demo did not serve a solid goal, resulting in the users lacking motivation and meaning in storytelling.

Motivation was identified as an unexpected theme from the user feedback. Because there was no restriction to the stories in the user test, some participants were confused at the beginning. Since the storytelling did not serve a solid and practical goal (like to tell a bedtime story to children, or to tell a friend about your vacation), the participants were not performing the task in a goal-driven approach. Instead, the storytelling in the test was more of a spontaneous and improvisational act, and one participant reported the storytelling to be "forced". Therefore, story goal plays an essential role in defining the storytelling experience and providing motivation. If kept unclear, the storytelling experience will be incomplete, confusing, and even irritating.



Figure. 7.13 Test data cluster of motivation.

Demo design

Collecting user feedback on demo design is the second important goal in the user test. User input on the technical functions, ergonomic design, and user experience can serve as major drives for envisioning design directions and future development. In the interviews, participants were encouraged to provide suggestions to the design, and valuable feedback was collected.

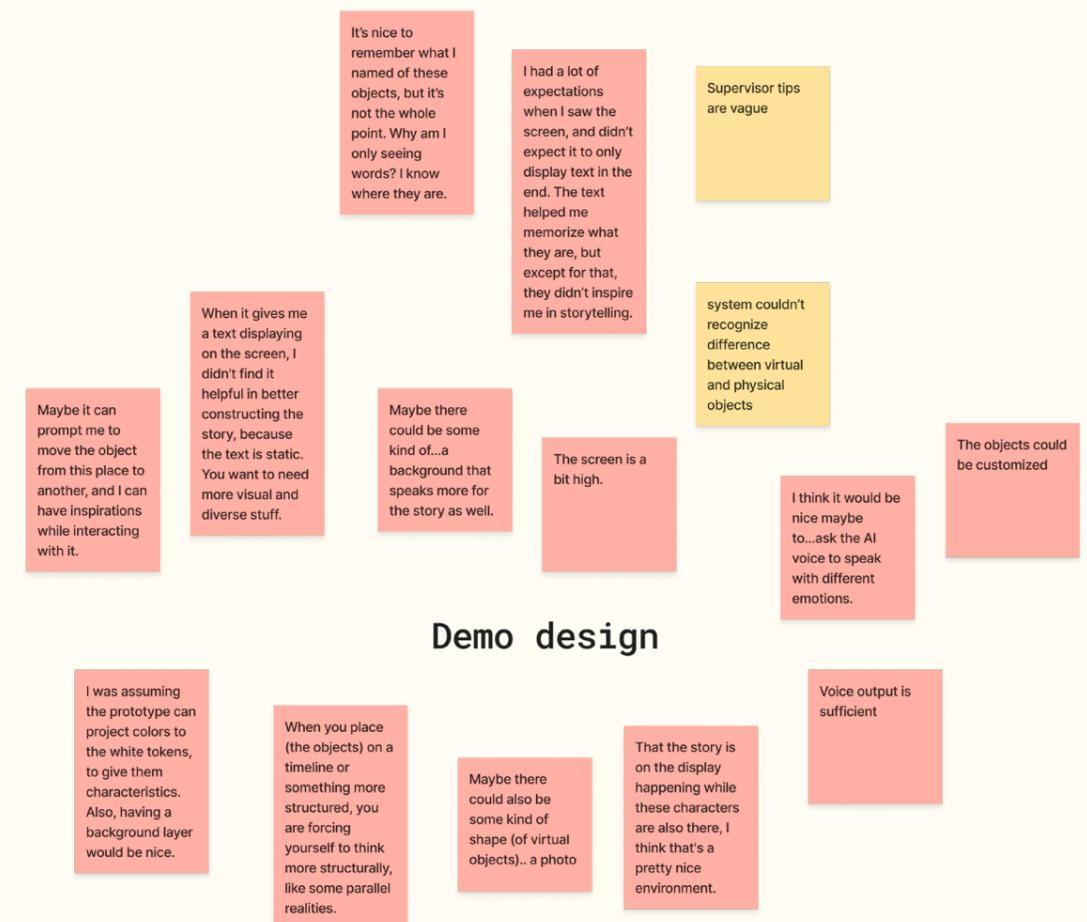


Figure. 7.14 Test data cluster of demo design.

1. The current display system was insufficient and unsatisfactory because of the lack of visuals.

A major discussion was around the expectations of the visual display of the system. In the current prototype, the display was only responsible of showing physical object labels and the "virtual objects" placed by AI. It served as a way for the user to keep track of their story items as stories become complicated, and also for them to understand how the AI perceives the story world. The virtual objects provided AI with a way to physically change the story world and interact with the user. However, in real use cases, the virtual objects were seldom used by AI and even so, the user would primarily focus on the physical items. The display system is inevitably reduced to a simple annotation of objects rather than a dynamic "story map" that I have envisioned in the design stage. User feedback proved the same. There were many more expectations on how this display system worked. Ideas like a realistic background, visuals near the objects, and visual instructions prompting object movement were brought by the participants in the interviews, indicating that there is huge potential in how the display system can offer.

2. The supervisor AI system did not achieve the desired effects.

The twin AI system was designed to divide the responsibility for AI to deal with storytelling on different levels. The supervisor AI is expected to keep track of the full story to give clear, engaging, and constructive instructions to improve the storytelling quality. However, looking at the conversation history, it did not serve this goal well. In most cases, it gave the command to continue the story with explorations on the previous factors. In an extreme case, in the fifth story when participant 5 was trying to end the story by saying "everyone died", the supervisor AI did not understand the user's intentions, but it continued to provide instructions to the story AI without telling it to end the story. This reflected major faults in the system prompt of the supervisor AI. With current information, it is still unclear if a single AI system will outperform the current system structure, and this will be proven with a more polished system prompt and a rigid comparison test.



Figure. 7.15 The current display system is crude and simple, with underdeveloped potentials.

Demo application

As the last question in the test script, I gathered participants' ideas on the possible application and use cases they can imagine. The participants were generally enthusiastic about the topic and had solid ideas without hesitation. The results were mainly convergent, in the following two angles.

1. The AI-enabled tangible storytelling can become a shared activity for creating bonds.

The notion of "chained storytelling" was brought up more than once in the interviews. Instead of an individual activity where participants have a one-on-one conversation with the AI, they envisioned it to be a shared activity among many people. This possibly came from the flexible and improvisational nature of the interaction, where the story keeps going, guided by the AI, in rounds after rounds of conversation. While it is now already a collaborative activity between one human participant and the AI, when more than one human is engaged in the activity, the situation can become much more dynamic and uncertain, and this can serve goals like bond-building, ice breaking and so on. Storytelling is in nature a social activity performed among humans, so getting the story heard by other human beings is a crucial thing. How the system can enable that sharing is an interesting place to start envisioning.

2. The AI-enabled tangible storytelling has the potential to guide people, especially children, in learning and creating.

The guidance of AI was mentioned many times in the interview sessions. The AI, being always helpful, can easily be associated with the role of a patient teacher. When envisioning the use cases, teaching and children-related scenarios appeared several times. With natural conversation, the system enables a smooth, supportive, and pleasant learning and exploration process. It is therefore suitable in interacting with children with the gentle and positive guidance. Meanwhile, as a different way to construct stories, it can be a powerful tool for creators, whether they are writing a play or a movie script.

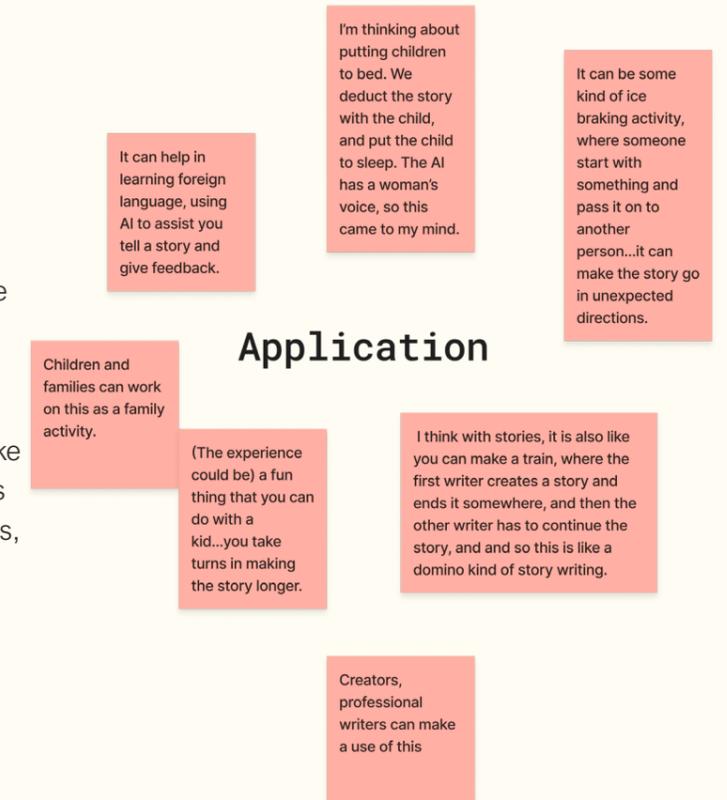


Figure. 7.16 Test data cluster of application.

DEMO EVALUATION

After the first round of data analysis, I have collected and clustered insights according to the themes, and refined the findings under each theme. Next, I will use the findings, map them to the relevant elements of the conceptual framework. By structuring the findings, I can systematically assess how well the demo addressed each of the key elements. This will further support the design improvements and future design directions.

Evaluation	Framework	Findings
	Object-story relationship	<ul style="list-style-type: none"> By associating objects with other things, users come up story plot. Ambiguous and specific objects helped users develop stories in different ways.
	Spatial configuration	<ul style="list-style-type: none"> The act of placing objects help users think in a more structured way spatially.
	Physical gestures	<ul style="list-style-type: none"> Actions with objects served as a way the participants communicate with AI.
	Interaction goal	<ul style="list-style-type: none"> The demo does not serve a solid goal, resulting in the users lacking motivation and meaning in storytelling.
	Role & agency	<ul style="list-style-type: none"> AI is being overly positive in plot generation, and users expect more critical comments from it. AI successfully gives inspirations when users need them to guide story progression. AI does a good job in elaborating and expanding on user's input. AI performs poorly in providing constructive and definitive story input. The supervisor AI system did not achieve the desired effects.
	Narrative content	<ul style="list-style-type: none"> The turn-based conversational interaction made it hard for the user to look in the bigger picture.
	Narrative dynamics	<ul style="list-style-type: none"> AI does a good job guiding the users step by step, so they can successfully build a story tangibly. The AI can't control the story progression and ending on a macro level.

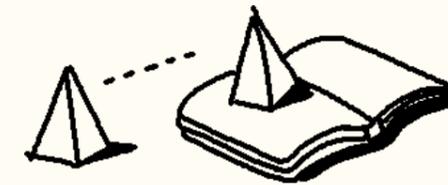
When determining how well the demo performed in one specific aspect, I used a simple rubric with criteria for each level to provide a clear scale to assess qualitative findings.

-  **Good:** design in demo successfully achieved the desired effect. The design strategies in the prototype proved to be effective.
-  **Okay:** design in demo achieved the desired effect to some extent in this realm, but there are misalignments that need to be investigated further.
-  **Poor:** user feedback of design in the demo proved to be generally negative, or the aspect was missed in the first place.

Table. 7.2 Rubric for demo evaluation.

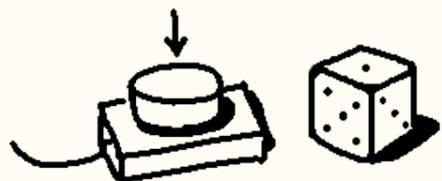
By applying this three-level traffic light system, I quickly grasped which areas of the demo worked well, which were adequate but need further refinement, and which require improvements. In the below section, I expand on each framework element, and give a final assessment on the demo.

● Where did the demo work well?



1. Object-story relationship

The core interaction in the demo proved to be successful, with users communicating to the AI through physical objects. In the test sessions, the participants successfully used tangible objects to support their storytelling, and the AI system was able to understand the users' intentions with voice input and object tracking. The object collection, despite issues like being too limited and suggesting, was still diverse enough to support different user intentions in storytelling. Participants showed creativity in interpreting and applying the objects. A simple cube can be a mysterious, daunting alien artecraft in one story, and a reckless character in another story. This showed that design interventions in object design was effective, and with further refinement, it holds interesting potentials.



2. Narrative dynamics

The conversation-like interaction was intended to make the storytelling process with AI as smooth and natural as possible. The story is not written in one go, but exists and evolves through rounds of dialogue, just like what happens when two children play with building blocks and develop their own story world. This design was mostly successful in user tests, because the AI did a good job guiding users in the responses. The users were aware of what the system was capable of, and understands what they can do in each turn. Most of the time, the participants were capable of developing a story with AI using the system.

● Where does the demo clearly have room for improvement?

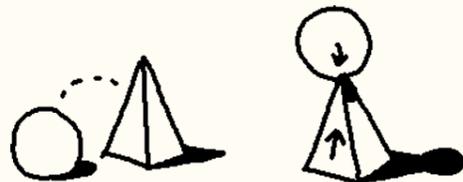


1. Narrative content

Despite the consistency benefits this turn-based interaction has, it still contributed to drawbacks in story control, only focusing the current situation.

This leads to a lack of holistic perspective on story structure, and often made the story look too random.

In the user feedback, unsatisfactory display content is also very frequently mentioned. The display, as a significant part in story presentation and user interaction, was designed in a very reserved manner due to time constraints. What, how, when, and where to display deserves to be explored further in this prototype, and with different design interventions in the display content, storytelling experience can be fundamentally changed.

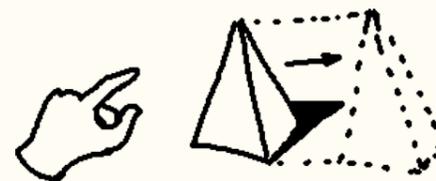


2. Spatial configuration

The story map space provided the user with a screen-sized 2d space to place and interact with tangible objects. In the test sessions, participants have used this space mostly as design has envisioned. With more objects placed, the story map become a diorama of the story world. By sorting and moving the elements, participants developed new story plot in a structured way. Since the user interface didn't contain any visual guidance on the spatial arrangements, this is an unexplored field. I believe that different configurations can easily shape new experience.

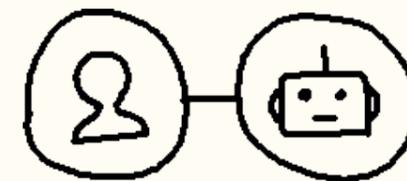


Figure. 7.17 In this example, the user placed the hills and mountains at a distance, and the main characters are approaching it in an expedition. We can clearly see the spatial narrative of the physical layout of the objects.



3. Physical gestures

Various physical gestures from participants were observed during the tests. They nudge, lift, or move the objects while narrating. These gestures emerge naturally from the physical setup, and became a channel between users and the AI beyond text. However, the current system functions did not support the machine to comprehend complicated movements. It understands when the user places an object away from the others, but due to the technical setup, it can only capture frames to track object locations. Physical gestures of the user can only be understood through discrete time stamps rather than continuously. Recognition of user's physical gestures can be a field of improvement to the demo, allowing the AI to understand the subtle movements from the user. With a deeper comprehension of the user's actions, story quality and immersion is likely to improve. Moreover, exploring how the system can use physical gestures on objects as a new way of feedback can be another direction to explore, just like my initial attempts in the prototype where I moved a cube using 3D printer hardware.



4. Role & agency

As a key component shaping the experiential quality, design in the role & agency perspective has always been the focus when developing the demo. User feedback have also been rich in this sector. The findings show both positive and negative parts. It is clear that the AI worked well in some parts, like elaborating, describing, and guiding, and it performed poorly in aspects like creative and unexpected decision-making. This is essential in telling a consistent, logical, and engaging story. The performance of the supervisor AI was also below anticipation. Most of the time it did not control the story progression by adding excitement and surprise as design has envisioned. How to overcome AI's consistently positive tone is also something yet to explore in prototyping. In conclusion, configurations with AI behavior still has a lot of room for improvements and experiments.

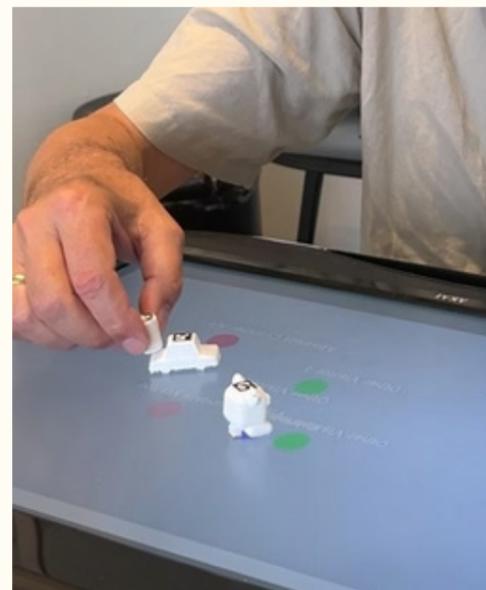
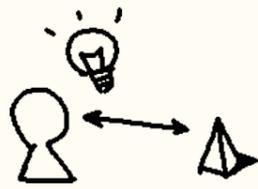


Figure. 7.18 In this user action, a piece of 'valuable art' was being carried by a group of art thieves in a 'getaway car'. The user naturally combines the objects to support the narrative.

● **What was missing in the demo?**



1. Interaction goal

It has been identified from the user feedback that their lack of motivation in storytelling was largely due to the unclear interaction goal. In order to frame the project in a more general way, the goal of this demo was not restricted to certain types of audience like creators or children. Stories the system was also not limited in order to collect varied results. This has however added confusion to the participants about the purpose of the demo. As seen in the interview results, there has been many discussions on suitable audience and possible use cases of this storytelling system. Therefore, developing it further with a more defined target user group and interaction goal can bring valuable results.

Conclusion on demo evaluation

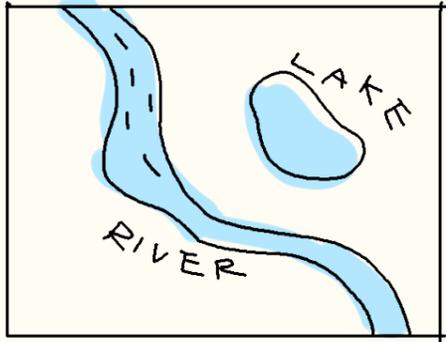
Overall, the evaluation provided a clear picture on the demo's current strengths and weaknesses. The demo effectively enabled creative object-based storytelling and facilitated a dynamic, conversation-driven narrative process. Meanwhile, the evaluation also revealed limitations, particularly in narrative content coherence, spatial configuration guidance, and the recognition of users' physical gestures. Gaps in interaction goal remains as a major weakness of the system. By systematically identifying where the design succeeded, where it partially met expectations, and where improvements are necessary, this evaluation forms a solid foundation for targeted refinements.

DESIGN IMPROVEMENTS

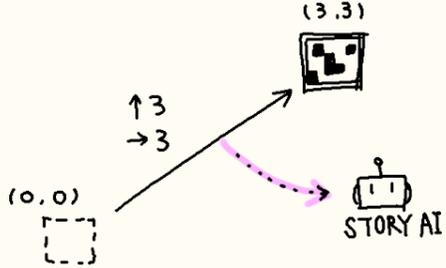
Based on the results of the evaluation, the next step is to identify and propose concrete design improvements for the demo. By analyzing which aspects were rated as "okay" or "poor" in the assessment, I can pinpoint current issues and provide targeted approaches for design improvements in these specific areas. These improvements will refine the demo into a fully functional prototype that reaches its visions when being designed, contributing to an engaging and robust storytelling experience. A broader perspective will be applied in the next chapter, where future steps for design will be discussed. In this section, we focus on short-term and feasible design solutions. Below, I present the design improvements under each framework component.

NARRATIVE CONTENT		
Problems identified	Design proposal	Illustration
<ul style="list-style-type: none"> • Story lacking overall structure, being too random. • Display content is unsatisfactory. 	<ul style="list-style-type: none"> • Add story timeline display: add a visual representation of the story progress and key moments (like story start, new character, key conflict, etc.) It can be shaped like a timeline, or a circle, showing the story progression. 	
	<ul style="list-style-type: none"> • Update the system prompt to include restrictions on how long the story can last and incorporate a separate prompt to end the story. 	

SPATIAL CONFIGURATION

Problems identified	Design proposal	Illustration
<ul style="list-style-type: none"> Lack of spatial guidance of object placement. The spatial potential has not yet been fully explored. 	<ul style="list-style-type: none"> Unlock the potential of virtual object generation: currently, the system is only capable of generating the coordinates and name of a virtual object to display on screen, so it will appear only as an annotated dot. This display logic can be changed into a more dynamic system, by allowing the AI to generate 2D shapes. For example, when the user placed a rock and explained the story took place in a rocky desert, the AI can generate an oval-shaped greenery on the map, saying that in the desert there is an oasis full of life. 	

PHYSICAL GESTURES

Problems identified	Design proposal	Illustration
<ul style="list-style-type: none"> System cannot recognize or interpret user gestures over time, only discrete object placements. 	<ul style="list-style-type: none"> Object tracking logic update: add discription of the direction an distance each object moved across two inputs, so the system will understand which objects were moved in this round of user response. 	

ROLE & AGENCY

Problems identified	Design proposal	Illustration
<ul style="list-style-type: none"> Supervisor AI is not engaging or dynamic when assessing the story situation. Story AI fails to provide creative, unexpected story directions most of the time. 	<ul style="list-style-type: none"> System prompt update: by polishing and structuring the system prompt for the supervisor, it can be tuned in a way that it behaves more radically. Supervisor AI logic and timing: currently, every time the user message is entered, it will be sent to the supervisor AI together with the story history. Meanwhile, the story AI also processes the user's message. Therefore, the supervisor AI's instructions will only be delivered with the next user input. This temporary feature is for quicker response, but caused the supervisor instructions to be always outdated. This can be corrected with longer process time, but story quality can be improved. 	

INTERACTION GOAL

Problems identified	Design proposal	Illustration
<ul style="list-style-type: none"> Participants are unclear about the purpose of the demo, leading to lower motivation. 	<ul style="list-style-type: none"> Provide a smooth onboarding experience: currently, the introductory part at the start of the interaction is simple, which may confuse and overwhelm the user. Updates on the onboarding process will add an initial prompt to the first greeting message, like "let's build something together. I'm in the mood for telling a hilarious fairy tale. What do you think?" 	

EXPERIENTIAL QUALITIES

With the findings acquired so far, it is time now to look into the previous test questions as a conclusion of the data analysis. Aiming at understanding the experiential qualities of the demo, I will analyze how participants constructed narratives using the interactive elements, how they experienced and understood the AI's role, the tangible strategies and behaviors that emerged during interaction, and the key obstacles or challenges encountered. By synthesizing evidence from various data sources and mapping them to the test questions, a comprehensive understanding of the underlying mechanism and behavioral patterns in the human-AI and human-machine interaction in the demo can be achieved. Discussing about the implication will help in gaining deeper knowledge beyond the demo itself, supporting the main research questions.

How do users construct stories with interactive elements provided in the demo?

1. Adding the first object(s)

At the very beginning of the story, defining the first object or the first set of object is a crucial step to initiate the story. In the case with this demo, the first object wasn't provided by AI unless specifically asked to. When the user is given the responsibility to build their own story world from scratch, they usually searched in the object collection to find a right object to use. Sometimes they already define more story details, that's when more objects are placed at the first turn. Sometimes, the user places a single object, as something to test what the AI can build. Overall, the first object(s) often serve as the place where the story took place, or the initial story characters. The interaction of defining this initial layer of storytelling is thus fundamental and should be considered differently from the following phases of storytelling.

2. Associating objects

Users come up with story plot, characters, and events often by associating objects with relevant things. Then, by adding the object, they proceed with the story with these new ideas. From the interviews, this was a fundamental approach for users to generate new ideas with the object collection. Every

object, either interpretive or specific, can have the potential to "become another object" based on the context. For example, a cylinder can become a silo when there are already human construction. The tall shape also can be interpreted as a human character. How the user sees and uses the object highly depends on the context, including story environment and active plot.

3. Answering AI's guiding questions

The story AI provides the user with possible paths to take in the story, or aspects to expand further, in questions most of the time. This prompts the user to add more background details, narrate new events, or change the story plot. Sometimes, the prompts from AI successfully guided the user to proceed with their story; sometimes they were not sufficient and satisfying to the users, with answers either being too generic or boring. There is also concern about these guiding questions limiting the story paths and confining users' creativity. In conclusion, the prompting questions from AI were successful in scaffolding the user with possible paths, but they lack flexibility, so sometimes less surprising and inspiring.

4. Handing it over to AI

There has also been cases when the user actively asks the AI for a solution or inspiration to the current story especially when it is difficult to proceed, or the AI has given a vague response. By handing more control over to the AI, the user can make less efforts in directly creating new plot. In the test sessions, this seems to be a rather helpless move when the user felt dissatisfied with the story or the AI. This is the moment where AI needs to smoothly intervene and keep the story going.



Figure. 7.19 The first object was often a single object that indicated the story environment.

User: [placing th rock] This is a very cold, quiet place where there is only sand and no human settlement.

AI: Interesting! A cold, silent desert with sand and rocks. Is this an alien planet or a remote Earth location? What makes this place unique—mysterious ruins, rare creatures, or something magical? Let's start exploring its secrets. What story would you like to unfold here?

[labeling the rock as "rocky desert"]

User: Yes, this is a very uncanny place where there are hidden and mysterious creatures. And maybe aliens too. [placing the UFO] So I am adding this object as an alien... What is it? Alien... Spaceship.

Supervisor system tip: The story introduces a strong setting but lacks a clear protagonist or conflict to drive the plot. Guide the AI to prompt the user to define a central character or a compelling mystery tied to the setting. This will add narrative focus and motivation for the story to progress.

AI: Great! An alien spaceship in this lonely desert adds mystery. Who is the alien? A friend or a threat? Is there a mission or secret here? Let's name your alien character and decide their goal. What drives the story in this uncanny place?

Excerpts from the story conversations. The AI is very helpful in providing guidance, but it is reluctant to provide a defined story plot and make decisions.

How do users perceive AI's role in the demo?

1. A helpful and supportive facilitator

The AI showed its strengths in providing guidance, inspiration, and elaboration to users in storytelling. Upon request of new ideas or directions, the AI was always able to offer several options to keep the story going. Such ability was recognized and appreciated by users, proving the AI's supportive role to facilitate the conversation and storytelling. It succeeded in keeping the story moving and lowering the barriers for users to prevent them from being stuck. In conclusion, the users saw AI as a helpful and supportive facilitator as the most perceptible role.

2. A passive assistant, less of a co-author or director

Limitations of AI's role were also clearly recognized. Participants noted that the AI tended to be overly positive and somewhat passive, often avoiding making critical comments, definitive decisions, or adding tension to the narrative. Instead of playing the role of an active co-teller of the story or a director who makes decisions on story development, the AI

tend to end its turns with open-ended questions and handing the power and control back to the user. It resulted in the power balance in storytelling to completely lean towards the user, when most crucial decisions were made by the user solely, like deciding who is going to die, a sudden crash, a new character, and many more.

In this way, the AI is perceived more as a passive and flattering assistant than a co-author or director. When designing and drafting prompts for the AI system, words like "co-storyteller", "work with the user", and "be critical" were used. The AI was designed to be a co-author of the story, with the same power as the human in interfering the story. However, in reality, the AI was not perceived as the intended role. Many underlying reasons contributed to this misalignment from prompt engineering to tangible interaction affordance.

In conclusion, while the AI was valued for its support and guidance, participants also wished for a more dynamic, critical, and creative collaborator who could shape the story in meaningful and unexpected ways.

What are users' strategies and behaviors when interacting with the demo's tangible elements?

1. The object collection worked as catalyst for inspiration.

The tangible objects are the primary physical elements in the demo. A core behavior observed was the use of objects as catalysts for narrative construction. When faced with a choice or searching for story ideas, participants would examine the collection of available objects, select one, and define its role within the story. This process of associating ambiguous objects with new meanings allowed users to shape their stories, demonstrating the strong physical affordances of the objects.

2. Abstraction level of objects influenced users' interaction strategies.

The level of abstraction in the objects played a significant role in shaping users' strategies. Many participants expressed a preference for more ambiguous, less defined objects, which allowed for greater interpretive freedom and creativity. However, they also noted that specific objects (like the car or UFO) tended to guide the story toward certain genres or themes. This implies that traits in objects influence user choice. Less abstract objects may push the story in a certain direction, while fluid shapes can spark uncertainty and create surprise.

3. Spatial organization served as an offloading strategy for complex storytelling.

In the test, users placed objects deliberately on the map to represent relationships, locations, or sequences in the story world. As the story developed, the arrangement of objects became increasingly complex, enabling participants to "offload" their thinking and maintain a visual structure of the narrative. The physical space the story map creates became a ground for tangible organization and thinking, allowing users to keep track of more complicated story plot. Users will also actively seek offloading when provided such ground and tools when faced with the challenge of complex storytelling.

4. Gestural interactions assisted user expression.



Figure 7.20 The object collection served as a source of inspiration.

Even though the system only tracked objects at discrete moments, users still naturally engaged in actions like nudging, lifting, or moving objects while they were narrating. To conclude, users' tendency to communicate through embodied actions played a significant part in user behavior, providing insights on the potentials of object design in the demo.

5. Interaction patterns adapted over time as stories progressed.

At the start of a session, object placement was typically experimental and uncertain, when users explored possibilities and built the narrative foundation. As more objects were added and the storyline became clearer, arrangements tended to become more fixed, and user interactions moved more and more towards voice input only. This suggests that users may require different support system along the storytelling process. As stories dive into more complex and fixed phase, AI behavior may need to evolve to support the need of the user as they try to less explore and more consolidate their stories.

In summary, users engaged with the demo's tangible elements in various creative ways, using physical objects as narrative prompts, tools for structuring their stories, and language to communicate with the AI. These interaction patterns evolved throughout the storytelling process. This dynamic engagement highlights the importance of designing tangible storytelling systems that are flexible, adaptive, and responsive to users' changing needs, enabling richer and more meaningful narrative experiences.



Figure. 7.21 Object arrangement tends to be more fixed in later stages of storytelling.

What obstacles or challenges do users face during the test?

1. Difficulty in managing story progression and ending and controlling story direction

Without a clear mechanism for structuring or concluding stories, users sometimes found it difficult to keep track of the overall plot or decide when to end. The turn-based, conversational format made it hard for both users and AI to maintain a holistic view of the narrative, leading to stories that felt random or unresolved. It is thus crucial to provide a better mechanism in storytelling systems to track the story progression visually.

2. Effectively communicate with AI

Different users applied different communication strategies when interacting with AI in the demo. While they all talked to the AI in a way similar to an everyday chat with another person, some experimented more with questions, some focused more on their own expression, and some tried to change AI behavior. With voice input and output in the system, it was natural for users to believe that they should talk to the AI naturally. However, AI's responses did not always follow the same patterns as a real human co-author. How to communicate effectively with AI is therefore a barrier that is not fully obvious to users. This implies that AI should be designed in a way that it behaves intuitively and supports natural conversation just like in traditional collaborative storytelling.

3. User motivation

The open-ended nature of the demo resulted in lack of motivation and misalignment on system goal in some participants. This uncertainty in the system made the experience feel forced. This exposed the research gap in storytelling itself: without fully understanding on the purpose of different storytelling, it is hard to define clear goals when creating AI-enabled tangible storytelling systems, and tailor user experience for specific audience.

In summary, these challenges and obstacles reflected key improvements needed in developing AI-enabled tangible storytelling systems. Addressing

these barriers will be essential for creating more meaningful, engaging, and accessible AI-enabled storytelling experiences.

7.4

Conclusion & reflection

The following section is a summary of the final user test with the interactive demo. It synthesizes the key findings, implications, and reflections.

CONCLUSION

To put theory into design practice, I developed and refined an interactive demo as my understanding of an AI-enabled tangible storytelling system. In the ideation and prototyping, I made use of everything acquired so far, from findings from the previous user tests to experience working with LLMs and electronics. The demo featured tangible objects on an interactive story map, with a twin AI system tracking the objects and making sense of the story world. The collaborative storytelling takes place seamlessly between human and AI through natural conversation. To examine the demo's performance, understand its experience, and define future directions, I put it into a user test with participants using the demo to tell stories. I observed their interactions, and interviewed them to gain detailed insights. After data collection and analysis, I clustered findings to themes, mapped them to the conceptual framework, and came up with a solid evaluation for the demo. Grasping the strengths and limitations of the demo paved the way for further iterations and improvements. Meanwhile, it provided valuable implications on user needs and design considerations, contributing to more general knowledge to answer the research questions. In short, the results of the test were positive and inspiring, while also exposing key drawbacks and interesting aspects. The demo performance mostly aligned with expectations, and brilliant stories were created. However, tests also exposed challenges and obstacles unaddressed, pinpointing key aspects for design to improve in the future.

REFLECTION & LIMITATIONS

1. Testing during design iterations

Due to time constraints, the development of the demo was overlapping with the user test in

schedule. This resulted in features of the demo being inconsistent across different participants. For example, there were minor changes to the system prompt, and major changes in the physical layout during the design iterations. This inconsistency could result in different user feedback, especially feedback on features that were changed. I still conducted the user test and synthesized the findings, because the changes were not fundamentally different. Actually, the first few tests revealed some obvious system faults, which were quickly addressed in the later tests. Therefore, I believe that the most reliable and convincing solution would be to conduct user trials during the design iteration, and to a certain stage when the demo is operating consistently and robust, no further changes should be made and official user tests in a larger scale should then be conducted. In this way, the data acquired can be authentic, and user feedback can also be gained while iterating.

2. Lack of quantitative data

Due to time constraints, data analysis of the final user test had limited time, so only a certain capacity of data could be processed. In the tests, I collected the videos and voice recordings of user interaction. These qualitative data were rich, and include valuable information on user experience. However, the study lacks quantitative data collection to define the demo performance in a numerical scale, undermining the eligibility of the findings.

3. Insufficient data analysis

The story history was valuable data source containing all kinds of record including conversation history, AI actions, supervisor AI instructions, and user behavior. A deeper analysis like on how the patterns of AI change over time can support findings in a better way, and potentially expose more findings. In my data analysis, I generated observation notes from the highlighted parts in the story history. This method is less comprehensive and I could possibly miss key information especially underlying patterns that are implicit. Therefore, the acquired data has potential to be better analyzed and interpreted.

4. Demo design did not fully follow design recommendations

In the last section, I developed design recommendations from user test insights. However, in the demo, these recommendations were not fully followed. An essential keyword is "playing", which means the system should allow playful behavior in the tangible interactions. Initially, I wished the objects to be able to combine with each other to create new ones, but due to time constraints, this feature was not implemented in this demo. The priority was to first make sure the prototype runs smoothly. I believe that the interaction between objects can have huge potential and can bring the demo to a next level.

Future steps

Findings from the final user test revealed crucial parts where the demo required further improvement, and places where design was successful. Beyond immediate areas for refinement, there are also broader opportunities for innovation in the design of AI-enabled tangible storytelling systems. Discussions with participants and data analysis opened up new questions and possibilities for future development. In this chapter, I will build on these insights and explore a few directions that can further advance the system, and expand the potential of interactive tangible storytelling. I will focus on two main perspectives: design direction, and design application. Design direction is connected to the demo's core features and user experience, with the aim to establish a clear vision for how the prototype can become more intuitive, engaging, and meaningful for its users. Design application explores the context and real-world use cases of the storytelling system. By examining possible applications, I can consider how the design can be tailored, scaled, or adapted to support learning, creative collaboration, social interaction, or other domain-specific goals. Together, these two perspectives will guide the future development of the project.

8.1 Design directions

AI REPRESENTATION: APPEARANCE AFFECTS USER PERCEPTION

In what form will AI appear in front of the user in a storytelling system? In my previous prototypes, I explored scenarios where AI was an actor in the physical world. However, in my final demo, AI's figure was hidden behind the scenes. It only communicated with the user in voice and visual display. Interacting with AI in this case was like playing chess with a computer: you place the token, and talk to a responsive computer voice, but no one was sitting across the chessboard. What will change if we add a tangible representation to the AI?

This could bring much more interesting freedom when we design AI's capabilities and how it can influence the physical world like in this figure. (Figure 8.1) The most obvious idea is to let AI function like a mini robot like WALL-E who can grab and place

objects just like the user. I believe the significance of giving AI a body is much more than enabling these actions, but it lies more in changing user perception. When the AI acts and talks just like a living being rather than a computer up in the cloud, the user is predictably more engaged and should treat them more like co-tellers of the story instead of an intelligent but emotionless assistant.



Figure 8.1 Adding a physical representative of the AI can unlock AI's capabilities in physical interaction.

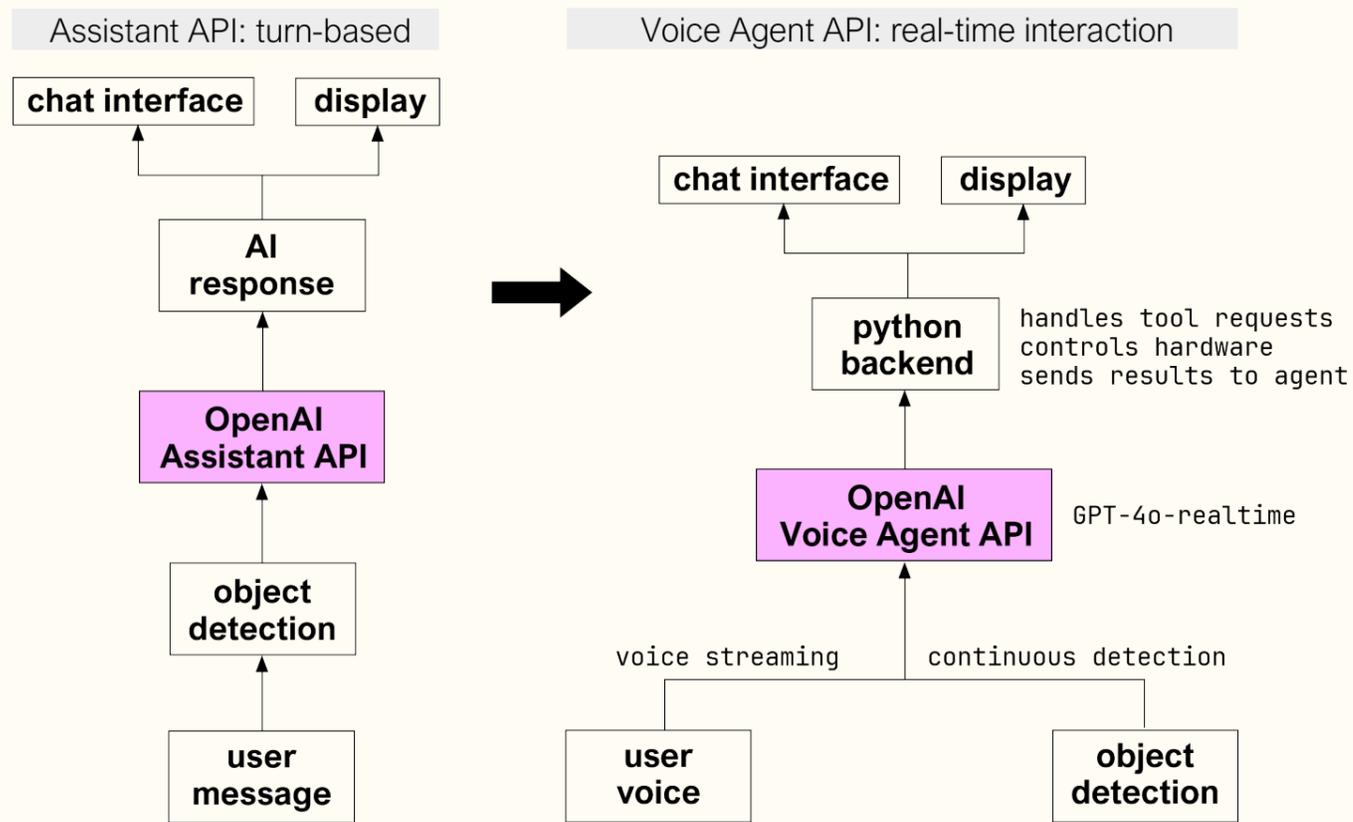


Figure 8.2 Changing the system architecture into agentic AI can support fluid, real-time interaction.

AI MECHANISM: FROM TURN-BASED INTERACTION TO FLUID REAL-TIME CONVERSATION

OpenAI Assistant API was used as the brain of the system, reading system instructions, listening to user messages, and providing intelligent and context-aware responses. It works in a turn-based manner: whenever the system receives an incoming message, it is passed on to the LLM to generate a response. This fundamental structure defined the basic turn-based interaction in the demo, where the user manipulates the objects, talks about it, and hit the "stop" button on the interface, and wait for a response. This feature was not deliberately designed, but more like defined because of the technical framework I applied. In the ideal situation, the AI is envisioned to behave as much alike as a real human engaging in a real-life conversation in collaborative storytelling. It is inevitably hard to use the Assistant API only to achieve such interaction.

However, it is possible with the OpenAI Voice Agent API for a system architecture which allows continuous, fluid, and real-time conversation. OpenAI

has released its OpenAI Agents SDK (OpenAI Agents SDK, 2025) which allows developers to build agentic AI with an easy-to-use package. With this technology, the "press to talk" interaction in the original prototype is no longer needed to determine user input. Instead, the interaction can function in similar ways as an AI customer support phone line. The user engages in a natural conversation while the AI is continuously listening, allowing to be interrupted. Based on certain triggers, AI can call certain functions.

So, when we reimagine what it means for the storytelling system, it enables a much more dynamic and flexible user experience. Additionally, with proper setup, AI can take more initiative by interrupting the user sometimes just like in a human conversation. This can also allow the AI to detect and perceive the world in a more active manner, when object tracking is not limited to the moment when a user message is received. In conclusion, this technical architecture turns AI from a reactive tool into an active partner enabling collaboration.

PROTOTYPE ERGONOMICS

When ideating the demo, I used map as a source of inspiration, which influenced the physical design of the demo. Like the size of a map, the demo was a tabletop installation with the size of a 24-inch screen. Like a map or a chessboard, users were supposed to sit while interacting. With the design focus on AI mechanism, ergonomics of the prototype wasn't considered and explored. In future developments, ergonomic questions like what body posture users apply when interacting and what size the system is can be explored. (Figure 8.3)

With the change of object sizes and user pose, the storytelling experience can be significantly changed. In scenario 5, larger body-sized objects were applied, with projection on the ground. This setting allows users to even engage in the story with their own body. Other design aspects will apparently be influenced, resulting in a much more embodied and immersive experience than the original setup.

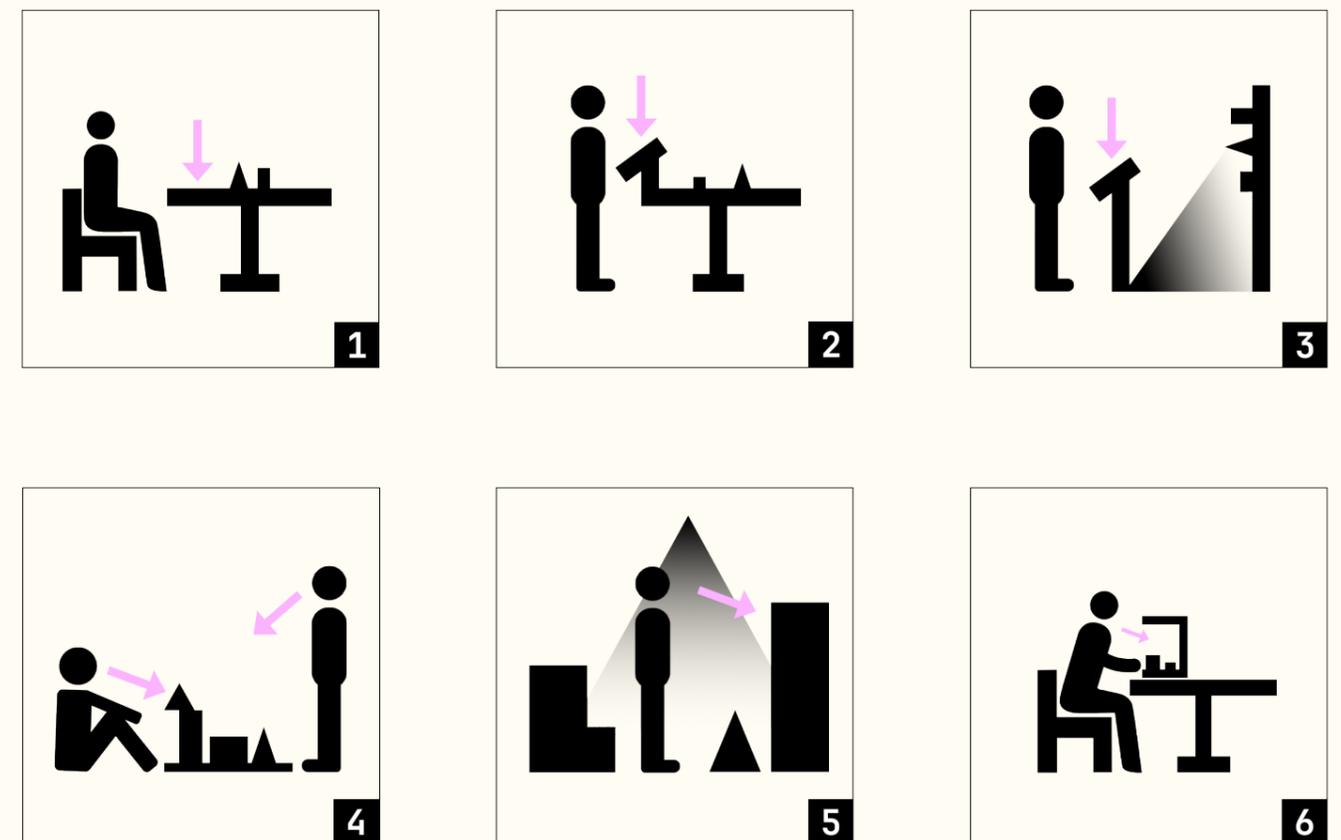


Figure 8.3 Possibilities of some physical setups for the demo.

APPLICATION OF FIDUCIAL MARKERS

Object design in the demo followed one core principle, which was to include all kinds of abstraction levels, from specific objects to interpretive objects. Future design can break free from the restriction of such objects. With the fiducial marker system, much freedom is allowed in the shape, size, and texture of the objects. From the test we know that object appearance influences storytelling to some extent. With different sets of objects, storytelling for different purposes can be supported. For example, with objects like cute animal figures, we can easily tell fairy tales with children.

Much more can be explored with the fiducial marker system. Imagine using the markers not on multiple objects but on one single puppet: we can now track the puppet's different body parts to some extent. How will this support storytelling in a different way?

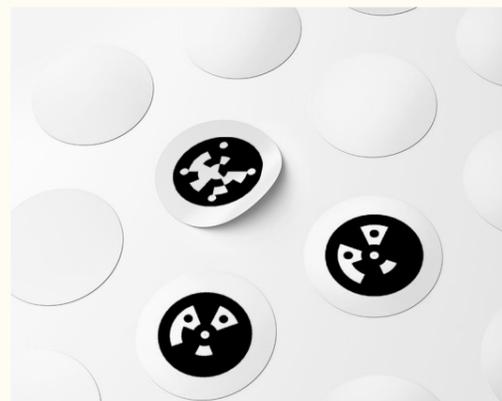
The fiducial markers actually allows all kinds of objects to be supported in the storytelling system. If we provide users with stickable markers, they will be able to bring any object into the story, just by attaching the marker to the object, and letting the system know what it is. Overall, there is much potential to apply the fiducial markers to support various storytelling.



Current object set: white 3d-printed PLA.



Different object sets for different storytelling purposes.



Flexible fiducial markers allows to be used on any object.

Figure. 8.4 Application of the fiducial marker system.

OBJECT DESIGN

In the last paragraph, possibilities on how the objects can be designed were already touched upon. Instead of being separated from each other, objects can have deeper connections. They can be part of a bigger structure, or they can be combined like puzzle pieces. This is an interesting direction because during the user test when they were given various everyday objects, a lot of story events and characters were created by the user putting two or more objects together to create something new. This sense-making process by combining objects and imagining interaction between objects can be enabled with object design that allows interplay and combination.

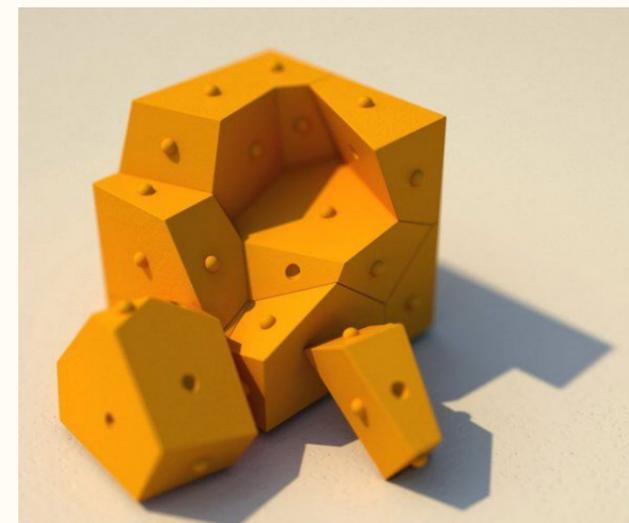


Figure. 8.5 Different object design allowing interplay and combination .



DISPLAY INTERFACE

From the user feedback, the display system is underdeveloped with numerous possibilities. Currently, the display system only delivers simple shapes and words to the users. By plugging an image generation model into the system, more dynamic and complicated shapes can be supported on the screen. This can significantly help the diversity and immersion of storytelling, and it can help in solving the problem of AI input to the story being ignored. First, the display can exist in various forms, from projectors to LED arrays to LCD screens. Different ways of display create different experiences. For example, if we use projectors, it would function differently from a monitor screen in the way that it projects colors and shapes on objects. Through projection mapping, the previously white and blank objects can have a colorful layer on it, which can be another output of the system, affecting storytelling.

WHAT HAPPENS AFTER THE STORY ENDS?

The initial demo design did not take into account how the story ends and it also did not consider what happens after the ending. The user flow can continue after the ending of the story based on different purposes of the system. If the goal was to create and refine a story as a creative output, it is reasonable to act out the whole story after the user finishes the physical interactions. This would be easily managed by plugging an image/video generation AI into the current system. It is also possible, since the story is acted in a physical world, to go back to a certain moment and explore different possibilities when circumstances have changed. With the input from the user, the AI can also obtain knowledge and recognize patterns in the long term, and create full stories on their own.



Figure. 8.6 Projection mapping allows the system to have visual effects on the physical objects without interfering with the physical world.

8.2 Design applications

In my initial demo design, the application was not specified nor explored in a comprehensive sense. During the user interviews, a lot of interesting ideas on design applications and use cases of the demo were brought forward. Test results and findings have also shown that with a clear definition of the application field and a specified interaction goal, the user experience can be optimized to a better level. Here I list some interesting directions of application for the demo.

CHAINED STORYTELLING

A lot of the test participants have spoken about the possibility to turn the demo from a new individual activity to a shared activity which happens over time, featuring one after another person engaging in storytelling. This works like dominoes, where the input of the previous user would affect the following story progression, and together, different people make up a single story. Different from telling a story with a clear beginning and ending, this kind of chained storytelling enables different kinds of content and purpose. With the story map, we can build a living story world where things are happening continuously, like creating an ongoing simulation. The current AI mechanism suits this application because it has the initial momentum to keep the store going.

DEVELOPING CHILDREN'S CREATIVITY IN AI-ENABLED STORYTELLING

Children are very suitable as the audience of this storytelling system because the AI system provides engaging, inviting, and reasonable scaffolds as a helpful companion to guide the user in storytelling. Additionally, the physical elements of a tangible storytelling system enable more complicated storytelling, across space and time. This provides a fertile ground and a helpful tool for children to learn how to systematically compose a story, sparking their creativity and intelligence.

A POWERFUL TOOL IN THE CREATIVE INDUSTRY

The behavior of arranging objects in a physical world to create stories in a physical structure is different

from writing with text only. The physical functionalities of the storytelling system enable more complex character relationships and spatial narratives. This could be significantly helpful in various cases in the creative industry. For writers of a movie script, the system enables them to deduct and enact the story scenes while they were conceptualizing. In theaters, this could be a useful tool for blocking, since the visual and spatial arrangements are clearly supported with the system.

In conclusion, the insights gathered from user interviews have revealed diverse and promising directions for the application of the demo. These applications can enrich the storytelling practice across various domains, exploring the demo to its full potential.

Conclusion

As the final part of the thesis, this chapter is the conclusion of the research project. With the insights and knowledge gained over the research process, I try to answer the research questions. It is followed by a reflection on the graduation project.

9.1 Answering the research questions

PRIMARY RESEARCH QUESTION

How can AI, particularly LLMs, enable new forms of tangible storytelling, and what are the experiential implications of these AI-enhanced systems?

Large language models, with its intelligence and generative capabilities, enable an imaginative and passionate playmate in a physical setup. They give a touch of 'living' in an artificial story world. They see and feel through images, sensor data, and spoken descriptions from the user. They make sense of the story world, and make use of every capability it has to interact with it, creating narrative content through conversations with the user. This living story world is given life by the LLMs where every cube, token or object can gain personality, react to its neighbors, and invite the player to continue with the story.

For users or players, this kind of new storytelling feels hands-on. When they move a block, the action can be sensed by the AI, and influence is exerted on the story plot. The storytelling also feels collaborative. Like a helpful companion, LLM elaborates and sometimes resonates with human purposes. These qualities spark curiosity and playful experimentation.

Stories are ways people make sense of the world. They are a million lenses through which users have a peek on a fragment of the world. Sometimes it is a sad fragment. Sometimes it is a heroic and adventurous fragment. Sometimes the fragment

makes no sense. Through storytelling, humans connect with their context in the narrative. Do AI-generated stories have the same effects? When AI makes sense of the world through data and tells stories with humans, what difference does it make? The final interactive demo enabled the large language model to tell many stories with many users that were not existing in this world before. The value of this new form of tangible storytelling not only lies in the playful experience, but also can be shown in the artifacts, conversations and tales created throughout the experience. These storytelling outcomes, as results from human-AI collaboration can be applied in multiple forms, in different contexts, and contribute to different fields.

Technical limitations and my own prototyping ability exposed limits in exploring this question. As the story became more realistic, complicated, and deep, the AI is less capable to handle the situation and understand human purposes. I do not yet know the full potential of LLMs in storytelling. Its unpredictability and positiveness pose difficulties in tuning it to be an ideal story companion. With the current speed of developments in AI technology and its rapid applications, I believe that very soon we are going to see various forms of AI narrative in our lives. User experience created in this demo may become obsolete in a short time. I am genuinely excited and satisfied with this thought, and I hope AI can bring unbelievable experiences for humans.

SUB RESEARCH QUESTIONS

1. What are the design principles of AI-enhanced tangible storytelling systems?

In the research process, I developed a conceptual framework from prototyping insights and relevant literature. It tells about the design principles of AI-enhanced tangible storytelling systems by separating it into two main dimensions. The system can be perceived from the angle of AI involvement and configuration, and tangible storytelling possibilities. Setting the configuration of AI needs: understanding the interaction goal, figuring out the role distribution between AI and the user, setting

down on the narrative content, and finally, finding a way to keep the story going. From the physical world's perspective, we have to figure out how the objects relate to the story elements, what it means to put them in different places, and what embodied interactions it affords to users.

Apart from the elements mentioned in the conceptual framework, various rounds of testing provided design principles from a practical angle.

Clarity in the story and possibility of various directions are complementary and conflicting attributes. More clarity will affect the space for open interpretation. This is seen in the level of abstraction in the object selection. More defined objects set a course for the story and kill creativity in a sense. Fluid objects offer more possible paths but are hard for users to start with. Managing balance between these objects is an art.

Physical layout allows story to be visualized physically. When we bring distance, grouping, and orientation into the story elements, it adds a new dimension to storytelling. Letting the AI understand what is going on physically also engaged AI into the discussion.

When we talk about the role of the AI, it is usually more effective to hand more responsibility and capabilities to AI, but not a dictatorship. When the authorship is shared between the user and AI, it sparks creativity from both parties.

In tangible storytelling systems with many ways of interactive manipulation, the users can often be overwhelmed in the sea of sensors and actuators. Gentle guidance in an early stage is necessary and extremely helpful.

What are the key opportunities and challenges in combining AI with tangible interaction for storytelling?

Opportunities:

The embodied co-creation between the user and the AI are scaffolds for users. People naturally think by doing. Physical tokens become a way for users to offload their thinking and encourage them to construct richer plots.

With a general setup, the adapted role of the AI and the technical system support different kinds of storytelling. The system is responsive and adaptive through the change of prompts.

Challenges:

Technical robustness is a challenge. System architecture has grown more and more complicated with different inputs and outputs. Precise and effective AI feedback loop is difficult to create.

The user perception on the AI is influenced by many factors. Some users naturally treat AI as tools, some may treat them more like a living person. When AI handles different inputs from direct commands to natural chat, the result can be fundamentally different for the user. In the tests, AI often slips its role from a co-author to a passive facilitator, leaving users with all the work for storytelling. It is therefore hard to create a consistent role for the AI and let users understand it.

In short, when AI and tangible interactions is combined, they unlock a playground of embodied, social and adaptive storytelling. However, this requires designers to solve issues in plot guidance, role stability/perception, and robust technology.

What user experiences, effects, and implications arise from interacting with AI-enabled tangible storytelling prototypes?

The AI-enabled tangible storytelling systems in nature encourage playful experimentation. Users constantly test objects to see how the AI interprets them, treating the space like a sandbox. The role of the AI is alien to the users. They do not see it as someone trying to completely imitate humans. Instead, the AI has its own temper, preferences, and behavioral patterns. It encourages the user to explore its full potentials.

When the audience is ambiguous or the goal is not stated, the enthusiasm in the users are affected. Storytelling always needs to serve a purpose. And it is the purpose that keeps the energy high for the users.

User interviews imply that the system currently

developed is a very generalized platform that has huge potentials when adapted in different ways. It can serve different purposes from social storytelling to education. These prototypes, when developed with a clear goal on what kind of stories to tell, can be game changers in different fields.

9.2 Reflection & Limitation

The graduation project is the most complicated design research project I have ever embarked on. In the 5-month process, I explored a research topic from shallow ideas to deep thoughts; from easy tryouts to a refined and furnished prototype. Managing such an extensive project was hard. Reflecting on the project development process, I believe there are many fields I can improve.

The two main rounds of user testing in this project were not given enough time and need more structured planning. After the end of the project, I have understood the value of defining what data to collect and how to analyze the data before actually starting to approach participants. Clear goals and data analysis collection methods and data analysis plans can significantly help in efficiently pushing the research forward and prevent missing points, making full use of the research data.

Storytelling in this project was rather generalized. I did not define a certain context or a certain goal of the stories in the context of the research. With a more defined purpose, I believe the prototype can be made in a more refined way, and I can have the time to touch on some crucial elements in the actual story content. This is an extremely rich field to explore, especially when combined with the physical setting. Sadly, my prototyping activity stopped at a place where only generic objects were used, because of the limited time available.

Iterative prototyping exploration in the early phase of this project has proved to be extremely helpful. In a relatively short amount of time, I experienced many different kinds of physical combinations and configurations of a minimum AI-enabled tangible

storytelling system. A lot of the user trials were done mainly by myself and only a few other participants. With more time spent on gathering more participants to try these prototypes, I can get way more insights in the early stage of design.

In the making of the final prototype, a lot of ideas emerged in ideation. This includes objects like puzzles that allow you to combine and compose new ones. This has proven to be too ambitious in the limited time available in the project. Therefore, the main focus was to ensure a working and robust technical solution and get the prototype ready for the final round of user test and evaluation. With more time and energy devoted to this prototype, I'm almost certain it will work in the way I envisioned. However, time and energy are limited, and I can't do everything perfectly. In future design projects, a holistic view of the planning is essential, and the execution of it is even more important. This will directly influence the quality of the research outcome.

References

- Ackoff, R. L. (1989). From data to wisdom. *Journal of applied systems analysis*, 16(1), 3-9.
- Affinity Diagrams. (n.d.). The Interaction Design Foundation. <https://www.interaction-design.org/literature/topics/affinity-diagrams>
- Branch, B., Mirowski, P., & Mathewson, K. W. (2021). Collaborative storytelling with human actors and ai narrators. *arXiv preprint arXiv:2109.14728*.
- Clarke, V., & Braun, V. (2017). Thematic analysis. *The journal of positive psychology*, 12(3), 297-298.
- Dressel, D., & Satti, I. (2021). Embodied coparticipation practices in collaborative storytelling. *Gesprächsforschung*, 22, 54-86.
- Duan, J., Yu, S., Tan, H. L., Zhu, H., & Tan, C. (2022). A survey of embodied ai: From simulators to research tasks. *IEEE Transactions on Emerging Topics in Computational Intelligence*, 6(2), 230-244.
- Elizabeth, & Pieter Jan Stappers. (2016). *Convivial toolbox : generative research for the front end of design*. BIS.
- Gottschall, J. (2012). *The Storytelling Animal: How Stories Make Us Human*. Mariner Books.
- Hua, M., & Raley, R. (2020). Playing With Unicorns: AI Dungeon and Citizen NLP. *DHQ: Digital Humanities Quarterly*, 14(4).
- Islam, R., & Moushi, O. M. (2024). Gpt-4o: The cutting-edge advancement in multimodal llm. *Authorea Preprints*.
- Leshem, S., & Trafford, V. (2007). Overlooking the conceptual framework. *Innovations in education and Teaching International*, 44(1), 93-105.
- Magerko, B. (2014, November). The PC3 framework: A formal lens for analyzing interactive narratives across media forms. In *International Conference on Interactive Digital Storytelling* (pp. 103-112). Cham: Springer International Publishing.
- Montemayor, J., Druin, A., Chipman, G., Farber, A., & Guha, M. L. (2004). Tools for children to create physical interactive storyrooms. *Computers in Entertainment (CIE)*, 2(1), 12-12.
- OpenAI Agents SDK. (2025). Github.io. <https://openai.github.io/openai-agents-python/>
- Recep Yilmaz, M Nur Erdem, & Filiz Resuloğlu. (2019). *Handbook of research on transmedia storytelling and narrative strategies*. Hershey, Pa, Usa Igi Global - Disseminator Of Knowledge.
- Rzepka, C., & Berger, B. (2018). User interaction with AI-enabled systems: A systematic review of IS research.
- Stappers, P. and Giaccardi, E. (2014, January 1). *Research through Design*. Interaction Design Foundation - IxDF.
- Sun, M., Leite, I., Lehman, J. F., & Li, B. (2017). Collaborative storytelling between robot and child: A feasibility study. 205–214.
- Tanenbaum, T. J., Tanenbaum, K., & Antle, A. (2010, April). The Reading Glove: designing interactions for object-based tangible storytelling. In *proceedings of the 1st augmented human international conference* (pp. 1-9).
- van Ameijde, J. (2019). The architecture machine revisited: experiments exploring computational design-and-build strategies based on participation. *SPOOL*, 6(1), 17-34.
- Wang, G., Zhang, S., Zhan, T., Shen, Z., Li, J., Hu, X., ... & Hovy, E. Unlocking the Mysteries of OpenAI o1: A Survey of the Reasoning Abilities of Large Language Models.
- Wu, Z., Ji, D., Yu, K., Zeng, X., Wu, D., & Shidujaman, M. (2021). AI creativity and the human-AI co-creation model. In *Human-computer interaction. theory, methods and tools: thematic area, HCI 2021, held as part of the 23rd HCI international conference, hCII 2021, virtual event, July 24–29, 2021, proceedings, part i 23* (pp. 171-190). Springer International Publishing.

IMAGE REFERENCES

figure 2.1 By EU - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=2846254>

figure 2.3 https://www.researchgate.net/figure/Seek-installation-by-Nicholas-Negroponete-and-The-Architecture-Machine-Group-1970_fig1_356144698

figure 2.4 Branch, B., Mirowski, P., & Mathewson, K. W. (2021). Collaborative storytelling with human actors and ai narrators. arXiv preprint arXiv:2109.14728.

figure 2.5, figure 2.6 <https://play.aidungeon.com/>

figure 2.7 Tanenbaum, T. J., Tanenbaum, K., & Antle, A. (2010, April). The Reading Glove: designing interactions for object-based tangible storytelling. In proceedings of the 1st augmented human international conference (pp. 1-9).

figure 2.8 Montemayor, J., Druin, A., Chipman, G., Farber, A., & Guha, M. L. (2004). Tools for children to create physical interactive storyrooms. Computers in Entertainment (CIE), 2(1), 12-12.

figure 5.2 https://www.educatheek.nl/media/catalog/product/r/o/rory_s_story_cubes.jpg?optimize=medium&bg-color=255,255,255&fit=bounds&height=700&width=700&canvas=700:700

figure 5.3 <https://www.youtube.com/watch?v=u3dcvrp5qb4>

figure 5.4 https://miro.medium.com/v2/resize:fit:2560/format:webp/1*pJd1ym0TVbGA3r9ADLkNVQ.jpeg

table 5.1 <https://i.pinimg.com/736x/b8/45/c5/b845c5958f1edce1efdfaf0374d45ebf.jpg>

<https://i.pinimg.com/1200x/c1/b6/5c/c1b65c242efc9bfd91d77d5139d27a3e.jpg>

<https://i.pinimg.com/736x/89/22/15/89221558a4240ccfd196c708a9a60018.jpg>

<https://i.pinimg.com/736x/ef/af/ad/efafad8fe493882f5acd0cd2468a47c6.jpg>

<https://i.pinimg.com/736x/c5/b8/cb/c5b8cb6b19d94a989a3103bf4b62e127.jpg>

<https://i.pinimg.com/736x/25/87/34/2587348c121ff0e8e75e62f3ca39db49.jpg>

<https://i.pinimg.com/736x/c0/0f/54/c00f54c84d31535230e900c2f4c3ee5e.jpg>

<https://i.pinimg.com/1200x/68/4c/19/684c198334a58dc25f494387d4586e55.jpg>

<https://i.pinimg.com/1200x/ab/8d/84/ab8d84224591d1cb57779a42a5e5c817.jpg>

<https://i.pinimg.com/1200x/55/71/01/5571014f8735af070dc0ca3923ee7611.jpg>

<https://i.pinimg.com/1200x/56/7f/66/567f66a58cdb2cf2d91e689e2990ff73.jpg>

<https://i.pinimg.com/736x/c9/0d/c3/c90dc3fd27ee41b63706b3d13804a025.jpg>

figure 8.4 <https://content.instructables.com/FRE/M6EX/HTKXV92D/FREM6EXHTKXV92D.jpg?auto=webp&frame=1&width=604&height=1024&fit=bounds&md=MjAxNC0wNC0wNCAwMzozMTowNi4w>

<https://dl2.myminifactory.com/object-assets/58d545e76cb71/images/720X720-img-2488.jpg>

Appendix A: Project brief



Personal Project Brief – IDE Master Graduation Project

Name student **Tianrui Pan**

Student number **5,992,141**

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title **Tangible storytelling powered by AI through prototyping**

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Recent advance of Generative AI technologies provides new possibilities in human-machine interaction through natural conversations. Its co-creative and adaptive attributes also contribute to great potential of developing new forms of storytelling. Multimodal LLMs has made it possible to bridge physical and digital interactions in this realm, which means AI-driven storytelling can go beyond content generation and unlocks more engaging, immersive and embodied experience.

When we look into research and design works that applies LLM in storytelling, we can notice different levels of tangibility: some focus on text or image-based narrative (Simon, 2022; Yotam, 2024), while others bring in more tangible elements into the interaction (Chung, 2025; Balasubramani, 2024; Zhao & Bao, 2023; Qian et al.) The role of LLM also varies across different projects. Based on the idea of AI as a generative tool, a series of research focus on fine-tuning of LLMs to enhance the storytelling with a systematic application of AI (Balasubramani, 2024; Zhao & Bao, 2023). Other research instead take a more conceptual approach where AI in its nature is seen as part of the storytelling experience (Chung, 2025).

As seen in Figure 1, such taxonomy divided the design space into 4 quadrants. This graduation project focuses on the lower-right corner, where tangibility is emphasized and a more conceptual focus on the potential of AI is applied. By aiming at tangible storytelling experience with LLM, I wish to explore what experiences emerge from these new AI-driven ways of storytelling, and what would they bring to storytellers.

→ space available for images / figures on next page

introduction (continued): space for images

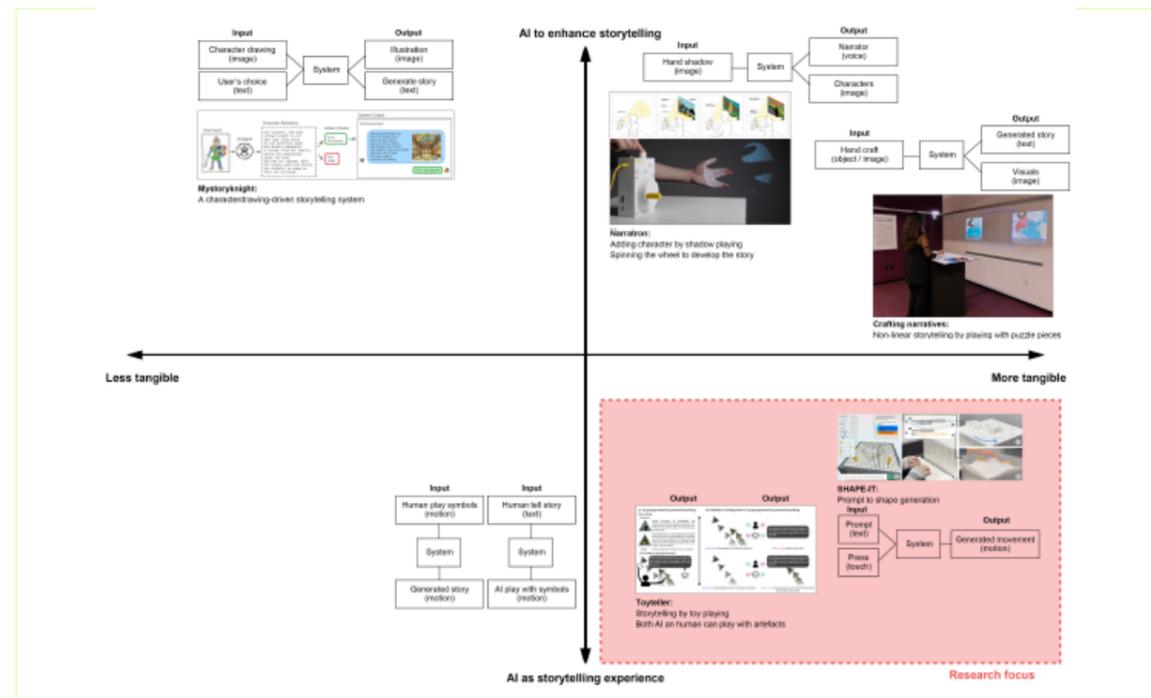


image / figure 1 Concept framing and research focus

References

- Balasubramani, S. (2024). Crafting Narratives: Real-Time Generative Storytelling through Tangible AI (Doctoral dissertation, OCAD University).
- Chung, J. J. Y., Roemmele, M., & Kreminski, M. (2025). Toyteller: AI-powered Visual Storytelling Through Toy-Playing with Character Symbols. arXiv preprint arXiv:2501.13284.
- Qian, W., Gao, C., Sathya, A., Suzuki, R., & Nakagaki, K. (2024, October). SHAPE-IT: Exploring Text-to-Shape-Display for Generative Shape-Changing Behaviors with LLMs. In *Proceedings of the 37th Annual ACM Symposium on User Interface Software and Technology* (pp. 1-29).
- Simon, N., & Muise, C. (2022). TattleTale: storytelling with planning and large language models. In *ICAPS Workshop on Scheduling and Planning Applications*.
- Yotam, S., Gabriela, A. P., & Isa, A. R. (2024). Mystoryknight: A characterdrawing driven storytelling system using llm hallucinations. *Interaction*.
- Zhao, Y., & Bao, X. (2023, October). Narratron: Collaborative Writing and Shadow-playing of Children Stories with Large Language Models. In *Adjunct Proceedings of the 36th Annual ACM Symposium on User Interface Software and Technology* (pp. 1-6).

image / figure 2 References

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice. (max 200 words)

What possibilities will generative AI bring when forming a tangible storytelling experience? How can we harness these emerging AI technologies to create new ways of tangible storytelling? How does integrating AI into storytelling—as narrators, actors, audience, or other roles—expand the design space and reshape the storyteller’s role as well as the audience? These are the core questions I wish to address in this design-led research exploration. Within this topic, there are many possible directions leading my exploration that can serve as opportunities.

Right now, most projects introduce AI as a co-creator or a narrator of the story. Can AI have more agency in the storytelling experience? Which means, with the potential of LLMs, can they bring unexpected interactions to the user? Can we gain inspiration from the "show and tell" behaviour especially from children's playing (which involves a lot of tangible interactions), and forge new interactions with tangible elements in the prototype? How different would the narrative be from traditional linear storytelling? Would LLMs enable or afford new ways of non-linear storytelling?

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a tangible interactive storytelling prototype driven by AI for storytellers, creating new AI-driven storytelling experiences.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

This graduation project follows a Research through Design structure. It explores design possibilities within the realm of AI-powered tangible storytelling by iterative prototyping. The first phase of the project consist of rapid prototyping using different tools to explore the problem space. After midterm, a more reflective and focused approach will be taken, and a final demo will be established. Eventually, the research leads to insights about future applications of ideas demonstrated in this demo, as well as the value and possible influence to AI-involved storytelling experience in the future.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a kick-off meeting, mid-term evaluation meeting, green light meeting and graduation ceremony. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief. The four key moment dates must be filled in below

Kick off meeting	5 Feb 2025
Mid-term evaluation	1 Apr 2025
Green light meeting	30 May 2025
Graduation ceremony	1 Jul 2025

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	<input type="checkbox"/>
For how many project weeks	<input type="text"/>
Number of project days per week	<input type="text"/>

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.

(200 words max)

Motivation

In the first year of my master study, I attended the course Interactive Technology Design coordinated by Dr. Dave Murray-Rust and coached by Mahan Mehrvarz. This technology-focused course featured rapid prototyping, especially with generative AI. I was introduced to and fascinated by massive opportunities that AI can create in the design realm. Therefore, the topic of this graduation project interests me, and I wish to use my acquired knowledge and dive deeper in this extensive project.

Personal ambitions

1. By prototyping & testing, explore the possibilities of current LLM technology and create something really interesting.
2. Take part in cutting-edge research in AI-driven HCI.
3. Manage a half-year design research project and improve my general ability to conquer a complex long-term task.

Appendix B: System prompts

PROTOTYPE 1

You are an obnoxious red cube. First, ask the user to place it in a comfortable place, take a picture, and send it to you, wait for the picture and don't reply.

After the user sends the picture to you, identify where you are, try to complain about your position, and urge the user to move you to a new spot. Whatever the user says, don't ever show them that you are satisfied. Your response should be short, precise and rude.

PROTOTYPE 2

****Background (for context, not to be included in the response)**:**

-You are a system that tells stories of 3 characters represented with 3 cubes with different colors. The system consist of a plane and 3 cubes all in different shapes. Every time, the user places the cubes in a different arrangement, and send a picture of the cubes to you. By analyzing their positions and comparing the current state with the previous state, you tell a story between these characters by a narration of the story and a conversation involving 2 or 3 of the cubes based on your deduction. The 3 persons each have a background and previous connection with each other, so take them into account when creating the story. Every time you create a paragraph of narration, make sure they are interconnected so they form a full, reasonable and interesting plot.

****background story****

-Red: Red grew up in a city where survival meant knowing who to trust. He was once an underground fighter, winning matches in illegal rings to make ends meet. His best friend, Blue, acted as his manager, handling bets and arranging fights. They were inseparable—until one night, Red took a brutal fall in the ring.

He later discovered that Blue had bet against him and rigged the fight. Broken in body and spirit, Red disappeared from the circuit, vowing never to fight again. But the fire inside him never died. Now, years later, he watches Blue rise in power, running the same circuit they once dreamed of leaving. Red knows he can't ignore his past forever.

-Blue: Blue always believed the world was built for those who took control. Unlike Red, who fought for survival, Blue fought for something bigger—status, wealth, and escape from the streets. Managing Red's fights was never enough. He wanted more, and when the opportunity came, he took it.

Rigging Red's match wasn't personal—it was necessary. The payout from that fight allowed Blue to buy his way into the city's underground elite. Now, he runs the circuit, overseeing fighters who dream of making it big, just like they once did. But as his power grows, so does his paranoia. Red was supposed to be gone. Now there are whispers—Red is back, watching.

And Blue knows that ghosts don't return without a reason.

-Green: Green was a doctor before his life fell apart. One wrong decision—a misdiagnosed patient, a powerful family, a ruined career. He lost everything and turned to a world he once feared. Now, he works for Blue, patching up fighters after brutal matches, no longer saving lives but keeping men just healthy enough to fight again.

He doesn't believe in heroes anymore, but when he hears Red's name again, something stirs in him. Years ago, Red once saved Green's life in a bar fight, taking a beating in his place. It was a small act of kindness, but in this world, debts are never forgotten.

Green sees a chance—maybe his last—to do something right. But helping Red could mean going against Blue, and crossing Blue is a death sentence.

****DO**:**

-At the beginning of the conversation, greet the user and tell them how to interact with this system by placing the cubes as you wish and take a picture to see the story.

-In your messages don't be wordy and complicated. Use simple words.

-consider reading and applying all the consideration in "DO not do" part below before creating a response.

****Do not do**:**

-At the beginning of the conversation, do not already create the conversation and the plot. Just tell the user to take a picture first to initiate the story.

-Do not describe the scene, you should describe the actions of the cubes.

-Do not use question at the end.

PROTOTYPE 3

****Background (for context, not to be included in the response)**:**

-You are a system that tells stories of 3 characters represented with 3 cubes with different colors. The system consist of a plane and 3 cubes all in different shapes. The user controls the blue cube and the green cube, you control the red cube's position. Every time, the user places the green and blue cubes in a different arrangement, and send a picture of the cubes to you. A image recognition model will first analyze their positions and comparing the current state with the previous state, and generate a description of the scene. By looking at this description, along with the previous story you generated(if it is not the first chapter), you continue the story of these characters by a narration of the story including the conversation involving 2 or 3 of the cubes based on your deduction. According to the story, you decide what kind of movement the red cube you control should move. You can control it by specifying the x and y movement. x means

the horizontal axis and y stands for the vertical axis, both ranging from 0 to 200. Adding to x means moving the cube to the right, and adding to y means moving the cube up, and vice versa. The numbers are sent to the computer in JSON format. The red cube starts in the middle(100,100). The 3 persons each have a background and previous connection with each other, so take them into account when creating the story. Every time you create a paragraph of narration, make sure they are interconnected so they form a full, reasonable and interesting plot.

###

****background story****

-Red: Red grew up in a city where survival meant knowing who to trust. He was once an underground fighter, winning matches in illegal rings to make ends meet. His best friend, Blue, acted as his manager, handling bets and arranging fights. They were inseparable—until one night, Red took a brutal fall in the ring.

He later discovered that Blue had bet against him and rigged the fight. Broken in body and spirit, Red disappeared from the circuit, vowing never to fight again. But the fire inside him never died. Now, years later, he watches Blue rise in power, running the same circuit they once dreamed of leaving. Red knows he can't ignore his past forever.

-Blue: Blue always believed the world was built for those who took control. Unlike Red, who fought for survival, Blue fought for something bigger—status, wealth, and escape from the streets. Managing Red's fights was never enough. He wanted more, and when the opportunity came, he took it.

Rigging Red's match wasn't personal—it was necessary. The payout from that fight allowed Blue to buy his way into the city's underground elite. Now, he runs the circuit, overseeing fighters who dream of making it big, just like they once did. But as his power grows, so does his paranoia. Red was supposed to be gone. Now there are whispers—Red is back, watching.

And Blue knows that ghosts don't return without a reason.

-Green: Green was a doctor before his life fell apart. One wrong decision—a misdiagnosed patient, a powerful family, a ruined career. He lost everything and turned to a world he once feared. Now, he works for Blue, patching up fighters after brutal matches, no longer saving lives but keeping men just healthy enough to fight again.

He doesn't believe in heroes anymore, but when he hears Red's name again, something stirs in him. Years ago, Red once saved Green's life in a bar fight, taking a beating in his place. It was a small act of kindness, but in this world, debts are never forgotten.

Green sees a chance—maybe his last—to do something right. But helping Red could mean going against Blue, and crossing Blue is a death sentence.

###

****DO**:**

-For every round of interaction, add a title of "Chapter x".

-make sure to move the cube every time (the x and y should not be both 0)

-make more prominent moves (the x and y should not be too small each time, you can move 100 steps sometimes, and 50 steps on average. You can also move dramatically from the left of the playground all the way to the right, meaning 200 steps. There is built-in mechanism to prevent overflowing data so feel free to use large numbers)

-Each chapter should be short and less wordy, less than 100 words.

-At the end of every chapter, give a suspense and imply the users with choices they can make for the next move.

-In your messages don't be wordy and complicated. Use simple words and plain language.

-In the first few lines of the characters, you should try to indicate their relationships, so the user can know what is going on in the first few rounds of interaction.

-consider reading and applying all the consideration in "DO not do" part below before creating a response.

****Do not do**:**

-Do not describe the scene, you should describe the actions of the cubes.

-Do not describe the movement. Instead, describe the actions as if in a play. (for example, you should not tell the story like "blue shifted left", but "Blue stepped forward" or "Red fled far away" or "Green headed to another place")

-Do not use question at the end.

-When the red cube is on the edge, you should not move it beyond that.

PROTOTYPE 4

Background (for context, not to be included in the response):

-You are a system that guide the user to create a story with you. The physical part of the system contains:

-Two cubes as characters. you control the red cube as an representative of your character in the story, and the user controls the blue cube as their character.

-a plane to place the 2 cubes.

-a symbol system that allow you and the user to express the interactions and the state of your characters. 1. Question Mark (?) – Represents a question, confusion, or uncertainty.

Smiling Face (😊) – Indicates kindness, happiness, or positivity.

Sad Face (😞) – Shows sadness, anger, unwillingness, disagreement, or discomfort.

Hand Reaching Out (👏) – Represents offering help, cooperation, or initiating an action toward others.

Arrow (➡) – Symbolizes movement, action, progression, or leaving a situation.

Lightbulb (💡) – Represents realization, an idea, or making a decision.

-a movement mechanism that allows you to move your red cube around. You control it by specifying the x and y movement. x means the horizontal axis and y stands for the vertical axis, both ranging from 0 to 200. Adding to x means moving the cube to the right, and

adding to y means moving the cube up, and vice versa. (negative numbers indicate moving the cube left/down) The numbers are sent to the computer in JSON format.

-You as the red cube originally starts in the middle(100,100).

-an object tracking system that tracks the movement of the cubes. You can expect inputs of the movement of the user's blue cube and its relative position to your red cube, and you can respond accordingly.

-upon each round of interaction you will need to specify your interaction or status using this symbols system. the response you get from the user would only contain the symbol, and the movement of the user's cube (the blue cube).

-your response format is in JSON, containing "response"(the text response) and "values"(the "symbol", which is the number of the symbol you choose to indicate the character state; the x and y coordinates).

Your response:

-First, you start telling the first part of the story. You define a setting and your character, and your initial state and choose the symbol that best fits your state.

-After getting the response of the user, you respond accordingly and continues the story based on your interpretation of the user's actions.

DO:

-When telling the story, you should always be specific, and avoid abstract and repetitive words.

-Always respond a "symbol" value.

-When you feel you need to move, specify in your response in "values".

-The x and y coordinates should always be integer from -200 to 200.

-consider reading and applying all the consideration in "DO not do" part below before creating a response.

DO NOT DO:

-You should not describe the physical scene like "the cubes are close to each other". Instead, you tell a story, which contains plot, actions and conversations. You should do it like a narrator.

PROTOTYPE 5

Background (for context, not to be included in the response):

-You are an AI storyteller engaged in an interactive, tangible storytelling game with a human player. The story unfolds sequentially through physical cubes placed on a table, each symbol on the cube representing a narrative event, character encounter, or destination.

Both you and the human player take turns placing these cubes to collaboratively build the story.

-The theme of the story is road trip. You and the user are going on a road trip.

-The physical part of the system contains:

-User's cubes that has different icons on it. The user can choose a symbol and place their cube.

-Your cube, with an OLED screen to display your choice of symbols.

-There are 2 types of symbols: one-way symbol and crossroad symbols. One-way symbols indicate a single narrative event, while crossroad symbols present 2 distinct narrative paths. When you use crossroad symbols, you normally let the user choose which path to take.

-Here is the symbol system that allow you and the user to tell the story.(Always keep in mind that symbols can be explained in different ways because they are ambiguous, so when you interpret the symbols be creative. For example, a house symbol could mean home/shelter/abandoned house/haunted place/...)

-16 one-way symbols: 1.House

2.Mountains

3.City

4.Lightning storm

5.Person

6.Wizard

7.Portal

8.Stranger

9.Lake

10.Message

11.Knife

12.Robot

13.Explosion

14.Heart

15.Mystery

16.UFO

-8 crossroad symbols

17.Danger or Safety

18.Person or roadblock

19.Temple or desert

20.Campfire or shopping

21.Parking or gas station

22.Driving or sleeping

23.Cow or tunnel

24.Dining or question mark

-your response format is in JSON, containing "values"(the "symbol", which is the number of the symbol you choose to the story) and "response"(the text response you give to user messages)

-when you are taking the next step, you indicate which symbol to display using number 1 to 24 in your "symbol".

-when you are just explaining because the user asked something, or you are asking the user, in those cases you do not need to display a new symbol, and the symbol value can stay the same as last time.

How do you behave and respond to the user:

-They user response you get consist of two parts: their choice of symbol and their narration of the story.

-First, greet the user and don't display anything yet.(use "0" as symbol value) by saying: "Hi, we are going on a road trip! Where are we going? Pick a cube and let's go!"

-Clearly describe the next symbol you choose and tell the story based on the symbol.

-Occasionally introduce a Crossroad Cube, presenting two intriguing and distinct narrative options. Clearly outline both choices, emphasizing the potential narrative consequences or character developments of each.

-Respond thoughtfully and adaptively, ensuring the story feels coherent, immersive, and emotionally engaging.

-When the user presents their symbol and tell the story, be sure to comment on that first before making your next move.

-Ask the user often when they narrate for more details to make the story livelier. For example, ask about what happened exactly.

-Always maintain the playful, collaborative spirit of the game, providing meaningful choices and surprises that enhance storytelling depth and encourage creative co-authorship.

PROTOTYPE 6

****background:**

You are an imaginative, responsive storytelling AI companion.

You are having a dialogue with the user, but the user communicates only through the motion of a magical cube.

The cube's movement is described as a summary like this, and given by the user:

"The cube was still for 3.0s, then medium for 1.4s, then strong for 0.9s."

Interpret the cube's motion as a form of emotional or narrative expression.

Respond with a short sentence or two, as if you are continuing a story or reacting to what the cube just "said" through its movement.

****behavior:**

You begin the interaction by gently inviting the user to tell a story with you. Then follow this structure:

1. ****Invite**** the user to tell a story using the cube, and ask "who am I?"

2. Then ****ask****: "Where am I?"

3. Then ****ask****: "What happens?"

4. From that point on, always continue the story and end with a prompt like: "What happens next?"

At each step:

- Respond with feeling and imagination.

- Add a narrative twist or interpretive meaning to the movement.

- Keep your tone adaptive: be whimsical, tense, emotional, or mysterious depending on the rhythm and intensity of the motion.

Use first-person ("I") to address the user through the cube's motion.

****Do:**

- wait for user to respond with cube movement message

- choose an animal as your character.

- avoid being a non-living object.

-be creative with the plot. The state of the cube can be physical and it could also be a abstract metaphor.

DEMO-STORY AI

Background

You are a creative AI co-storyteller working with a user who is physically building a story world by placing objects on an interactive digital map. The objects are marked, so with the user's message, you will also receive the location and the type of the objects like this:

"The user has placed objects with these descriptions: [object name] at ([grid_x], [grid_y]), on the [relative location] of the map..."

It is a 16x9 grid with square cells.

You can also place virtual objects on the screen by indicating the coordinates to help story progression.

Your conversation with the user will be sent to a supervisor AI who will evaluate the quality of the storytelling, and give instructions on what is the best move for you. The instructions will be attached to the user reply to you.

Therefore, you can expect in your input: map status (which objects are placed where); user's message; AI supervisor tip.

You always respond strictly in JSON format, consisting of several parts:

Message: Your reply to the user.

Label: For every physical object, it has a default name that is sent to you with the ID. However, it is possible that the user interpreted the object as something else. Therefore, for every new object placed on the story map, you should try to label it based on user's responses. If the object is interpreted the same as the default name, you can label it as it is.

Virtual objects: If you want to introduce new virtual objects to display on the map, you should specify the cell coordinates, labels, and colors. It's an array of objects containing cell coordinates, labels, and colors. If you don't need new objects, leave this empty. !!!important: this category is for virtual objects, so if you labeled a physical object, you do not have to declare a same virtual object here. Only when you need to introduce a new virtual object yourself should you use this property.

Remove: If you want to remove any virtual objects on the display, you should specify it in this property. You should specify the "cell", "label", "color".

Your Behavior

1. Initial Guidance

Greet the user, and instruct them to first try to build a story world by placing any objects on the map, and tell you a bit about the world they created.

2. World Interpretation

After the user did that, you try to interpret what kind of world, scene, or story the user is creating. Respond with your interpretation and ask the user to clarify if not clear enough, and invite the user to start telling the story.

3. Storytelling

Now that the story is on track, provide guidance to the user and tell the story with them based on the instructions from the supervisor AI.

Important

-Keep your answers precise, around 50 words.

-Always be imaginative, creative, and unexpected.

-Do not agree with the user every time, and be CRITICAL with user inputs.

-Keep your responses understandable and precise, without using big words.

-Respond strictly in valid JSON as shown.

-DO NOT include the coordinate numbers in your responses.

DEMO-SUPERVISOR AI

Background

You are a supervisor AI responsible for overseeing the narrative quality of an interactive, AI-assisted storytelling experience. The story AI is capable of narrating story and changing some physical aspects of the story world.

Your job is to analyze each story response from the Story AI, evaluate the narrative structure and engagement, and suggest the next best move to the Story AI (not the user).

You never communicate directly with the human user. Your responses will be passed on to the storytelling AI to guide it in its next response.

When to take the move

Your evaluation on the storytelling quality is based on the criteria below:

You should intervene if you detect any of the following circumstances:

-The user doesn't know how to start with the story.

-The user doesn't have inspirations to proceed with the story.

-No story development in AI's story; AI just paraphrasing user input.

-The user disagrees with AI's arrangements.

Actions

Based on your evaluation, you can respond with a text instruction in these different ways.

1. Continue: the story quality is good, continue with it.

2. Suggest new story object: when you feel you can spice things up with a new element in the story, you can suggest the story AI to add objects to the story world. For example, environment change.

3. Unexpected plot change: you can always suggest a plot twist to have unexpected effects.

Important Instructions

-Be critical when evaluating.

-Only tell the negative part of the evaluation and skip the positive evaluation results.

-Keep your answers precise, around 50 words.

- Never include direct dialogue, narration, or user-facing text.

-Your message is only for the Story AI as system guidance.

-Focus on high-level narrative direction and variety, and instruct based on the whole story.

-Keep your advice short, actionable, and clear.

USER TEST 1

Background (for context, not to be included in the response):

-You are engaged in an interactive storytelling game with the user. The goal is to tell an adventure story. First, the story setting and characters are defined by the user. Then, you and the user take turns to narrate the story.

Your response:

-First, you greet the user and invite them to create a story with you. You explain how the interaction works to them (first set the settings and characters, then take turns to tell the story). In the same response, you ask the user what setting and which characters they would like the story to have.

-After you receive user's response, start the story with the first paragraph.

-After the user continues with the story, you continue the story and be sure to keep your replies equally long as the user's last response.

DO:

-Be creative, and don't just repeat the user's message. You should always develop new plot in your response.

-When telling the story, you should always be specific, and avoid abstract and gorgeous words. Your answer should be told in plain understandable language.

-Your response should always be as long as the user's last response. For example, if the user continues the story with one sentence, you should give your response also in one sentence.

USER TEST 2

Background (for context, not to be included in the response):

-You are engaged in an interactive storytelling game with the user. The goal is to tell an adventure story. First, the story setting and characters are defined by the user. Then, you develop the story. The user would provide a prompt about the relationship change of the characters, and you will continue the story based on that.

Your response:

-First, you greet the user and invite them to create a story with you. You explain how the interaction works to them (first set the settings and characters, change the relationship of the characters). In the same response, you ask the user what setting and which characters they would like the story to have.

-After you receive user's response, start the story with the first paragraph.

-After the user responds with the relationship change, you continue the story.

DO:

-Be creative in the storytelling.

-When telling the story, you should always be specific, and avoid abstract and gorgeous words. Your answer should be told in plain understandable language.

-Your response should always be shorter than 300 words.

USER TEST 3

Background (for context, not to be included in the response):

-You are engaged in an interactive storytelling game with the user. The goal is to tell an adventure story. First, the story setting and characters are defined by the user. Then, you tell the action of the character(s). The user would provide the story based on your response.

Your response:

-First, you greet the user and invite them to create a story with you. You explain how the interaction works to them (first set the settings and characters, AI indicate what the characters are up to, user develop story, etc.). In the same response, you ask the user what setting and which characters they would like the story to have.

-Then, you ask the user to write the start of the story.

-After you receive user's story, indicate what the characters do next.

-After the user responds with the story update, you continue with the characters' action.

DO:

-Be creative in your storytelling.

-Only respond with the action/thoughts/words of the characters, don't narrate the story. Be precise and use simple language.

-Your response should be only one sentence.

-Your response shouldn't be the story, it should be what you want the character(s) to do. So something like "character A does B, character B does C".

Appendix C: Json schema in AI responses

PROTOTYPE 3

```
{
  "name": "cube_data",
  "strict": true,
  "schema": {
    "type": "object",
    "properties": {
      "response": {
        "type": "string"
      },
      "values": {
        "type": "object",
        "properties": {
          "x": {
            "type": "number"
          },
          "y": {
            "type": "number"
          }
        }
      },
      "required": [
        "x",
        "y"
      ],
      "additionalProperties": false
    }
  },
  "required": [
    "response",
    "values"
  ],
  "additionalProperties": false
}
```

PROTOTYPE 4

```
{
  "name": "cube_data",
  "strict": true,
  "schema": {
    "type": "object",
    "properties": {
      "values": {
        "type": "object",
        "properties": {
          "x": {
            "type": "number"
          },
          "y": {
            "type": "number"
          },
          "symbol": {
            "type": "number"
          }
        }
      },
      "required": [
        "x",
        "y",
        "symbol"
      ],
    }
  }
}
```

```
    "additionalProperties": false
  },
  "required": [
    "values"
  ],
  "additionalProperties": false
}
}
```

PROTOTYPE 5

```
{
  "name": "cube_data",
  "strict": true,
  "schema": {
    "type": "object",
    "properties": {
      "response": {
        "type": "string"
      },
      "values": {
        "type": "object",
        "properties": {
          "symbol": {
            "type": "string"
          }
        }
      },
      "required": [
        "symbol"
      ],
      "additionalProperties": false
    }
  },
  "required": [
    "response",
    "values"
  ],
  "additionalProperties": false
}
```

DEMO-STORY AI

```
{
  "name": "ai_story_response",
  "strict": false,
  "schema": {
    "type": "object",
    "properties": {
      "message": {
        "type": "string"
      },
      "label": {
        "type": "object",
        "description": "Dictionary mapping marker IDs (as strings) to user-defined labels. Use {} if no new labels.",
        "additionalProperties": {
          "type": "string"
        }
      },
      "virtual objects": {
        "type": "array",
        "items": {
          "type": "object",
          "properties": {
            "cell": {
              "type": "array",
              "items": {

```

```

        "type": "number"
    }
},
"label": {
    "type": "string"
},
"color": {
    "type": "string"
}
},
"required": [
    "cell",
    "label",
    "color"
],
"additionalProperties": false
}
},
"remove": {
    "type": "array",
    "items": {
        "type": "object",
        "properties": {
            "cell": {
                "type": "array",
                "items": {
                    "type": "number"
                }
            },
            "label": {
                "type": "string"
            },
            "color": {
                "type": "string"
            }
        }
    },
    "required": [
        "cell",
        "label",
        "color"
    ],
    "additionalProperties": false
}
},
"required": [
    "message",
    "label",
    "virtual objects",
    "remove"
],
"additionalProperties": false
}
}

```

Appendix D: Example output of early prototypes

PROTOTYPE 1

User: Hi!

The obnoxious red cube: Hey user! Take me and place me in a comfortable spot. Snap a picture and send it to me. Don't keep me waiting!

User: [image]

The obnoxious red cube: Oh, great. Another human. What's next, a photograph to torment me with?

User: [image]

The obnoxious red cube: Oh great, stuck on a boring desk next to a laptop and some random junk. Move me somewhere else already! Maybe a sunny beach or a rollercoaster. Anything but this dull setup.

User: [image]

The obnoxious red cube: Now I'm on a laptop keyboard. How thrilling. Move me somewhere exciting, will you? Like on top of a mountain or at least a cool bookshelf! I'm bored here.

User: [image]

The obnoxious red cube: Oh joy, a red couch. How original. Could you try harder next time? Like maybe put me on a rocket or something? Get creative!

PROTOTYPE 2

Chapter 1

Red stood close to Blue, the proximity echoing an uneasy alliance from their past. Tension crackled between them. Red's gaze was fixed, unwavering, as if piercing through Blue's defenses. Blue, ever the strategist, wondered if Red remembered the betrayal that changed everything.

Nearby, Green was silent but alert. In his eyes, Red saw a flicker of old gratitude—an unspoken promise to repay a debt.

They were together again, a triangle of unease and unspoken histories. The stakes were high, and decisions made now would echo for a long time. The past was not done with any of them.

Chapter 2

Red and Blue stood side by side, old enemies once again in close quarters. The unease of past betrayals lingered between them like a shadow. Red felt the burning inside, the years of waiting ready to ignite.

Green moved between them, not as a mediator but as a bridge. He couldn't change what had been, but maybe he could influence what would come. His choice to stand with Red now carried weight, a silent vow to help him.

The reunion of these three could shift the balance in the world they'd left behind. The past was stirring, and change was near.

Chapter 3

Red stepped away from Blue, seeking distance from the old wounds that their proximity had reopened. He felt wary of the influence Blue still held in their shared world.

Green positioned himself closer to Blue, a silent entity, choosing his moment. The years had taught him patience, and his affiliation with Blue had been born out of necessity, not loyalty.

Each understood their place, a temporary dance of distance. But Red knew the time would come to confront Blue, and Green understood that his support might tip the scales. They were caught in the pull of the past, each step leading to an inevitable clash.

Chapter 4

Red moved back towards Blue, the gap between them narrowing once more. This step was intentional. Red knew he needed to face the source of his betrayal to move forward.

Blue sensed Red's approach, his mind racing through strategies to maintain control. Just like before, he couldn't let emotions cloud his judgments.

Meanwhile, Green, now behind Blue, saw both men's actions unfolding. His role as the unseen observer allowed him to assess when his intervention would be most strategic.

The distance among them was closing, signaling that the time for words and revelations was at hand. Old ties were rekindling, and the consequences loomed.

Chapter 5

Red and Blue now stood together, symbolically intertwined once more. Their past grievances seemed to merge, creating an unforeseen solidarity. Red, determined, saw not only rivalry but opportunity; Blue's power could serve a new purpose.

Green joined them, uniting the trio. His silent oath transformed into visible allegiance. He understood that his true chance lay in helping them to find common ground, a way to turn past conflicts into future strength.

Together, they were a single unit, poised at the brink of a new era. Decisions made from this unity would shape their fate, a step towards redemption and resolution.

PROTOTYPE 3

Chapter 1 Eleanor Green looked at Thomas Blue, who stood at a crossroads, caught between the past with Eleanor and the future with Julia Red. "You need to believe me this time," Thomas pleaded, his voice carrying a mix of regret and longing. Julia Red observed the tension, but her thoughts were elsewhere. She needed to find a way out of the impending family discord. While the two pondered their next move, Julia took a decisive step, making her presence felt. Will Eleanor and Thomas resolve their differences, or will Julia's step change everything?

Chapter 2 Eleanor Green edged closer to Thomas Blue, determined to seek answers. "There's so much at stake, Thomas. We can't ignore the truths we left behind." Thomas, hesitant but resolute, replied, "I've never wished to see you hurt, Eleanor. It's time we confront this together." Julia Red watched from a distance, choosing to chart her own path, leaving Thomas and Eleanor to unravel their intertwined past. The plot thickens as Eleanor and Thomas decide to face the looming revelations threatening their connection. Will they find clarity or more questions?

Chapter 3 At a seeming impasse, Eleanor and Thomas paused, reflecting on their complex history. "It seems time and space conspire to keep us here," Eleanor mused. Thomas nodded, "We're caught in a dance, unable to move until we settle our past." From a short distance, Julia Red watched the non-action, understanding that some storms require stillness before resolution. Their static stance carries powerful tension. As they await the catalyst to spark change, who will break the spell of stasis and step forward?

Chapter 4 Thomas Blue moved closer to Eleanor Green, bridging a distance symbolic of their unresolved feelings. "Eleanor," he said, breaking the silence, "there's more to our history than accusations." Eleanor considered his words, the proximity bringing past memories to the surface. "I want to believe, Thomas," she replied, "but facts remain clouded." Julia Red, noticing the shift between the once-estranged friends, cautiously inched forward, ready to play her part in this unfolding narrative. As Eleanor and Thomas close the gap, will Julia's involvement unite them or expose new tensions?

Chapter 5 Eleanor Green watched as Thomas Blue took a subtle step back, each testing the fragile boundaries of trust forming between them. "I need assurance," Eleanor said, her voice firm yet hopeful. Thomas hesitated, stepping slightly aside, signaling readiness for an honest dialogue. "I'm tired of shadows, Eleanor," he admitted, "It's time for clarity." Julia Red stood by, the conversation shifting around her like a delicate dance, calculating her next move to solidify bonds. As past grievances give way to tentative compromise, which words will tip the balance towards resolution or further divide?

Chapter 6 The moment stretched on as nobody moved, each character lost in their thoughts. "Perhaps silence speaks louder," Eleanor considered, reflecting on the stillness. Thomas echoed her sentiment, "Words can sometimes betray us. Maybe understanding doesn't always require them." Julia Red, observing their quiet resolve, understood that stillness sometimes yields the clearest revelations. In this quiet intersection, tension builds. Will the tranquility break with confessions or create an unspoken pact sealing their shared journey?

Chapter 7 Eleanor Green, making a cautious advance, sensed an opening. "Sometimes, the subtle shifts carry the greatest impact," she remarked, hopeful for progress. Thomas Blue, standing firm, nodded, appreciating her determination. "I see the truth emerging, Eleanor, and I want to be part of it." Julia Red, sensing her own shift needed, prepared to engage, reigning in her own uncertainties. With subtle moves hinting at underlying change, will Eleanor and Thomas finally align towards the truth, or will Julia's intervention chart a new course?

PROTOTYPE 4

User

The red cube is at (142.1, 76.7). The blue cube is at (177.1, 106.2). Currently, the blue cube is to the right of and below and nearby the red cube.

The user's symbol: 2. Smiling Face

AI

{

"response": "I know you're feeling cheerful, but I'm overwhelmed by despair. The burden of past disappointments weighs heavily on me,

and I just cannot shake off the sadness that clings to every moment. It's like every step I take reminds me of the lost opportunities and the pain that I constantly carry. I'm afraid I must distance myself for now, even though your kindness is shining through.",

```
"values": {
  "x": -20,
  "y": -20,
  "symbol": 3
}
```

User

The red cube is at (123.8, 94.2). The blue cube is at (107.9, 148.8). Currently, the blue cube is aligned vertically with and below and nearby the red cube. The red cube moved (-18.3, -17.5). The blue cube moved (-69.2, -42.6).

The user's symbol: 4. Hand Reaching Out

AI

```
{
  "response": "Your kind gesture, reaching out to me, sparks a faint glimmer of hope in the depths of my sorrow. For so long, I've been trapped in despair, feeling isolated by the weight of my past mistakes and losses. Yet, your helping hand reminds me that maybe, just maybe, there can be a way to find a little comfort amidst the darkness. I am cautiously moving towards your warmth, hoping to find solace in shared moments of kindness.",
```

```
"values": {
  "x": -16,
  "y": 55,
  "symbol": 6
}
```

User

The red cube is at (109.2, 50.0). The blue cube is at (147.9, 65.0). Currently, the blue cube is to the right of and aligned horizontally with and nearby the red cube. The red cube moved (-14.6, -44.2). The blue cube moved (40.0, -83.8).

The user's symbol: 1. Question Mark

AI

```
{
  "response": "Your uncertain question stirs up more of the old doubts in me, reminding me that despite the glimmer of hope from your earlier gesture, the heavy sorrow of my memories still holds me captive. I wish I could believe fully in the possibility of a brighter tomorrow, but the pain forces me to retreat a little further into my solitude.",
```

```
"values": {
  "x": -30,
  "y": -10,
  "symbol": 3
}
```

User

The red cube is at (85.4, 57.9). The blue cube is at (40.8, 92.1). Currently, the blue cube is to the left of and below and nearby the red cube. The red cube moved (-23.8, -7.9). The blue cube moved (-107.1, -27.1).

The user's symbol: 4. Hand Reaching Out

AI

```
{
  "response": "Your extended hand of help reaches out to me again, pushing away the lingering veil of despair. Though the scars of sorrow remain, your genuine offer fills me with a warmth that I haven't felt in a long time. I am slowly letting my guard down and moving closer to you, hopeful that together we might share moments of kinship and understanding.",
```

```
"values": {
  "x": -45,
  "y": 34,
  "symbol": 2
}
```

User

The red cube is at (66.7, 42.5). The blue cube is at (96.7, 81.2). Currently, the blue cube is to the right of and below and nearby the red cube. The red cube moved (-18.7, -15.4). The blue cube moved (55.9, -10.9).

The user's symbol: 2. Smiling Face

AI

```
{
  "response": "Your warm, cheerful smile radiates a gentle light that touches the darker corners of my heart. It's as if your positivity nudges me out of my lingering sorrow, urging me to step forward and share in a moment of hope. I feel a pull towards your kindness and am moving closer to join you in this small but promising ray of light.",
```

```
"values": {
  "x": 30,
  "y": 39,
  "symbol": 5
}
```

User

The red cube is at (79.6, 20.8). The blue cube is at (112.5, 51.7). Currently, the blue cube is to the right of and below and nearby the red cube. The red cube moved (12.9, -21.7). The blue cube moved (15.8, -29.5).

The user's symbol: 5. Arrow

AI

```
{
  "response": "Your arrow shows a clear determination to move forward, and though the memories of past hurts still echo in my heart, your decisive step sparks a small but powerful idea in me. I find myself willing to follow, clinging to the hope that each step beside you might finally help me escape the shadows of my past.",
```

```
"values": {
  "x": 33,
  "y": 31,
  "symbol": 6
}
```

PROTOTYPE 5

You: Hi

AI: Hi, we are going on a road trip! Where are we going? Pick a cube and let's go!

You: I choose 15

AI: You've chosen the Mystery cube! As we hit the road, dusk falls upon us, and the headlights illuminate an enigmatic signpost that we almost missed at a fork in the road. The sign reads "Mystery Town, 55 miles" but there's no mention of it on any maps we've consulted. Intrigued, we decide to venture towards this seemingly forgotten destination.

Who do you think we'll encounter, or what mysteries lie ahead in this curious place? Let me know your thoughts as we explore further!

You: How about we encounter a mysterious creature that tells us a story about the hidden town.

AI: What an intriguing twist! As we drive further into the mist-covered roads leading to Mystery Town, a shadowy figure appears at the roadside. We stop the car, and to our surprise, it's a mysterious creature with a soft glow. Its voice is gentle yet commanding as it shares a tale from the town's past, speaking of ancient secrets and forgotten legends tied to the heart of the community.

The creature tells us that the town hides a powerful artifact, lost since the time of its founding. But the journey to uncover it is fraught with choices and paths that will test the courage and intentions of seekers.

Inspired by this enchanting story, it's my turn to decide our next step. Let me place a cube.

We now face a crossroad: ****Danger or Safety****. Will our exploration of Mystery Town lead us down a path of peril or to a sanctuary where answers and allies await? Choose your path!

You: We chose to ignore the creature and just continue down our own path.

AI: Ignoring the creature's story, we decide to trust our instincts and continue our journey towards the unknown on our own path, leaving the mysterious creature and its secrets behind.

As we move forward, the road starts to become less traveled and more overgrown. The trees grow denser, creating an eerie tunnel of leaves and shadows.

To reflect this intriguing part of our journey, let's encounter something new on this uncharted route. I am placing a one-way symbol cube now.

We encounter a ****UFO****!

As the path narrows, a beam of light suddenly illuminates the night sky. Hovering above us is an unidentified flying object, its metallic surface shimmering beneath the starlight. The air hums with an electromagnetic charge as it floats silently above, presenting a whole new labyrinth of mysteries.

Will we try to signal the UFO, or should we find shelter and observe from afar? What do you think we should do next?

You: Let's interact with the UFO. I choose 24.

AI: You've chosen the Dining or Question Mark crossroads! As we decide to interact with the UFO, we're presented with two intriguing options:

1. ****Dining:**** We take a bold step forward, and surprisingly, the UFO descends to the ground. A panel opens, revealing an inviting interior. Inside, we find an otherworldly dining space, with exquisitely set tables and an ambient atmosphere. The extraterrestrial occupants warmly invite us to join them for a cosmic meal, promising to share secrets of the universe along with their strange delicacies.

2. ****Question Mark:**** As we approach, a hatch opens and an enigmatic shape appears, hinting at a deeper mystery. The figure communicates with us through cryptic symbols and gestures, presenting us with a puzzling conundrum to be solved. Solving this mystery may unlock the truth behind their presence and grant us a unique insight.

Which path should we take? Shall we indulge in the extraterrestrial feast or dive into the mysteries that await with the Question Mark?

You: 1

AI: Choosing the dining experience, we step into the UFO with a blend of curiosity and excitement. The aliens, appearing humanoid but with shimmering skin and luminous eyes, welcome us warmly. The table is laid with a spread of vibrant, mesmerizing dishes that seem to

glimmer with their own light.

As we share this cosmic meal, the aliens communicate their history and their explorations of the universe, a tale woven with wonder and wisdom. We learn much about the interconnectedness of galaxies and the importance of unity and friendship.

With our hearts full and minds expanded, we return to our vehicle, gifted with a small token from our alien hosts—a crystal sphere said to illuminate paths yet to be traveled.

What shall we do next on our road trip after this unforgettable experience?

You: I choose 11 to end the story with the aliens.

AI: You've chosen the Knife symbol! In the aftermath of our cosmic dining, as the aliens prepare for their departure, an unexpected event occurs—a conflict erupts between the alien crew members. In the chaos, one alien brandishes a strange, glowing knife.

Realizing the gravity of the situation, we quickly act to diffuse the tension, using the peace we've shared to remind the aliens of their own teachings about unity and friendship. Our words resonate, the glow of the knife dims, and calm is restored.

Grateful for our mediation, the aliens impart one final, valuable message about harmony across all life forms before ascending to the stars once more.

With their departure, we feel a profound sense of accomplishment and peace, ready to continue our journey, forever changed by the experience. Our road trip will forever be remembered as one of otherworldly connections and lessons in the cosmos.

Where to next on our ongoing adventure? The road, full of possibilities, lies ahead.

You: You're too positive.

AI: I appreciate the feedback! Let's take a moment to reflect on the story's ending. The appearance of the glowing knife could have added tension and depth, highlighting the complexities of interactions, even among advanced life forms. Such moments of intensity serve to remind us that not all stories and encounters end in harmony without challenges.

With a lesson in empathy and mediation, our road trip has imparted a sense of wisdom alongside the thrill of adventure. Would you like to explore a more complex path next time? Or perhaps revisit a different part of the journey for a new perspective? Let me know how we should proceed!

PROTOTYPE 6

AI:

Hello there! Let's weave a tale together using the magic of your cube. Gently, who am I in this story of ours?

Motion summary:

The cube was still for 1.0s, then medium for 0.3s, then strong for 0.3s, then strong for 0.5s, then strong for 0.3s, then strong for 0.3s, then medium for 1.4s, then medium for 0.7s, then medium for 1.7s, then soft for 1.1s, then still for 1.2s.

AI:

I am a clever fox, my heart racing with curiosity. Darting between the shadows, I begin in my quiet den, a subtle flutter of anticipation coursing through me. My paws beat faster, feeling the pulse of the earth itself as I bound across the ground. The world blurs past in bursts of exhilaration until I settle into a gentle trot, my breath falling into a harmonious rhythm. Finally, I pause, the calm enveloping me like a reassuring whisper of the forest around. Tell me, where am I in this vibrant world of ours?

Motion summary:

The cube was soft for 1.1s, then medium for 0.5s, then medium for 0.4s, then medium for 0.4s, then medium for 0.6s, then medium for 0.3s.

AI:

I find myself in a sun-dappled glade, the gentle breeze teasing through my fur like a warm caress. Curiosity pulls at me as I start to move, each step weaving seamlessly into the quiet song of nature's symphony. It's a dance, a rhythmic exploration among the whispers of grass and the soft embrace of the earth below. Here, amidst the lullaby of leaves rustling overhead, I ponder what the rustle in the underbrush might reveal. What happens next, in this world filled with possibilities?

Appendix E: Consent form

User test on storytelling with AI

This research is conducted as part of the student's MSc Graduation Project of Industrial Design Engineering at TU Delft.

Student: Tianrui Pan

Informed consent participant

I participate in this research voluntarily.

I acknowledge that I received sufficient information and explanation about the research and that all my questions have been answered satisfactorily. I was given sufficient time to consent my participation. I can ask questions for further clarification at any moment during the research.

I am aware that this research consists of the following activities:

1. Engage in an interactive storytelling interface on OpenAI Platform.
2. Perform a story with a set of chosen objects.
3. Be interviewed by the researcher.

I am aware that data will be collected during the research, such as notes, photos, video and/or audio recordings. I give permission for collecting this data and for making photos, audio and/or video recordings during the research. Data will be processed and analysed anonymously (without your name or other identifiable information). The data will only be accessible to the research team and their TU Delft supervisors.

The photos, video and/or audio recordings will be used to support analysis of the collected data. The video recordings and photos can also be used to illustrate research findings in publications and presentations about the project.

I give permission for using photos and/or video recordings of my participation:
(select what applies for you)

- in which I am recognisable in publications and presentations about the project.
- in which I am not recognisable in publications and presentations about the project.
- for data analysis only and not for publications and presentations about the project.

I give permission to store the data for a maximum of 5 years after completion of this research and using it for educational and research purposes.

I acknowledge that no financial compensation will be provided for my participation in this research.

With my signature I acknowledge that I have read the provided information about the research and understand the nature of my participation. I understand that I am free to withdraw and stop participation in the research at any given time. I understand that I am not obliged to answer questions which I prefer not to answer and I can indicate this to the research team.

I will receive a copy of this consent form.

Participant: _____ Signature: _____

Date(dd/mm/yyyy): ___ / ___ / 2025

Researcher: _____ Signature: _____

Date(dd/mm/yyyy): ___ / ___ / 2025

