

Letters to José: A Design Case for Building Tangible Interactive Narratives

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Abstract. The field of interactive digital storytelling has been largely focused on screen-based, algorithm-driven narrative systems. While a considerable number of tools, models and experimental cases have been built to explore different aspects of the narrative and system design, very few of them are applicable for the category of tangible narratives. This paper presents a design case, *Letters to José*, to contribute to the body of works in tangible storytelling. Conducted through a research through design process, the building and evaluation of this case reveals key design aspects and considerations for authoring tangibles narratives, as well as the interactive narrative experience it brings. From the design process and the study findings, we identify a critical design category – artifacts for storytelling – whose characteristics and roles in an interactive narrative system are discussed. In reflecting the decision-makings, we address the complex design problems for building tangible interactive narratives.

Keywords: Tangible Narrative, Artifacts for Storytelling, Interactive Narrative, Tangible Interaction, Research through Design, *Letters to José*.

1 Introduction

This paper presents *Letters to José*, a tangible interactive story implemented in a physical-digital hybrid system enabled with multimodal interactions. We introduce the making of this tangible story, discuss the experiences the story brings, and reflect on the lessons and implications that can contribute to authoring of tangible narratives. Using a research through design method, we approach interactive digital narrative (IDN) from a material, physical angle in order to explore more varied experiential qualities than those brought by conventional screen-based forms of narrative. We are particularly interested in how physical artifacts can support the interactive engagement with a narrative, as well as those motives, factors, and mechanisms that lead to enjoyment of a narrative.

With a goal of expanding the understanding of tangible narrative, we contribute a fully implemented design case, *Letters to José*, to the repository of IDNs and the limited body of works of tangible narratives. Our design and evaluation affirm that physical artifacts and narrative structure play an important role in supporting enjoyable narrative experience. Methodologically, we also introduce Research through Design as an approach to the practice of IDN to bridge better between research and design. Ultimately,

we hope to contribute to the “kaleidoscopic view” of IDN advocated by Janet Murray [27], by demonstrating artifact-based tangible narratives as a promising IDN form.

2 Related Work

Interactive Digital Narratives (IDN) are “a form of expression enabled and defined by digital media that tightly integrates interactivity and narrative as a flexible cognitive frame” [18]. We consider Tangible Narratives (TN) are a form of IDN because they well fulfill the definition. However, the interaction process in TN is not limited to screen-based interface like in most existing IDNs. Instead, different tangible physical artifacts are mapped to distinct aspects of the narrative [6] and tangible interaction technology is tightly knitted into a structure that involves a plot, different characters, and other narrative elements [14]. Here we will review the current status quo of TN and the related works that provide us theoretical basis and design inspirations.

2.1 The ‘Implicit’ Tangible Narrative

In a recent paper discussing disciplinary research directions of interactive digital narrative (IDN), Koenitz and Eladhari [19] list a number of recent interactive stories as substantial achievements, all of which are screen-based works. Not only do we not see enough cases and working prototypes of tangible stories in general, but we do not see much updated theoretical discussion on newer forms of interactive narrative – including tangible stories, in the community of IDN. This can be due to the first of five critical challenges identified by Koenitz and Eladhari [19], which is the “dependency on legacy analytical framework.” They explain that the field largely inherits theoretical instruments from “earlier mediated forms of narrative” and the views are bound to be limited.

The situation is not optimal, either, in the design and development of authoring tools for IDN. We can hardly identify tools and models applicable for story applications that are not screen-based and/or built with embodied tangible interactions. In their conclusion of a survey of 300 tools, Shibolet et al. [35] stress that “interaction models and user experience with narrative design – particularly through embodied/gestural interfaces” are “at best implicit in IDN-specific authoring tools.”

As of the time of this writing, there is not even a single cohesive definition of what a tangible narrative is. The terms *tangible narrative* and *tangible interactive narrative* seem to be interchangeable, the former being used in most influential works. Tangible narratives are sometimes denoted from the system perspective as *Tangible Storytelling systems* [42], *Tangible and Embodied storytelling systems* [3], or *Tangible Spatial narratives* [23]. They are also framed from the practice of storytelling as *Tangible and Interactive Storytelling* [13] or *Object-based Tangible Storytelling* [41]. Tangible narratives are also implicitly referred to, from the perspective of tangible interaction and interface design, as tangible platforms [23, 39], environments [1], or simply tangible interfaces that support a narrative [4, 5, 22, 25, 34, 40].

As Koenitz and Eladhari [19] rightly point out for IDN as an emerging discipline, “we should seize the opportunity to not only change the object of inquiry, but also our instruments to measure them in order to understand specific characteristics and enable

novel insights.” In this light, we take an adventure and explore the potential of embodied tangible interaction for constructing novel interactive narrative experiences.

2.2 Previous Work in Tangible Narrative

In our work, we draw insights from literature both within and beyond IDN. For narrative structure, we borrow from narratology some of the principles of interactive narrative proposed by Marie-Laure Ryan [33]. For interaction design, we ground part of our theoretical basis in the early work of Hiroshi Ishii [16, 44] and other works that contributed to the foundations of Tangible Interaction (e.g., [9, 15, 17, 22]). We also consider perspectives from the study of play and games (e.g., [45]) and of different forms of interactive storytelling (e.g., [26]). Lastly and importantly, we draw insights from existing design cases (e.g., [5, 13, 41]) and from frameworks that intend to facilitate the creation of TN [6, 14]). What follows is a set of key concepts and frameworks that helped build our understanding and theoretical foundation of TN.

Diegetic Objects. Holmquist et al. [15] discussed the idea of heightening the sense of involvement by providing *physical, diegetic objects* – some computationally enhanced – that represent important parts of the narrative. They explored the narrative’s expressive aspects by situating the player in different perspectives of the story. In a similar approach, Mazalek et al. [22] presented a method that considered cooperative and social interactive experiences in the form of *viewpoints*. These viewpoints allow the user to interact and modify a linear narrative in a shared space.

Cognitive Hyperlinks. Tanenbaum et al. [41] introduced *Reading Glove*, an interactive narrative system that makes use of RFID-enabled gloves to bound a digital narrative to physical objects. Their work introduced the notion of *cognitive hyperlinks* – “reoccurring themes, characters, locations, and other literary elements that help a reader to make sense of the structure of a story.”

Defining Tangible Narrative. Even though most authors root varied tangible narratives in the different relationships between what is physical, what is virtual, and what they represent of the narrative, they come short in defining them. Harley et al. [14] provided a simple yet vital characterization of TN: “tangible interaction technology is understood as a *necessary component* of the narrative or its construction” and “the resulting narrative *will include* at least one of the following: plot, character, or setting” (emphasis added) [14]. This characterization is supplemented by the system view provided by Catala et al. [3]: “tangible and embodied storytelling systems rely less on computational story modeling, and instead focus primarily on free story creation and play.” They pointed out that “ideally, a system should combine the affordances of both modalities, this is, provide physical interaction and a good story” [3]. Considering the above, within our work we frame TN as *hybrid interactive experiences representing the structured sequence of events in a story by digitally bounding and mapping narrative content to one or more physical artifacts and environments*.

3 A Research through Design Approach

Building a tangible system requires knowledge and skills from both design and tangible interaction, the latter being an established area in the field of human-computer

interaction (HCI). Building a tangible story, consequently, is significantly different from creating self-contained software that usually run as an interactive story on the screen. We thus turn to practice-based design and HCI research and adopt the method of research through design to guide the overarching research process.

As Frayling [10] observes, research is transversal to all practices, among them, art and design. The relationship between research with design and art can be understood from three perspectives: *research into art and design*, *research for art and design*, and *research through art and design (RtD)*. We choose the perspective of RtD because it includes materials research, technical experimentation, as well as action research and practical experiments [10]. Introducing this perspective into HCI research, Zimmerman and Forlizzi [46] define Research through Design as “an approach to conducting scholarly research that employs the methods, practices, and processes of design practice with the intention of generating new knowledge.” As practice-based research, the approach of RtD is adopted not only to many topics of HCI [20], but also to “many worlds of design” [12]. An author of tangible narrative is bound to work in the intersection of IDN and HCI; we therefore believe RtD will benefit our research and design process.

An important characteristic of RtD is that it does not intend to build knowledge *for* the making of an artifact, but to build knowledge *through* the process of designing the artifact. This requires rigorous and meticulous documentation of the design process. For instance, we created prototypes with different levels of detail and functionalities to explore specific aspects of the experience. The true value of these prototypes, more than experimental platforms to “try something,” lies in the annotated observations and insights documented as written ideas, self-addressed notes, conceptual maps, sketches, and diagrams, which formed our autoethnographic journals. Through these, we established a way of systematically creating evidence of the research process, and generated new theory grounded on the findings that led to the iteration of the experimental work.

4 Designing *Letters to José*

Letters to José is a true story based on a series of letters sent in a late 1940s’ Colombia, which were addressed to José, a fresh army recruit, by Jesús, a young medical student and José’s brother. Among the letters, there was a noteworthy chronological gap of around six months on each; perhaps several more were sent and received but got lost over time, with only 27 remaining. There is no written record of José’s responses since many of the material memories of Jesús, including letters and photos, were gradually discarded after he passed away in 1998. Nonetheless, the remaining letters preserved a sense of order in the matters and events discussed. These family letters, perhaps by fate, eventually fell into the hands of the lead author of this paper, who is José’s grand nephew and also Jesús’s grandson.

The design project in this research is thus a process of transforming these letters into an interactive experience. The project first went through several preparatory steps including transcribing – from handwritten and typed texts to digital texts – and translating – from Spanish to English. It then entered the first phase to organize the texts into a coherent story and form a narrative structure. With the story roughly assembled, the next phase – editing and scripting – was focused on “making sense” of what the story

meant through a long editing process that paid particular attention to how interactivity could support specific narrative events. Once the detailed structure with the scripted actions was completed, the phase of crafting and prototyping started, leading to the final narrative product underlain by a tangible interface system. The following provides more details of the organizing phase and the editing and scripting phase.

4.1 Organizing and Structuring

With a preliminary translation completed, the content of the letters was arranged by the timeline with all the events between 1948 and 1957. To keep the narrative concise and manageable, only those events between 1948 and 1952 were integrated into three major character arcs. The first arc describes Jesús studying to become a doctor. The second arc portrays Jesús's life as a medical intern. The third and final arc depicts Jesús's life as a family man. Each character arc does not follow the traditional three-act structure. Instead, *Letters to José* is a character-driven narrative where the storyline follows the gradual transition from student into doctor and family man. This transition motivates the interactor to explore events and characters and progress with the story.

Once an overarching structure is established, each letter was broken down into its corresponding chronological events, and grouped into short texts – labeled as *S* content, as in *story content*. Along with the three main character arcs, a series of secondary arcs were created based on the anecdotes shared by Jesús about the life of other family members. These secondary arcs are not confined to one main character arc, but transverse to the entire narrative. This two-level structure allows the interactor to track crucial events that begin and end in the same secondary character arc.

To facilitate the tracking and understanding of each event, we decided to introduce an expositional type of content to the main narrative structure with three purposes: *expectation* (*e*), *dilemma* (*d*), or *context* (*c*). These *exposition* content are labeled as *E* content. Exposition with expectation *E(e)* intends to generate an expectation of what will happen in each major character arc. Exposition with dilemma *E(d)* intends to develop an active response – in the form of choice – from the interactor. Finally, exposition with context *E(c)* provides the interactor with a clarification of the connections between events. Table 1 shows some examples of these coded contents.

In its final form, *Letters to José* is a hybrid between a non-linear and a linear narrative. It is non-linear because the narrative structure allows the interactor to deviate in the secondary arcs. The structure of *Letters to José* is a combination of two types of structures – the maze structure and the vector-with-side-branches structure in Ryan's [32] typology of structures of interactive narrativity, which we call *mixed-maze* structure. According to Ryan, a maze structure includes multiple paths with a common starting and ending points, whereas a vector structure has a main path with side branches.

4.2 Editing and Scripting

Editing. With the above basic structure defined, many of the missing gaps of the story were filled in with narrative information obtained through background research and an interview with José. We noticed that the length of the final story was too long to be presented as an interactive narrative, given the limited attention span of people and the

high cognitive load of experiencing a story like *Letters to José*. It thus became necessary to edit a new version that fit the needs of the experience better. With this in mind, the story was revised for length, clarity, and order. Editing in this round focused on creating a chronologically organized narrative of each chapter while considering possible interactive and scripting needs. For example, several sentences were re-written or combined, prioritizing authoring creativity to absolute loyalty to the original autobiographical texts. Other fragments were removed, merged with others, or grouped into new ones.

Scripting. Previously when organizing *Letters to José* as a *mixed maze* structure, common points (e.g., anecdotes of a certain family member) in each letter's events were identified and links were built among them. These links could lead to other *exposition* or *story* contents and thus help create side branches. These branches are moments in which the reader can explore the storyworld with a clear way to return to the main storyline. In most cases, they are secondary character arcs that provide context between events.

At this point, however, the narrative structure was still 'static' without a strong sense of direction for the interactor. We thus created the third type of content – after story content and exposition content and call it *operation* (*O*) content. Their function can be informing – or *O(i)* or describing an action – or *O(a)* (see Table 1). *Informative* contents, as interface elements, address the person, advise, and guide how the person can act. Meanwhile, *action* contents provide feedback and then introduce possible actions. Both *action* and *informative* contents connect transversely with *exposition* or *story* contents. *Action* and *informative* contents are cognitive affordances that provide spatial and performative information. They direct the interactor towards auditory or visual cues that intend to trigger new narrative fragments.

Table 1. Content fragments of the script of *Letters to José*.

Text	Content	Directs to
<i>O(i.1)</i>	<u>Sign:</u> Touch the words "Bogotá or Cali"	<i>S(L.1A)</i> →
<i>S(L.1A)</i>	<u>Audio clip:</u> <i>After many days of not writing for reasons that will become clear later, it is a pleasure to take this time to write you a letter as I have many things to tell you.</i>	<i>O(a.1)</i> →
<i>O(a.1)</i>	<u>Audio clip:</u> <i>Read the text on the right panel, look for the light, and then pose and place the Puppet to continue.</i>	<i>O(i.2)</i> → <i>E(c.1A)</i> →
<i>E(c.1A)</i>	<u>Text:</u> A whole year went faster than anyone expected. This was the beginning of the 1950s, just when José started working training pilots.	<i>O(i.2)</i> →

Unlike *story* or *exposition* contents described above, *action* and *information* contents have a specific syntax. They should point to a location inside a physical place (i.e., the represented storyworld), and they should identify the object on which the interactor can act and/or describe the possible outcome of that action. The final step in creating the narrative was to script the different links between *story* contents, *exposition* contents, and *operation* contents. Scripting in this design project, therefore, means both script writing of the operational texts and system scripting in order to create linkage between text nodes just like in a hypertext. **Fig. 2** depicts the overall narrative structure with varied types of contents.

Looking at Ryan’s [31] characterization of plots, *Letters to José* can be described as an epistemic plot that is a superposition of two lines of stories. On the one hand, one story is the small events told by the letters, centered around Jesús’s life. On the other hand, another story is the narrative events intended to lead the interactor to discover and explore other side events. In epistemic plots, the desire to know is the key to engage the interactor [31]. This kind of narrative experience allows people to engage with the story as actors and spectators at the same time.

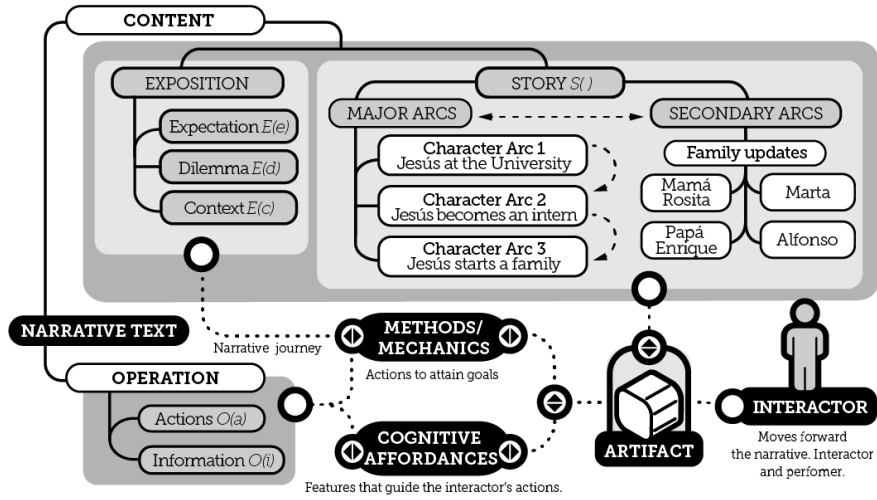


Fig. 1. Narrative structure of *Letter to José*.

4.3 Crafting and Prototyping

We decided to explore in *Letters to José* the under-researched physical-digital hybrid form in creating our tangible interactive story. After implementing three iterations of prototypes with various combinations of form factors and interaction mechanisms, *Letters to José* is finally presented as three interactive, multimodal, unfolding paper worlds that combine unique paper mechanisms with different visual, performative, and auditory modes (Fig. 2)

Each paper world houses a BareConductive Touch Board (TB) paired to a NodeMCU ESP8266 – both Arduino-based microcontrollers. The TB handles touch events using capacitive electrodes connected to graphics screen-printed with conductive paint. The NodeMCU controls a module that reads RFID tags in different artifacts. It also controls photocells, reed-switches, and a thermistor. Upon touching, reading a tag, or triggering any sensor, the TB plays an audio clip. With the ESP8266, each paper world *talks* to each other using though the User Datagram Protocol (UDP).

Every paper world is divided into separate panels, which are both the interface and the stage of the story. Each panel offers different ways to engage in using various artifacts. For example, the interactor can take upon the role of the main character represented in the cardboard puppet, unlock hidden stories, or touch words to activate short audio fragments of the story. Because of its non-linear nature, the narrative is distributed across the panels, branching out, or sometimes returning into the main storyline. In this

experience, the interactor's senses are stimulated in different ways; the story is told by a narrator but also read by the interactor, materials react to actions, and light sets timing and pace. These artifacts allow the person to move between interfacing with the interactive system, performing meaningful actions, immersing into the narrative, and back.



Fig.2. General overview of the set-up of *Letters to José*. On the left, Chapter 1 and 3, to the right Chapter 2. On the bottom, to the left, the Puppet; in the center, the Family Cards.

Some of the artifacts featured in *Letters to José* are:

- **Cardboard Puppet.** It is the avatar of the main character. The interactor must pose the Puppet by matching a specific shape to activate each narrative fragment. A magnet inside it triggers a reed-switch, which ultimately activates an audio clip.
- **Family Cards.** They represent José's family in the story. When placed close to an RFID module in a paper world, the tag in the card triggers a clip about their life. When a pull-out tab in the card is pulled, the face of the character is revealed.
- **Paper Flower.** The flower is unveiled using a fold-out mechanism. There is a 0402 surface-mount LED at the end of the flower's pistil. When the interactor blows the flower, the variation in the voltage of the LED triggers the audio clip to play.

5 Experiencing *Letters to José*

To observe how people are engaged with *Letters to José* and react to this unique form of tangible narrative, we conducted a small-scale study with twelve participants, using concurrent (quantitative and qualitative data were collected at the same time) and embedded (the quantitative data informed the qualitative methodology) exploratory mixed methods, in Creswell and Plano Clark's terms [7]. The main goal of the study was to investigate participants' phenomenological experiences and understand the motives, factors, and mechanisms that led them to enjoy the narrative. While most of this information can be gathered qualitatively, we decided to deploy three existing quantitative surveys as an aid simply gauging the high-level quality of *Letters to José*, in the areas of engagement, narrative transportation, and agency. The emphasis of the study, however, was placed on the qualitative component of the data, which is also the main source for us to derive knowledge in people's subjective experiences of tangible narratives.

5.1 Study Design

Participants and Procedure. The participant sample was based on a convenience sample recruited at our university. No reward or benefit was offered to the participants. All

twelve participants were students – between 18 to 44 years old – from different academic programs; seven were women and five were men. Eleven out of twelve participants were non-native English speakers from regions, however, where English is recognized as an official language. Five opted to individually interact with the narrative, while seven participants did it in two separate groups, one group with three participants, and one with four. In both groups, the participants were friends or classmates.

After giving their written consent, the participants were instructed on how to interact with the narrative. For the participants to gain the best experience and for the benefit of their time and attention, they freely interacted with Chapters 2 and 3 of *Letters to José*, following the instructions relayed by the audio clips, while the researcher observing on the side and taking notes. Once completing the experience, the participants individually answered three open-ended questions in written form. Next, they individually completed three short questionnaires, each measuring the level of agreement concerning different aspects of their experience. The session was then concluded with a semi-structured interview that focused on the experiential aspects of the narrative with particular attention to play, performance, and interactivity. A typical session lasted from 45 to 55 minutes, of which around 25 minutes were spent on experiencing the narrative.

Data collection and analysis. As mentioned above, participants responded to three instruments. The first one was the open-ended questionnaire with three questions sought to quickly recall and rationalize some of the most recent and relevant aspects of their experience. The second one was a set of three questionnaires with slight appropriation to our study context: 1) the User Engagement Scale (UES-SF) [28], 2) the Transportation Scale (TS-SF) on aspects related to being immersed in the narrative [2], and 3) the Sense of Agency Rating Scale (SOAR) that measures subjective alterations to the participants' sense of agency [30]. The last instrument was semi-structured interview, which was recorded in audio and transcribed to textual notes.

For data analysis, we only used the quantitative results – from the set of surveys and a timed-log – as a relative reference for each participant's levels of engagement, transportation, and sense of agency. The main analysis focused on qualitative data from participants' written answers, the researcher's notes, and statements from semi-structured interviews. We followed an abductive approach to our analysis by combining inductive coding (a list of a-priori codes) with an interpretative procedure based on Smith et al.'s [37] *Interpretative Phenomenological Analysis* (IPA).

5.2 Study Results

Using both inductive and deductive processes in our data coding, we identified five categories of themes. Through an inductive process, two categories emerged: the phenomenological experience, or what shaped the participant's subjective experiences, and the sensorial materiality, or the relationship between materialities and the participant's senses. Using a deductive process, three categories emerged: 1) the presentation, or how the participants understood the relationships between form and materiality, 2) the system, or how they interacted with the digital artifact, and 3) the narrative, or how the story elicited affective and cognitive responses. In general, our observations and comments from the participants suggest that the experience of *Letters to José* was quite

positive and unique compared to other interactive narratives. Both physical artifacts and narrative content presented in our chosen narrative structure stimulated the participant's perception and imagination and created enjoyment.

Phenomenological Experience. In this category, the analysis identified such subjective aspects as curiosity, enjoyment, exploration, and frustration. For instance, the participants felt curious when they acted by chance and unintentionally but found hidden surprises or entered a plot branch. Most participants expressed that they enjoyed the experience for different reasons; for example, because they were able to act, play, and unfold the narrative through physical, ludic actions, or because the narrative stimulated their imagination by the visual and audio cues. Like how Participant 16L commented on manipulating objects: *"the part where I had to place or pull objects [was] fascinating since it helped me visualize the real scenario."* On the other hand, the participants generally described three types of frustration: cognitive (e.g., language limitations), narrative (e.g., lack of context), or perceptual (e.g., missing audio cues). These negatively affected the enjoyment of the experience. From a purely phenomenological point of view, the participants' lived experience also influenced their comprehension of the narrative. In a related manner, meaning-making was reinforced (or hindered) by the coherence (lack thereof) between the representation of the story-world, the understanding of the story events, and the actions they could perform.

Sensorial Materiality. In this category, the analysis focused on the way particular material aspects of the experience, such as radiating light, speech and soundscape, and material qualities of the artifacts were perceived by the participants' senses. The participants expressed that the sound drove most of their interactions, while light supported many of the instructions relayed audibly. Their sense of touch allowed them to not only feel directly involved with both the narrative and the control aspects of the experience, but also appreciate different aesthetic characteristics of the narrative system. Such characteristics as the visual features, soundscape and the material qualities of the panels were aesthetically pleasing to the participants. Among the most interesting findings is the primacy of sound over other perceivable modalities, sometimes leading to the loss of attention. Nevertheless, the modality of sound was also one of the most enjoyable aspects of the experience because it helped trigger the participant's imagination.

Interactive Narrative Experience. Here the analysis focused on the effects brought by the set of design elements that form the ontology of the interactive narrative system. These elements come from presentation design (– mostly related to interface design but also including performance logic design), story design, and system design. Most participants agreed that the overall agency is limited in terms of the actions they could do. However, they were satisfied that they could control the story's progression and influence the way the narrative unfolded by taking mostly spontaneous actions in their physical performance. There were moments in which they planned their actions out of curiosity, or as an answer to a prompt of the system. The different mechanics of the narrative system made sense to most of the participants, as they were able to gradually internalize them along the way. Crucially, the participants attributed their story comprehension to the artifacts that helped establish a narrative context and the two-level mixed-maze narrative structure that made them feel curious to explore the narrative. Additionally, the first-person narration made some participants feel empathetic towards the

main character of the story, leading to a sense of amazement, introspection, and sometimes emotionally connected to specific narrative events. For example, Participant 04B commented: “*I remember... one of the family cards... says: never be too late to contact your mom. And it's a little bit touching to me. It reminds me to spend more time with my parents.*” In a case like this, an interactor identifies with the character because of similar life experiences. They felt rewarded because the experience stimulated their senses and it was *their* active participation that allowed the story to unfold.

6 Discussion

Artifacts for Interactive Storytelling. With reflections of the design process as well as the study results, we identified *artifacts* as a critical design category for tangible narratives with three primary qualities revealed in our research and design. The three qualities are: *a position in time and space (diegesis)*, *a relationship between representation and action (embodiment)*, and *its role in the narrative system (function)*. Both diegesis and embodiment are gradual qualities complemented by the artifact’s function in the narrative system. The higher the value of diegesis (diegetic, transdiegetic, or extradiegetic) and embodiment (full, coupled, or non-graspable) in these qualities in the artifacts of a narrative system, the more tangible they are, and the closer their representation is to the story. In real world, artifacts are objects with unique communicative and semiotic purposes. In a tangible narrative system, artifacts have concrete meanings; they can variably represent a character of the story, a function of the system, a tool, or everything at the same time. Our study findings showed that participants responded to the artifacts in *Letters to José* not only on how they worked in the narrative but also on how they stimulated their senses through the visual, tactile, or even auditive features.

In other words, artifacts for storytelling must have a position in time and space, establish a relationship between what represents and the possible actions, and assume one or more roles in the narrative. As suggested in our study findings, *artifacts* in *Letters to José* had various impacts in the phenomenological experience of the participants; they can drive their comprehension of the story, support their curiosity and interest in the narrative, and provide and constrain their agency. The Puppet in *Letters to José*, for example, can be characterized differently. It is fully diegetic because, as an artifact, it represents the likeness of the main character in the storyworld and the real world. However, it is fully embodied because it not only can be posed, so it looks like it is driving a car or sleeping in the bed, but also can trigger sound in another part of the presentation space. Finally, the Puppet can also be transdiegetic when used only as a mediator between the tutorial and the interactor. Its function in all the cases described above, is exploratory because its operation does not alter the narrative in any way.

Designing Hybrid (Physical-Digital) Narrative Systems. We have discussed above the role of physical artifacts in a narrative system. When it comes to placing artifacts in a hybrid system, there are a few design lessons we learned from both our process and the literature. *First*, consider the artifacts’ materiality, not only its tangible aspects but also the way the artifact is perceived by other senses [29]; they can vibrate, emit sound,

have different textures, or even produce a smell. Sometimes this materiality can set the conceptual context of the storyworld or stimulate the imagination of the interactor. All these aspects might contribute towards adding meaning to the artifact in the context of the narrative, as seen both in *Letters to José* and examples in literature (e.g., [43, 36]). *Second*, have a clear understanding of the possible roles of the artifact. This is because interaction through artifacts in a narrative is usually less rational or pragmatic, allowing for playful and fun methods of interaction, again as seen both in our study and examples in literature (e.g., [8, 11, 38]). *Third*, the dual role of the artifact as an ‘input’ that triggers digital content and an ‘output’ that expresses digital content [16, 44] can be an interesting resource that authors and designers of hybrid systems can take advantage of.

7 Conclusion and Future Work

Letters to José is at the same time a tangible story and a research through design project, through which we explored various design aspects and experiential qualities of tangible narrative. Within the scope of this paper, we presented the structural considerations of *Letters to José* and briefly discussed some of the most relevant findings of a study that sought to investigate participants’ experiences with *Letters to José*. One of the key findings is that it is of vital importance to organically integrate ludic actions with designed stimulation of the interactor’s imagination through different modalities and materialities in interactive storytelling. In reflecting our research through design, we identified the critical design category of *artifacts for storytelling* and discussed extensively on their characteristics and roles in supporting the narrative experience. We also demonstrated a series of decision-makings to address complex problems related to shaping interactive experiences in the context of tangible narratives.

Although our study showed positive reception of *Letters to José*, more work needs to be done in order to derive more generalized findings for researchers and practitioners in IDN. In the immediate future, we plan to refine the categories of the current study results, with reference to our design annotations along the making process, so to elicit a set of critical constructs for an authoring model for tangible narrative systems. We also plan to further refine the categories related to artifacts and materiality and derive principles regarding physical design for TN.

Ultimately, our ideal tangible narratives, located in the broader realm of IDN, must illustrate non-competitive, self-expressive play that provides greater agency, use system mechanics to exploration the narrative world, prioritize narrative aesthetics over win/lose states and foster immersion through narrative pleasure, but above all the mediation of artifacts that support the storytelling process.

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