Loominary: Crafting Tangible Artifacts from Player Narrative

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ABSTRACT

While game narrative provides a story for the player to experience, the moment-to-moment decisions made by the player are just as important to the experience. These decisions make up a personal narrative that the player creates through their choices and actions within the game. These stories describe the player's experience, and are the stories that often get shared and retold by the player. However, these narratives are rarely captured by the game and instead rely on the player to memorize and retell them. In response to this, we designed Loominary, a game platform that plays Twine games using a rigid heddle table-top loom as a controller. Not only does this provide a new method of interacting with a game, but also records each of the player's choices into a tangible object that is created by interacting with the game. Loominary is a working prototype and in this paper, we discuss the design considerations and areas for improvement.

Author Keywords

Computational craft; game narrative; physical interface; tangible artifacts.

ACM Classification Keywords

• *Applied computing~Media arts* • *Applied computing~Computer games*

INTRODUCTION

In many story games, players are invited to explore a story world and work their way through the narration. In the process of interacting with the game and story, the player and the game designers are co-creating a narrative as a product of play. The authors and designers impose a set of constraints on the general shape of the outcome, but the details of the final crafted narrative are in the hands of the player.

Crawford [5] describes the moment-to-moment choices of a player as the basis of interactive storytelling. These player narratives are frequently more interesting and important to the player than the story created by the designers. Prominent game designer Wright [18] said in his talk at SXSW in 2007, "Players invariably come up with stories about what they did in games. They're never describing a cut scene." We posit that players have more personal investment in the narratives they have crafted than the ones they have been given, and often these crafted stories are unique to the player which increases their ownership of the story.

While players create their own narratives, the final product is rarely captured by the game, and instead it is up to the player to memorize or capture the details of their choices. There are places that exist such as websites like Obsidian Portal [19] and forums such as Giant in the Playground [20] which have dedicated areas for players to post their stories from their gaming adventures. Player narratives have also been captured in visual formats such as Let's Play videos, twitch streaming, and fan art. However, all of these methods rely on the player to create the retelling of their story.

Loominary was created to capture player narrative in a visual way through the creation of a tangible artifact as part of play. The game uses a small table-top rigid heddle loom as the interface to the game, with the player's choices being made by taking actions through the use of the loom. Through play, the player creates a tangible artifact, with their choices represented through the colored yarns they weave with. The crafted traces of the player's choices are diegetic artifacts that provide a record of the improvised outcome of play. The artifact can also provide a way to visually compare experiences between players, and work as a visual aid for the retelling of their narrative.

This paper describes the design and details of Loominary, and the method employed to capture the player's narrative in a tangible way.

RELATED WORK

We situate this game in the field of computational craft, which broadly focuses on ways computation and craft can both co-exist and inform each other. Weaving is only one of many forms of craft, but the domain of computational craft is small enough that we looked outside of weaving for inspiration for our game.

Loominary generates a pattern in the woven artifact through the actions of the player and from the physical action of playing the game. The specific pattern is co-created from

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both the game and the player making choices. Crafts created from computational pattern generators are not new, and work such as Elliot's [21] Processing pattern generator and Grow's [7] blackwork pattern generator generate patterns for quilts and blackwork fill patterns for computerized embroidery machines, respectively. Both of these works utilize the generative power of computation for creating new crafted works. Unlike our work, these programs generate an entire pattern that is then followed by a human creator. However, we drew inspiration from Elliot and Grow's work by studying the volume and variety of possible outcomes and considering how that could be modified to support possible player narratives.

Using crafted materials as interfaces to games has been done before in games such as eBee [4] and Addie's Patchwork Playground [16]. eBee uses hexagonal quilted pieces, each with a pathway across the piece made of conductive fabric sewn on the surface. The players take turns laying the pieces on a board to try to connect the power source to a light source and completing a circuit. In Addie's Patchwork Playground, a quilt with conductive fabric buttons uses capacitive sensing to turn the quilt into a controller for a platform style game. The digital game uses fabrics and stitch motifs to connect with the aesthetic of quilted controller. Our work was inspired by the crafted and tactile nature of the interfaces for these games, although we chose to incorporate the act of crafting as part of our control scheme instead of using a finished product, as we are interested in a personalized artifact from play.

Games also exist in which the player has access to, or is able to get personalized artifacts of their play session. One such example is Firewatch [3], an adventure game in which the player moves through beautiful scenery and takes in-game photos while following the story goals. The player then has the option of spending money to purchase physical "photos" matching the pictures they took in game. In the game Threadsteading [1], players take turns controlling a computerized embroidery machine or a computerized quilting machine in a strategy game where they battle for resources. Through play, the pre-printed fabric board has the game output sewn on it and the board with the final design is available for the winner to keep. Both of these games make use of physical artifacts as reminders of the player's game session and were inspirational in the making of Loominary. However, in Loominary the player is more directly making the artifact, and the finished woven piece does not specifically look like a game artifact, and in fact can even be worn as a scarf.

There also exist a number of games that use artifacts to tell stories. In the Intimate Fields [2] game there are a series of items, each associated with a different posy, or small love poem. As the player interacts with each item, the posy is printed out on a thermal printer.

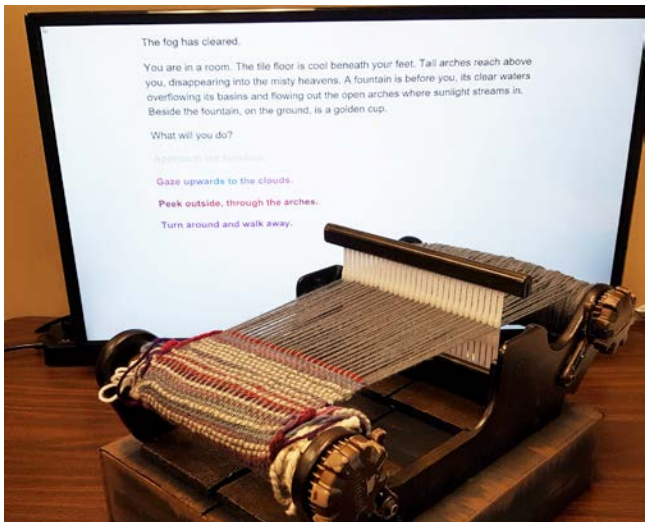

Figure 1. The loom controller with the game displaying behind it. The electronics are hidden in the base.

The Reading Glove [17] gives the player a glove to use to interact with various storied items. When picking up each item, they hear a piece of a story, with the narrative sequence being chosen based on the ordering in which the player interacts with the items. Games and experiences such as these led us to be interested in story artifacts. In our work we used this as a starting point for creating Loominary which creates a story artifact through play.

LOOMINARY

Loominary is a game in which the player creates a tangible narrative artifact through the process of play. The game is a Twine game, which looks similar to a Choose Your Own Adventure style game. In the Twine games for Loominary, all the choices in the game are assigned specific colors.

The game controller is a physical table-top rigid heddle loom as shown in Figure 1. To make a choice in the game, the player weaves a row in the artifact with yarn the same color as the choice they want to make. In this way, the player's choices are literally woven into a physical record of their play session.

Two of the Twine games we have created for Loominary are retellings of Greek myths, in which the player takes on the role of the Fates and weaves the fates of the characters. One game looks at the story of Medusa, while the other follows Oedipus. While these games were created specifically for Loominary, any appropriately color-coded Twine game could be adapted to work with the system.

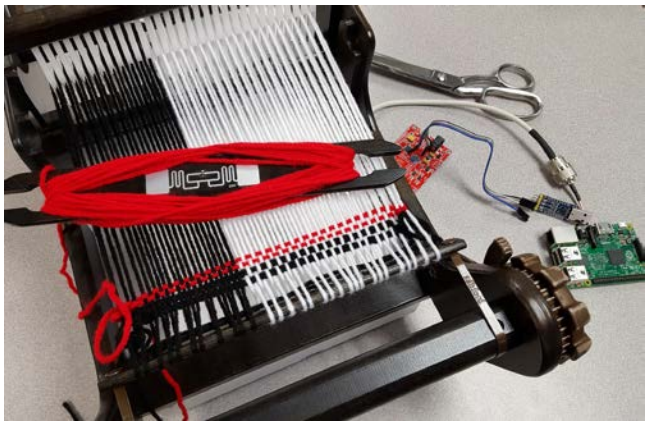

Figure 2. The shuttles (the sticks that hold the yarn) are pre-wound with specific colors and each is tagged with an RFID sticker.

We also have two other experiences for Loominary. One is a tutorial which walks the player through the process of weaving. The second is a child-friendly game in which the player spends the day with Posey the Pony, exploring the landscape, eating berries, and brushing hair.

Mechanically, the loom is unaltered. However, the shuttles (flat wooden sticks that the yarn is wound around) each have a unique RFID tag as shown in Figure 2. Each shuttle is pre-wound with a unique color and the system is calibrated to match the RFID to that yarn color.

The hardware and software for the project consists of several parts as shown in the architectural diagram in Figure 3. The first is a large RFID antenna connected to a RFID reader module. The antenna registers the RFID tags located on the shuttles as they pass in range and sends the data to the RFID reader module. We have set a delay between readings as the shuttles are in range of the reader for some length of time while weaving, which varies between players. However, players may weave with the same color multiple times in a row, and we needed a way to differentiate between one or multiple weaving actions.

The RFID reader module translates the data from signal to code and sends it to a Raspberry Pi. The Pi is the computer for the system as a whole and handles the interaction between the software programs. A monitor is connected to the Pi to show the game on screen.

There are three major programs in the project. The first is a NodeJS server which hosts the Twine games as an HTML page. The second program handles receiving the RFID signals from the RFID reader module. This program takes the encoded signal and sends it via JSON to the server. The server then sends this signal via sockets to the Twine game, where the color choice is handled in JavaScript within the Twine story. This Twine HTML page is viewed by the third program, a standard web browser.

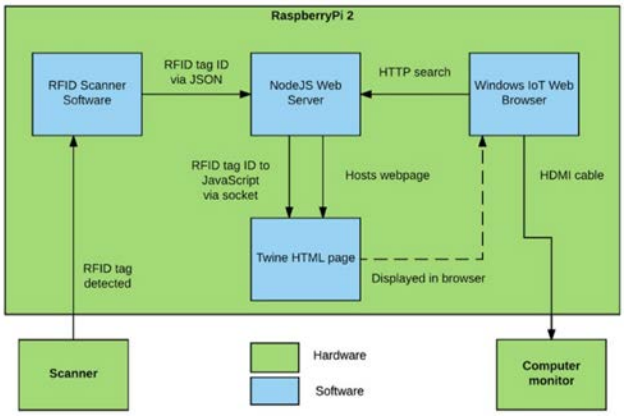

Figure 3. Architecture and software diagram of the Loominary system.

The project is open source, and information about materials, source lists, tutorials, and code are all available at the following link: http://www.loominary.info.

Interface Design

In building Loominary, we designed the interface first and then built a game to leverages its affordances. We surveyed different forms of creation in art, craft, and maker domains. While CNC (computer numerical control) machines are common in makerspaces (e.g. 3D printers and laser cutters) and were initially appealing as it is less of a logical leap to work with a computer game, we discounted them as we wanted to give the player the experience of using their hands to create the object that represented their story. This led us towards arts and crafts.

While the line between arts and crafts has evolved and shifted over time to the point where it is beyond a simple classification [11], we chose to define our interface as a crafting interface, as the current iteration of the game does not allow for much artistic expression. When looking at the history of crafting, there is a long and rich history of both subversive and overt storytelling [6,8] which we are only scratching the surface of, but gives us many interesting areas to explore in further work.

Based on the decision to utilize a crafting interface, it was important to choose an appropriate craft form for the player to interact with. There are many crafts from which to choose from, but we began by assuming the player has no prior knowledge. We therefore wanted to select a craft with a low barrier to entry.

We chose a rigid-heddle loom as the controller for a number of reasons. While weaving is a skill-based craft, rigid-heddle loom weaving has a smaller form factor and is straightforward to learn and teach the basics of the plain weave. This style of weaving also does not require complex hand dexterity such as that required by knitting or crochet, and the loom itself is portable, has minimal moving parts, and doesn't require safety equipment unlike some other craft forms.

Additionally, weaving has a long history with computation, and a centuries-long history with storytelling. The importance of more intricate designs in weaving led to the Jacquard loom [9], which used long punched cards to control the hooks that determine the pattern. Using punch cards to "program" the loom became the conceptual precursor to the use of punch cards in programming.

Woven tapestries have and are still being used for storytelling throughout the world, such as the Angers Apocalypse tapestries [12] from the late 14th century, which depict scenes from the Book of Revelations, to the Andean textiles [10] still being woven in Peru. Tapestry and Andean weaving are both more elaborate forms of textile creation than what we use in Loominary, but it was part of the inspiration that led us to using a loom as the controller for our game.

One of the more difficult aspects of weaving is setting up the loom by warping it – running the length-wise yarns in a way that has consistent tension and is appropriately wound around the roller. We have worked around this by preparing the loom ourselves ahead of exhibitions, but this does cause some issues that we cover in more depth in the discussion section.

We also considered the aesthetics and form factor of the loom. The table-top loom we are using is small and unimposing, but still retains the aesthetically pleasing appearance of a wooden, well-crafted item. Furthermore, we chose to hide away the majority of the electronics and cables inside a rustic-looking box. This helped set the "magical" tone for the game as well as beautify the appearance of the system since players would not be distracted by modern machinery or flashing lights, aside from the monitor displaying the Twine story.

Once the loom was chosen, the next step was finding a way to indicate the player's choices. Color was determined to be best suited for this purpose. Color is familiar to many people, as a selective visual variable it can quickly communicate choice, and it is not domain specific. While changes in weave types or yarn types can also be used, these require more specific domain expertise which worked against our assumption that the player would have no previous knowledge.

Color also gives us the ability to code game decisions with cultural meaning, which can be used as shortcuts and to indicate consequence in our design. For instance, in the game following the story of Medusa, certain sequences depicting Poseidon's rape of Medusa are captured in dirt brown, signifying the distastefulness of the act. While color significance is culturally dependent, it is still useful for the game designers to consider in the creation of the games.

Due to the lack of domain specificity, using color also eased the mapping between the weaving and the game interface. Using different weaves or yarn types would have required introducing unfamiliar interfaces to the player.

Figure 4. A portion of a woven scarf after multiple play sessions during an exhibition. Each time there are at least 3 grey weft yarns in a row, it signals the beginning of a new play session.

Given the use of an already unfamiliar controller, we wanted to minimize the amount of translation and knowledge gains required to play the game.

With these choices in mind, the final artifact created in the game is a scarf with the color of each row correlating to a choice that the player made. As the loom is pre-prepared with the warp (lengthwise) yarns, the game designers choose the color of the warp, while the weft (widthwise yarns) is added by the player. Generally neutral colors are used for the warp to allow the focus to be on the weft colors, but this is an area for future design exploration. See Figure 4 for an example of a section of a woven artifact created through play.

While using a loom and color as the interface to our game gives us many novel affordances, we do recognize that there are extra limitations imposed by these choices. For instance, the loom requires two hands to operate, and the use of color means that it does not work well if the player has color-blindness. Accommodations could be made to increase accessibility in these respects by choosing colors that have contrasting value, and using a loom that has been modified for use with one hand.

Game Design

The game's interface naturally influenced the game design; crafting is often a slow, meditative process. On the other hand, real-time video games tend to be fast-paced and twitch-based. Because of our choice to use a crafting interface, these types of games were not appropriate for our use. While this does have some limitations on what games are possible to create using this interface, we find the affordances of a crafting interface to be worth the constraint in game design.

To accommodate the loom as an interface, we looked at turn-based and slower game styles. Because the impetus of the project was looking at player narratives, narrative-centric forms of game play seemed the most appropriate for our use. Twine was a natural fit given that the games are text-based, not timed, and have built-in support for color-

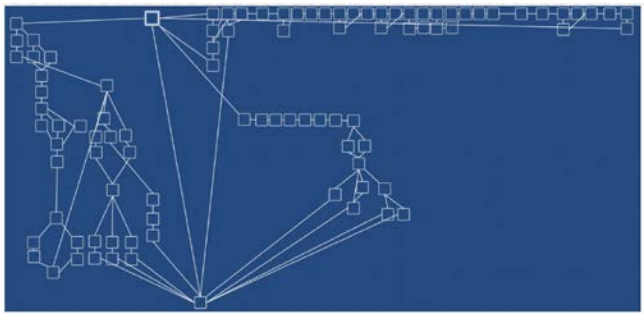

Figure 5. The graph structure of our Twine games. The left section represents the story of Medusa and has more branches than the other two stories. The middle section is the tutorial which is fairly linear until the end. The right section is quite linear but has many inter-dependencies.

coded options. Even the name is a good match for the project given that the player would be working with yarn.

For the development of the game, we initially looked at adaptations of Greek myths where the player takes the role of the Greek Fates and weaves the lives of the characters in the stories. We have completed initial versions of three games and a tutorial. Two of the stories deal with Greek myths of Medusa and Oedipus and the tutorial fits thematically with these stories. The third story was created in response to the number of young children who were interested in trying our game, as our stories were not appropriate for children. We created a shorter experience that allows the player to spend a game day with Posey the Pony and is appropriate for all ages.

We chose this Greek myth genre as an attempt to integrate the weaving with the game. Weaving the fates of mankind is a metaphor that many people are familiar with, and many of our adult players understood the reference to The Fates. To strengthen the integration, the colors of the options (and therefore color of the yarn the player is working with) were chosen to work with the story. For instance, the story of Medusa uses greens, greys, and brown which are fitting to the content and characters in the story given that Medusa herself is often depicted in these colors.

In the creation of the game, the designers also had to keep the tangible artifact design possibilities in mind. We created games in which the options would have real consequences on the storyline. While there are some events that are unchanged based on the player's choices, the different possibilities are tied together. For instance, some narratives are unavailable unless the player has explored a different narrative pathway in an earlier play session. We chose to create the games with this type of structure because it would lead to more variation in the final artifacts.

The graph structure of the games is shown in Figure 5. The longer the game play is, the more the differences in player choices can be seen. For instance, the differences in the artifact created by playing the story about Posy the Pony are minimal while those created by playing the story of Medusa are more noticeable. Additionally, the more branches that are available within the story, the more variation there is between artifacts. For instance, the fairly linear nature of the Oedipus story leads to locally similar artifacts, whereas the story of Medusa can lead to a larger variety of colors in the final artifact. Given that a linear story would produce no variation, this is not a surprising outcome.

In some cases, the game designers also used color strategically while creating options in the game. Important choices used special colors so that they stand out in the final design of the artifact. We also relied on American cultural implications of color to signify things that were happening in the games, such as greys and purples being used for the calm and mystical feel for the tutorial.

We further considered the ease of which the colors could be differentiated when appearing in the text. For instance, while having multiple shades of green may be aesthetically pleasing, it did not work in practice to have players attempting to differentiate whether an option was kelly green, fern green, or grass green. Instead we needed to limit our color scheme to colors that were more easily differentiated. This somewhat limited our color options as we balanced a pleasing final artifact with the need for players to correctly recognize which colors they needed to be picking between.

While this paper discusses the stories we created, Loominary was designed to be a platform for storytelling with a loom as the interface device. The technical architecture allows for any number of stories to be authored and easily played using the loom interface. Authors can produce a story in Twine, modify passage links to be bound to a color of yarn, and export the story to the hardware. Given this ease of authoring paired with the entire project being open source, we hope that others will use Loominary to create their own experiences.

DISCUSSION

Loominary is exploratory and has many details that could be improved by future design and technical iteration, and many directions that we intend to explore further.

Player Narrative

As stated previously, we looked at player choice carefully when creating the games for Loominary. We are interested in making sure the player has interesting and meaningful choices; to create playable stories [15].

Figure 6. Young players of Loominary learn how to use the controller. They then went on to teach the controller to their other family members after learning.

Looking at the possible traces through the games, we feel that we have managed to create some interesting and meaningful choices, but that this could be pushed further in future games. We feel that this is, in part, due to using Greek mythology as the foundation for our stories. Because these stories have been told and retold for centuries, there is a strong understanding of the narrative structure and how the stories should proceed. This led to over-constraining the space for the narratives to develop, and we have already begun creating stories in different spaces which rely on less constrained story settings.

Another area of improvement is in creating longer experiences. Currently, a single play through of the Medusa storyline takes about 10-15 minutes, and creates about 5" of woven material. While the story is meant to be played multiple times, and the length of play is appropriate for exhibitions, it would take many repeated games to create woven material of significant length. We attempt to remedy this with the Oedipus game, which is longer and requires multiple plays before the player accomplishes their goal. However, a full playthrough of this game still comes short of a significant woven piece.

Given the nature of sharing stories between players and on the internet, it seems clear that players feel a connection to the narratives they have created in the games they play. However, the ownership of the story is murky given that the game designers are co-creating the player's narrative through the constraints of their game. With Loominary, the player is still co-creating a narrative, but they are also solo-creating the woven artifact, which we hypothesize the players will feel greater ownership towards. We are interested in exploring further what differences may exist between how the players view the narratives they've created in traditional games versus the games played on Loominary where they have created their own narrative-based artifact. We hope to research this further with longer stories and more choices available. Making this possible is discussed in further detail in the following section.

Interface

In use, we have found that the loom is compelling to audiences, and met our goals of ease of learning and use. We found that both children and adults were able to learn the control mechanism quickly. In some instances, including the one pictured in Figure 6, the users felt confident enough to teach the controls and how to weave to their friends and family members after they themselves had learned.

However, the loom does require significant effort to set up for play. Warping a loom requires skill and space, and needs to be done for the game to be playable. We have worked around this by pre-warping the loom before exhibitions with a length that is suitable for many play sessions, but it is a significant limitation given our eventual goal of creating tangible artifacts for each player. It means that after play we have a single artifact with many people's stories woven into it, instead of each player being able to take their own piece.

Finishing techniques for a woven piece also requires time and skill, although techniques exist that are novice friendly. To address both the set up and finishing issues with using Loominary, we plan to include links to video tutorials of how to warp a loom and how to finish a woven piece on our github page to assist those who wish to create their own versions for play at home.

Given the amount of time that making a scarf would take, we have found that an exhibition is not an appropriate setting for having each player create their own artifact. This limits the testing we can do to study whether the artifact has personal meaning to the player and whether it retains that meaning after time has passed. Given the time constraints of finishing a piece, we will likely address this by finding ways to make the game available for longer play sessions in a quieter, solo setting.

In future games, we are addressing this by designing the systems from the ground up to be appropriate for an exhibition setting (since that is the most likely way people will interact with these games) with each player being able to keep the piece they have created while still contributing to a collaborative story. We are also investigating ways in which a collaborative storytelling artifact can be experienced and appreciated by everyone that helped create it, such as having it displayed in a public space.

For the electronics, we rely on RFID and a long-range RFID reader to capture what color the player is weaving with. Because the player can weave with the same color

multiple times and the RFID reader is so sensitive, this can lead to a difficult balance in properly capturing the act of weaving. Additionally, RFID interference can be an issue given the strength of our antenna.

A more mechanical solution may help with this, but we initially had a goal to keep the loom as unaltered as possible for aesthetic reasons. However, this will need to be addressed in future iterations of the hardware, as it is a limitation with play that can make the controller feel unreliable. It is possible that making our own shuttles with accelerometers or other sensors available could solve these issues.

Aesthetics

While the loom is aesthetically pleasing and compelling, there is still room to improve the aesthetics of the game and artifact. We are already working on creating new games that use fonts and backgrounds other than the defaults as a step of refinement. Twine also supports the use of graphics, which could also be used to improve the visual quality of the stories.

The artifact itself is a mixture of stripes of color based on the player's choices (see Figure 4). The stories were not created with the finished aesthetic in mind beyond the initial color scheme. The stories could be written to take different player tendencies in mind. For instance, if the description text was created to always use cool colors, and plot point descriptions used warm colors, players who explore all the description text would create a bold, striped artifact, while those who skipped descriptive text would create a more solid looking artifact.

Along with improvements, there are areas of interest that we wish to explore further with this work. We are currently driving the aesthetic of the woven artifact by the game play alone. That is, the game does not take the player's own interest in color and color choice into account. This ignores the fact that players may be interested in the artistic expression of the woven piece itself. Creating games set in worlds with recognizable scarf patterns (Harry Potter, Dr. Who, etc.) could lead to experiences in which players may be drawn towards a certain aesthetic of woven artifact. Matching this with player modeling and prediction systems would allow us to see how far players can be pushed out of their preferred play style when driven towards a specific outcome and can be used to measure the strength of the player's aesthetic versus in-game goals.

Creating visual and tangible play traces for each player gives us a novel way to compare the uniqueness of the game's possible narratives. Looking at play traces to measure the expressive range of a system [14] as well as using play traces to find the most used paths through a game [13] is a common method of study. However, having tangible play traces allows players and observers to easily compare how different the outcomes might be without needing specialized skills or knowledge, or access to data.

CONCLUSION

Games provide a sandbox for players to explore, and through gameplay, the players create a personal narrative based on their choices in the game. These narratives are generally ephemeral, and rely on the players to remember and retell the story. In this paper, we presented Loominary, a narrative game experience with a physical loom controller in which players create a physical and tangible artifact recording their choices through the process of play. The woven artifact uses color to represent the player's choices in the game as a color-coded play-trace.

There is still much to be learned and explored in this space, and we are excited to continue working with crafting interfaces to investigate the ways tangible artifacts support and grow our understanding of player narratives.

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