Shared Narratives as a New Interactive Medium: CrossTale as a prototype for Collaborative Storytelling

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Abstract—**Through ages, storytelling has been used as one of the main ways for sharing knowledge. We envision the use of shared narrative spaces as a new kind of media that empowers the collaborative creation of vast narrative worlds. We identified existing information systems related to storytelling, and evaluated how they support multi-authored non-linear narratives. A pilot experiment was conducted to understand the user interaction model with shared narratives more profoundly, and we extracted the main interaction factors observed: the different modes of interaction performed towards the informative space, the exploration of a non-linear medium through linear storylines, and the preservation of literary consistency. This model was later transduced into a set of design implications for collaborative narrative systems, which were used as a premise for designing a prototypical tool called CrossTale. Finally, we conducted two experiments to evaluate CrossTale's interaction model and user experience. We discuss how the results of these experiments show that shared narratives have the potential of becoming a distinct type of interactive medium supporting a new genre of user experience.**

Keywords-shared narratives; information systems; user experience; multi-authored composition; storylines; consistency.

I. INTRODUCTION

The present article is an extended version of the work presented in CrossTale: Shared Narratives as a New Interactive Medium [1], which examined the use of shared narrative spaces as a collaborative medium through a prototype tool named CrossTale. In this article, we deepen on our understanding of the interaction aspects of shared narrative spaces and their implication on designing systems supporting multi-authored storytelling; and also present a complementary research on consistency preservation through the development of new experiments with CrossTale.

Traditionally, storytelling (from mythological parables through literature classics to modern literary fiction best-sellers) has been associated with the oral and written media, the first two channels of information transmission to appear in human history. Since then, different models of cultural expression had appeared, and those modalities had taken profit of technical advances giving birth to the main contemporary narrative vehicles such as novels, cinema, TV series or comic-books. All those kinds of narrative mediums share the trait of linearity, which suits the temporal causality of classic narratives. In spite of that, several experiments about experiencing narratives in a non-linear way were done (e.g., Moholy-Nagy "total theater" [2] and Borges' tales [3]). With the apparition of digital media, new opportunities arise for creating and experiencing narratives in new ways.

Many contemporary works focus on understanding and modeling storytelling as an interactive experience. Mehan's Talespin [4] is a pioneering approach for automatically generating stories from atomic parts, and is an instigator of a larger body of research focusing on computer-generated narratives. On the other hand, other works studied narratives from an HCI perspective, placing user interaction at the center: Brenda Laurel's work on interactive fictions, impacting HCI as a discipline by underscoring the properties human interaction with information [5]; and Chris Crawford's work on interactive storytelling [6], which addresses aspects of game design. A wide range of actual works focus on models for creating non-linear narratives [7] [8], but to the extent of our knowledge they do not address this task from the perspective of user experience and the study of the user's understanding of non-linearity and narrative consistency.

In terms of media evolution, interactivity represented a change from the mono-directionality of traditional storytelling to a new paradigm better suited for non-linear narratives: through hypertext fiction, conversational adventures or other videogames, users are an active part of the system, performing the exploration required by a non-linear medium. There were also changes concerning the human aspects of media authoring and experiencing. The "fanzine" movement (magazines created by fiction followers who create non-canonical stories) gave way to the apparition of internet communities of novel, movie and TV-series fans that gathered at forums, shared their stories, and catalogued their fiction worlds using tools as wikis. The professional production of fiction also benefited from technological advances, and software for the development of commercial fiction has made appearance, with some examples, as Celtx [9], operating in the cloud as a collaborative tool.

We use the term shared narrative space to address the informative spaces concerning vast narratives created, developed, and maintained through the collaboration of multiple authors. A vast narrative space can be defined as a set of narrative information units organically to form a non-linear story. Those units can have a wide range of granularity depending on the nature of the narrative (e.g., an issue of a comic-book in the informative space of the Marvel Universe,

a book in Terry Pratchett's Discworld literary saga, or a chapter in Borges' The Garden of Forking Paths). It is a ludic and cultural medium of expression and communication. As a narrative, it is composed of a story and a discourse (storytelling). The story consists of a setting in time and space, characters, and events (or plots). It is usually thematically unified and logically coherent. Its elements are connected through cause and effect relations, thus temporal order is meaningful [10].

This non-linear medium is comparable to the real-life development of events: multiple stories are happening at the same time, and each can be told from different viewpoints. This points towards the suitability of non-linear narratives not only in developing fiction, but also as a way of sharing information like in online networks (e.g., forums, chats, and communities of creators). Theoretically, the content of social networks could be considered a narrative based on the sequential groupings of threads as scenes. Each forum thread could be regarded as one linear development inside a bigger story, and parts of the same thread could belong to different developments as a cause of this inter-relation. However, the relations between threads are usually vague or inexistent, and there is a need for a global connection between them to provide thematic unification and overall coherence.

Our purpose is to define the adequate system concepts and design to represent and interact with non-linear narratives. Therefore, we developed two empirical experiments with paper-based and digitally-implemented prototypes to extract and understand the user's mental model of interaction with a narrative space, as a basis for the development of modern interactive systems for narratives.

This paper is structured as follows. First, we give an overview of some relevant works related to shared narratives and point out their common concerns about accessing complex information structures and preserving its consistency. Next, we present six major types of information systems related to storytelling, and evaluate their support for shared narratives as a medium for content generation, collaboration and communication. Then, we illustrate a pilot experiment conducted to extract the user model of interacting with a shared narrative space. This model is explained distinguishing its major interaction aspects: First, we detail the different approaches taken by the users interacting with the narrative information depending on their reading or creative tasks; secondly, we describe the "time-space-development" mental model users follow when comprehending the informative space, and how they search for character and plot relations in order to establish linear reading paths or "storylines"; finally, we expose how readers request consistency to understand the narrative. In the succeeding section, the observed interaction factors are transduced into design implications for informing the design of multi-authored narrative systems, and we present CrossTale as a prototype based on these design suggestions. The next section describes CrossTale user evaluation showing the feasibility of supporting new elaborated user experiences with shared narratives. We then discuss how our results deepen our understanding of the characteristics of the interaction with shared narratives: we consolidate our space-time-storyline paradigm for exploring and contributing to narrative spaces, and point to how implemented rules can contribute to maintaining consistency, explaining how this affects the user experience. In our discussion, we argue in support of the potential of shared narrative spaces as new media for collective generation and development of content, communication, and human interaction. Finally, we conclude by summarizing our work and discussing its limitations, and then address their implications on future works.

II. Related Works on Shared Narrative Spaces

There seems to exist a common problematic when approaching the construction of non-linear, interactive narrative structures: the linearity of the narrative classical dramatic structure (that comes from a one-directional medium) seems to be in contradiction with the divergent, open structure that interaction needs as a bi-directional medium; so it is necessary to find a scheme that facilitates a balance between interaction and storytelling. This occurs at a large scale in mediums like videogames, where the interaction is ontological (the user interaction alters what occurs in the narrative world), but it also appears during explorative interaction in non-linear storytelling (where the user interaction consists on selecting which parts of a complex narrative space wants to visit and from which point-of-view), as different configurations of order and content create different narrative structures [3].

Several studies have approached the creation of platforms for the authoring of interactive stories. One notable example is StoryTec [11], a digital authoring tool for interactive multi-media storytelling based on the outcomes of the INSCAPE project [12]. This system employs an editor to model the story as a branching graph, establishing the conditions or triggers that let the user to jump from one state to another. The work of Tanembaum on cognitive hyperlinks for authoring non-linear narratives [13] presented an innovative approach on how to deal with the complex interconnections between different story parts taking place in different moments or places, linking them through suggestive concepts. This idea was an inspiration for the development of the our "Storylines" device, and we will discuss what kind of concepts can be used to establish a relationship between two story fragments as part of our work.

However, as far as we are concerned, many of those systems were conceived and designed as single authoring tools (although they can be used by multiple authors to create a single narrative). The end users do not have to understand the narrative structure underlying their interactive reading experience. Multi-authoring requires those structures to be easy to understand and manipulate (expanding, altering, etc.), and has also particularities which should by addressed by specifically designed mechanisms.

About those specificities on the side of multi-authored experiences, in their work about vast narratives [14] Harrigan et al. provide a large compilation of different scenarios of shared narrative spaces, as literary and television fiction franchises, games, or creator's communities. Harrigan's book exposes the problematic

arising during the creation and maintenance of those vast narratives, and how different systems propose different approaches for those problems: the difficulty of making accessible, for both creators and audience, those large amounts of inter-dependent stories in an understandable way; and how to deal with the consistency problems that can appear when different authors participate in the same narrative space.

The work of Y. Cao et al. [7] proposes an interesting approach to a system for collaboratively generating non-linear multimedia stories. It employs the traditional approach of modeling non-linear storytelling as a node tree, but adding the use of story templates. One of those templates is based on Campbell's "heroes journey" stages [15], seeking to ensure the narrative quality of the output. This work also puts emphasis on describing the different kinds of roles that users take in an on-line narrative generation platform. The need of a template for constructing stories and the attention to the roles show how difficult is to generate a navigable narrative structure and maintain its coherence when the narrative space is non-linear and shared between different authors.

Del Fabro et al. [16] approached the theme from a different perspective in their work about real-life events summarization. This work proposes a system to automatically generate the summary of a public event as seen through the large quantities of participants that uploaded their videos, photos and comments to the Internet, and specifically the social networks. Although the output of this system is linear and automatically generated (it cannot be considered an "authoring" tool), the depiction of real-life events from simultaneous and interconnected points of view is an application of non-linear collaborative storytelling that we consider in our discussion section. Del Fabro's system actually has to face the same problems that most multi-authored (or in this case, multi-source) narratives seem to face: multiple points-of view are difficult to locate in a shared narrative space. It is difficult to spatially and temporally locate each single event in relation with the rest of the narrative, and also consistency problems arise.

In conclusion, from our point of view most shared narrative spaces face a similar problematic inherent to their essential nature. First, non-linear storytelling is an oxymoron: the non-linearity makes difficult for both authors and readers to organize and understand information that is subject to the narrative law of cause-and-effect. The "reading order" of the events is central to this understanding, and a non-linear space implies that this order is not defined. Second, the problem of accessing and understanding a complex space of interrelated information also contributes to the difficulty of maintaining narrative consistency when multiple authors expand the same informative space.

III. CONTEMPORARY INTERACTIVE SYSTEMS FOR STORYTELLING AND NARRATIVES

In [3], Ryan proposed a classification of interactive narrative types based on the nature of the user participation: users can either experience the narrative acting as an internal character of the story, or as an external agent; they can either alter the ontology of the narrative through interaction, ontologically alter the narrative world through interaction, or explore the narrative without inducing any change. This classification provides a framework to analyze and characterize contemporary systems for interacting with narrative by reflecting on how the user experience is contributing to the narrative, and how the narrative is influencing the user experience.

We have identified six major types of information systems directly related to interactive narratives: The first type are adventure books, which comprise a tale where the reader follows a character and makes choices that lead the story towards distinct developments; the second is tabletop role-playing games (or RPGs), in which the player creates a character and its story, and then devises the character's actions according to a set of rules; adventure videogames are the third type, and they put the player in the role of a character that resolves puzzles in order to advance in the story; the fourth type is role-playing videogames, where the player makes navigation decisions to reach one of several possible endings; the fifth type is Forum or chat-based RPGs, where players collaboratively create a story (usually with a few rules of engagement); the sixth and last type is web communities of fiction writers (fan-fiction), that create stories in the same fiction world, but not always collaboratively. A high number of fan-made wikis can be found on the web, compiling formation about events, characters, and places concerning those worlds. Harrigan gives a wide overview of the complications of maintaining these vast narrative spaces, and how the different systems or communities address them [14]. These systems are described in Table 1 according to Ryan's framework.

TABLE I. CONTEMPORARY SYSTEMS OF INTERACTIVE NARRATIVES

System	Example	Author /reader role	Main role	Author interaction	Reader interaction
Adventure Book	Choose your own adventure	Separated	Reader	-	External Ontological
Tabletop RPG	Dungeons & Dragons	Mixed	Author	Internal, Ontological	-
Adventure videogame	Monkey Island	Separated	Reader	-	Internal Exploratory
RPG-Videogame	Baldur's Gate	Separated	Reader	-	Internal Ontological
Forum / chat RPG	Aelyria.com	Mixed	Author	Internal, Ontological	External Exploratory
Fan-Fiction community	Fanfiction.net	Mixed	-	External, Ontological	External Exploratory

Seeing the particularities of the informative structure of narratives, we point at differences between existing systems and interactive storytelling. In particular, none of these types of systems entirely supports shared narratives as a medium of social interaction. Three of them (books, adventure

videogames and RPG videogames) are unidirectional mediums, created by authors and consumed by other people as readers. They support a varied degree of interaction with the content, but they do not allow users to contribute. Tabletop RPGs and forum or chat RPGs, allows user-generated content to be added to ongoing discussions, which together do not constitute a coherent story that can later be consumed as part of the user experience. Only fan-fiction Internet communities fully support both the addition of user-generated content and its consumption as part of the user experience. But the lack of collaboration and cooperation between contributors tends to divide the narrative space into distinct and incoherent flows of events, which only share the original work as a point of reference, resulting in independent narratives.

The case of fan-fiction communities is the major exponent of a multi-authored narrative system in which usually no one acts as both reader and author to the same shared narrative, but each participant is only the author of his narrative sub-space and reader of others. A similar handicap exists in forum RPGs, where each contribution is by force situated directly after the previous one, and is the only possible type of contributions.

In conclusion, none of these systems fully empowers participants to contribute efficiently to the shared narrative space, nor to collaboratively organize and maintain its overall structure and narrative coherence. The aforementioned problems of finding some "order" to access and understand a complex space of interrelated information and maintaining its consistency are approached, mostly, by having different independent narrative spaces (so not sharing one single narrative space) or simply by restricting the contributions to that space. Therefore, there is still a need for supporting the users' ability to understand and navigate the space, allowing the narrative to grow in an organic way, and extending its contents from any desired point in the narrative flow.

Figure 1. The settings and development of the pilot experiment

IV. UNDERSTANDING INTERACTION FACTORS

The first experiment, "Story on a Wall" (Fig. 1), was an observation experience designed to allow users to freely create both a narrative and the rules that operate it. 20 subjects (university students) were provided with paper templates as a frame to create scenes and a set of elements (fairytale characters and objects) that they could use. Scenes were crafted creating an image (drawing and pasting elements) and a short literary text. The story was developed on a large glass wall posting the scenes and drawing arrows. Each arrow connected two temporally consequent scenes, but aside of this the narrative meaning of the relations (i.e. thematic or point-of-view connections) was left for the subjects to interpret. The subjects proceeded one by one to read the story on the glass, and then modify or expand it by creating new scenes, posting them in the wall, and drawing connections. Although subjects were encouraged to expand the story, there were no constraints on what the subject was allowed to do in the narrative space: they could rearrange, modify or eliminate previous scenes. Observations were made during this process, and the subjects were later asked to fill a questionnaire of 18 questions. The questionnaire evaluated the story comprehension and consistency as perceived by the subjects (asking them to rate story comprehensibility and coherence in a scale), and inquired about the reading or navigation paradigm that they used (how had they selected the relations between scenes, which narrative elements and concepts they followed throughout the story, and how the reading order was decided). It also asked about their contributions (number, content, location, etc.), and if they added scenes to the narratives or contended in modifying existing ones.

The kind of interaction performed is external, as the users do not assume the role of any particular character. It is also ontological during the creation, and exploratory during the reading. The analysis of the resulting story and the questionnaire answers revealed several aspects about the nature of the user comprehension and interaction with the shared narrative space. From these results we will derivate, in the next part of our work, a set of design implications to develop and study interactive narrative systems. We can resume the interaction factors observed as follows:

A. *Three interaction modes*

The subjects' interaction with the narrative space shows that at least three different views for three different purposes are needed for a multi-modal interaction with narratives. These views are illustrated in Fig. 2.

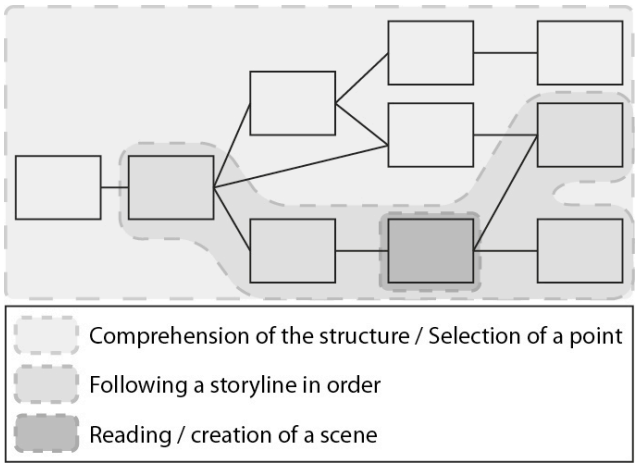


Figure 2. Viewpoints related to the interactions with the narrative space

A global view of the space is used to approach and comprehend the whole narrative space and its structure, as well as when selecting a point in time and place to add a new scene. Then, a "zoom-in" view is used for viewing a scene inside a storyline and understanding the other storylines related to it. Finally, the composition view allows users to create and edit scenes focusing on the crafting of a single scene.

B. *Navigation through storylines*

The results revealed that subjects project a "time-space-development" logic on the narrative. Although the story in this pilot experiment was mainly developed as a classic "choose your own adventure" narrative (this is, a set of branching paths), when reading and expanding the story, subjects considered higher level relations between those branches (e.g., the relations between events that subjects considered taking place simultaneously in different, unrelated spaces). This can be resumed as the story being mentally situated on a space with a temporal and causal logic, represented in two axes: the temporal relationship between the scenes (time), and the places where these scenes occur (space).

All subjects followed linear sequences (which we call storylines) for reading, being a linear sequence of connected scenes that track the development of a specific character or plot. The relations between scenes were only indicated through links, so the concepts that characterized the relation between the scenes were mainly determined by the readers' perception. When asking the subjects, all of them coincided on the scenes being related by following a character or a plot relationship, which also indicates that contributors, although maybe unconsciously, established the relations following that paradigm. 14 out of 20 followed those storylines throughout the narrative space from the first scene to a finishing one before backtracking (the others abandoning some storylines and jumping to new ones arbitrarily). In addition, 12 of them followed character developments, and 10 of them followed plot relationships.

Understanding how users navigate the narrative space leads us to consider a visualization that copes with this "time-space-development" logic and facilitates the creation and finding of storylines as the main way of explore and contribute to the space, consequently facilitating the user interaction.

C. *Preservation of literary consistency*

The results also show that the generated narrative space is unitary, coherent, and with a limited divergence. It is unitary in the sense that all the scenes are interrelated and are part of the same story. In fact, the divergence of the narrative space away from the central topic is limited: subjects found it easier and socially proactive to expand existing storylines instead of creating new ones. This notion of unity is directly derived from the fact that the entire story is predefined and all the storylines are happening simultaneously in the same time stream. This raises consistency issues in the literary fabrics of the narrative, which users thrive to treat by re-ordering scenes or inserting new ones.

The literary consistency of the narrative, defined as its elements and plots being in agreement/non-contradictory, is considered fundamental for understanding the story. Most subjects stated a dislike towards the notion of conflicting storylines, being consistency one of the main concerns when modifying/ adding scenes to the narrative space: maintaining consistency in the growing narrative was one of the main motivations for 8 out of 15 contributions, and 5 subjects used their contribution only for correcting consistency issues. Also, the totality of the changes made to previous contributions was for the sake of consistency. In the end of the experiment, only 5% of the scenes were considered inconsistent with the rest of the narrative.

Consistency therefore seems to have a great degree of influence on the resulting user experience as exposed by the result analysis. The subject-perceived consistency level (Figure 3) is relatively stable if slowly decaying, even though it tends to stay on the high portion of the scale. This may be happening due to the accumulative complexity of the story and the growing cost for achieving consistent scenes. For this reason, the system should implement mechanisms for helping to preserve literary consistency without restricting the non-linearity of the narrative.

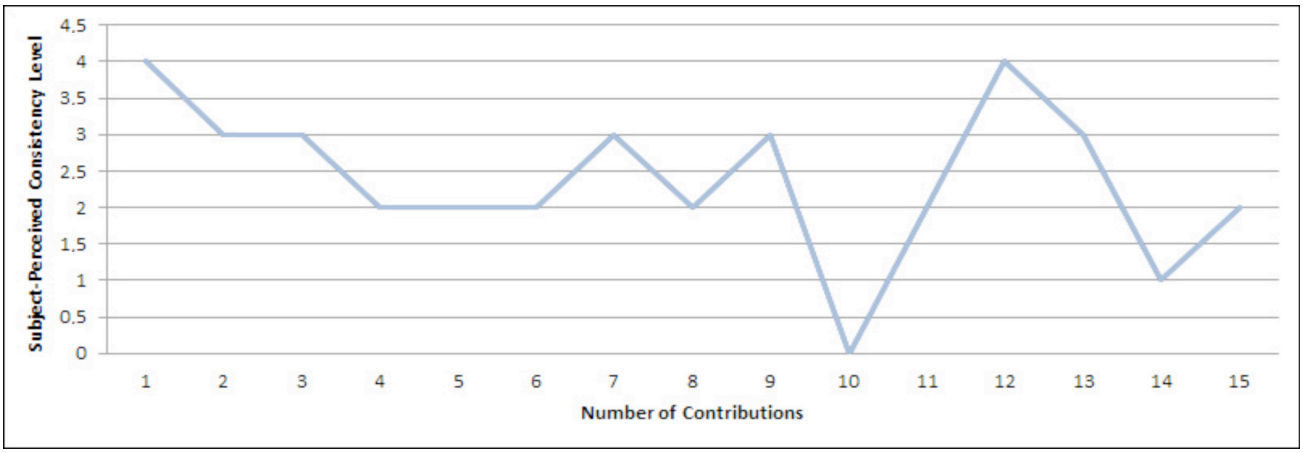


Figure 3. Evolution of the user-perceived consistency during the pilot experiment

V. PROTOTYPING SHARED NARRATIVE SPACES

The resulting interaction factors extracted from the first experiment were transduced as a set of implications (Table II) for the design of information systems that support interacting with shared narrative spaces. We developed a prototype named CrossTale based on those design implications to reproduce the user experience according to them.

TABLE II. DESIGN IMPLICATIONS EXTRACTED FROM THE INTERACTION MODEL

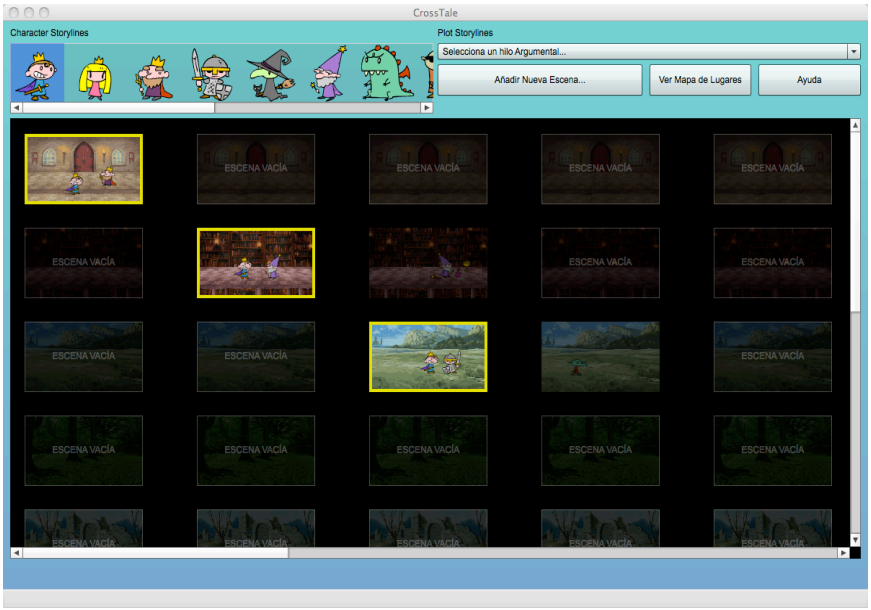
Interaction Factors	Design Implications
Projection of a logic based on time, space and developments.	Organization of the informative space based on time and space axis.
Reading by following linear sequences about a character or a plot.	Navigation through suggested plot and character storylines.
Unitary and coherent narratives.	Mechanisms for preserving congruence.
Global viewpoint for comprehending the whole story.	One interface mode for a global view of the informative space.
Reading a storyline through a zoom-in viewpoint.	One interface mode for following storylines.
Focusing on a single scene for creating and editing.	Independent interface mode for scene edition.

A. Three interface modes

CrossTale implements three interface modes corresponding to the three interaction modes defined previously. The global view (Fig. 4 a) lets users explore the whole narrative space, and has two differentiated contexts: the main context shows the narrative space visualized as a grid, with the axes representing time (from left to right, the scenes are ordered in temporal order) and space (each row representing a different place where the story takes place, as the kings castle or the enchanted forest). The upper context in this view allows the exploration through storylines (explained in the next section) by selecting characters and plots. When a character or a plot is selected, all the scenes belonging to that character/plot storyline appear highlighted forming a reading path. Selecting a scene changes the interface into the reading view (Fig. 4 b) in which the scene is maximized for reading. In this view, the user can also navigate back and forward by the current storyline. Finally, by selecting an empty frame in the global view, the user accesses the creation view (Fig. 4 c). In this view, s/he can create a scene selecting characters and objects from the right-side menu and by arranging them through drag-and-drop. The user also can introduce a title and the literary text describing the scene, and indicate to which plot storylines lines is related the current scene (allowing the definition of new ones). This context also implements the "consistency preservation" rules, which are further described in this section.

B. The storylines device

In traditional linear storytelling, a single author creates story (the content) and discourse (how is it presented). But in non-linear storytelling, the reader decides this partially (alters part of the discourse) when he chooses to follow some part or another of the narrative space in a desired order.



(a) The global view

(b) The reading view

(c) The creation view

Figure 4. Three interface modes of the CrossTale prototype

As we stated in our findings of the "Story on a Wall" experiment, subjects observing the "branching-structured" narrative established higher-level conceptual relations between its parts to find their own reading order, projecting temporal and spatial logic between all the elements. The concepts relating one scene with another were perceived as maintaining a character or plot relationship.

Following those pilot experiment discoveries we developed the "storylines" paradigm to allow the ordered exploration and development of the narrative space. The aforementioned grid of scenes, arranged in spatial and temporal axis, deconstructs the "scene tree" and presents all the information in a way where the user can easily recognize the spatial and temporal relation between all scenes. The paths of reading or "storylines" are provided by the interface when the user selects one character or plot to follow, highlighting a temporally ordered sequence of logically related scenes. This way, each scene can belong to an unlimited number of storylines based on what characters take part in it and to what plots the scene events are related.

Concerning the nature of those relations, character reactions are the easier to understand and work with. A character storyline is simply composed by all the scenes where a character appears, ordered temporally. Usually those scenes contain temporal and cause-to-effect relations between them, describing the story of the character. This type of plotlines evades easily the problem of non-linearity, because following a character implies following a linear development: the character, being at one place at a time, experiences the story partially and linearly, similar to the users' linear perception of time development.

The notion of plot is more abstract than the preceding, and also more difficult to implement. As authoring tool, in CrossTale plots are decided by subjects, so the authors decide to assign different created scenes to the same plot, considering that they are describing a thematically-unified "sub-story" inside all the story world (e.g., in our fairy-tale, where lots of different actions are occurring, the plotline about the kidnap of the princess and the different factions who are searching for her). Not all scenes are linear in time, because the same plot can follow different characters, jump in time, and/or develop in two or more places at the same time. The plot storyline is presented following the temporal sequence, and scenes taking place simultaneously are shown intercalated.

C. Consistency preservation rules

CrossTale implements a set of constraints that can be activated in order to maintain consistency during the scene composition process. These constraints were designed to prevent subjects from adding scenes that somehow disrupted the sense of space or time. For instance one character could not be present at different places simultaneously or no one could travel further than one location away between two timeframes (locations were connected in an arbitrary way and this information was transmitted to subjects by providing a map).

These rules were designed after the most common modifications performed by subjects during the previous experiment, attempting to anticipate potential displeasing outcomes and preventing them by blocking certain actions. A text dialog will be also displayed to inform the subject the reason why he cannot commit the change he is trying to (e.g., "The Princess cannot appear here because she is in another place at this moment"). If these mechanisms perform optimally, the whole story might experiment a global consistency increment and users might chose to concentrate on providing another kind of content.

VI. EVALUATING CROSSTALE

Our CrossTale system is a tool designed and implemented following the design implications extracted from the mental model of interaction observed during the pilot experiment. Therefore, we tested the tool through new experiments in order to assess the adequacy of this model in the development of systems to create and interact with non-linear, multi-authored narratives.

The objective of these experiences was to evaluate the adequacy of use of the different interaction modes, the paradigm of narrative space representation and exploration through the storylines device, and the usefulness and impact of the consistency preservation rules. With those aspects interrelated and being part of a complex system, we developed a couple of experiences to better understand the repercussions of those interaction factors. The first experience served us to evaluate the interaction mechanisms in terms of adequacy of design and user experience, with users performing creative tasks with the tool. Observations of the results of this creative task were used to analyze the nature of the created narratives and how users developed their storylines using the provided tool devices. Finally, a second experiment was conducted in order to test the impact of the consistency preservation rules on the produced narrative and the user experience. The description of the conditions and the result analysis of the evaluation experiments are presented next.

A. Evaluating the interaction mechanisms

The main experiment with the prototype, in order to test the adequacy of its design and the user experience, consisted of creating a narrative in a similar way to the pilot experiment. A total of 15 subjects (undergraduate students in media studies) were enlisted, and asked to freely use the interface to read and create a shared narrative with their own contributions. Each subject was briefly introduced to the interface controls, and then given an unlimited time to interact and the freedom to add as many scenes as wanted. Then, the subject executed eight interaction tasks provided by the evaluation team, and observations were made. Afterwards, each subject answered a questionnaire to rate the experience on a Likert scale, and evaluate the suitability of the design for reading and contributing and the overall user experience.

The results of the task-driven evaluation are summarized in Table III. It describes how many subjects employed each interface view for each task. The results show that 11 out of 15 subjects performed all tasks easily, and the remaining 4 subjects successfully performed 6 out of 8 tasks. The

subjects used the global view and/or the reading view to identify and comprehend the narrative elements. Similarly to the first experiment, some subjects concentrated on characters while others on plots, but everyone used one of these two paradigms for finding storylines and navigating the narrative space. During the contribution task all the contributors also used the creation view to compose new scenes, but this view was never accessed for performing the identification tasks. These results indicate that the design supports the modes of interaction identified in the first experiment, and that these modes dispose of adequate functionalities. However, most subjects prefer having more information about the context of scenes while reading them. This means that the dissociation between the global and reading views could be revisited.

TABLE III. RESULTS OF THE DESIGN ADEQUACY EVALUATION

Task NB	Task	Correctly executed	Global View	Reading View	Both Views	Navigating with Storylines
1	**Identify the beginning scenes**	15	13	13	11	11
2	**Identify story end scenes**	15	13	9	7	7
3	**Identify main characters**	15	15	15	15	15
4	**Identify important places**	15	14	14	13	13
5	**Identify simultaneous scenes**	11	13	4	4	4
6	**Identify scenes in the same location**	12	14	2	2	2
7	**Approximate the duration**	15	13	13	11	10
8	**Find any inconsistency**	15	8	12	7	8
9	**Contribute (optional)**	13	13	6	6	5

Table IV shows the evaluation results of the user experience. All subjects appreciated the experience of interacting with narratives through CrossTale. In particular, they found that CrossTale supports reading a non-linear narrative (4.33/5), contributing to it (4.77/5), and finding and correcting inconsistencies (3.92/5).

TABLE IV. RESULTS OF THE USER EXPERIENCE EVALUATION

Question	Average Score
Overall experience	3.93 / 5
Found the system entertaining	4.33 / 5
Design makes reading easy	3.93 / 5
Design helps to maintaining consistency	3.92 / 5
Design facilitates contributing	4.77 / 5

Using Ryan's framework for the classification of interactivity with narrative systems, we can say that the users of CrossTale performed an external interaction during the whole experience, as they took on the role of agents external to the story, and read and contributed in it from outside the fiction world. This interaction is exploratory while reading, in the sense that the readers choose between storylines to follow but the reading itself does not change nor affect the structure of the narrative space. Finally an ontological participation is performed when the user takes the role of author and expands or alters the narrative world.

B. Use of storylines in the composed narrative

We present a general analysis of the resulting narrative compared with the narrative created in the pilot experiment. Figure 5 shows the structure of the resulting narrative. Users do not link scenes directly in CrossTale, but relations are established by the share of common characters/plotlines. According to this, we present the basic scheme with the time-consecutive scenes sharing characters connected (so they can be followed through character storylines), and each version of the figure showing what of those scenes belong to each of the four plot storylines the subjects used.

From the initial set of 8 starting scenes given to the first subject the resulting narrative ended up having 35 scenes, so 27 scenes were added by the subjects, with an average of 1.8 scenes per subject. This is slightly superior to the 1.4 scenes per subject added in the pilot experiment, which could indicate that the interface makes the addition of the scene relatively easy. Following the analysis of the character plotlines, the story has 6 bifurcating scenes (scenes from which different character plotlines going to different new scenes emerge) compared to the 9 bifurcations of the pilot experiment narrative, and 3 ending/unconcluded scenes compared to the 4 in the pilot. As a general conclusion, the properties of the generated narrative being unitary and with limited divergence are preserved, if not emphasized, through the use of CrossTale.

Analyzing the use of storylines, plot storylines generally do not create completely new reading paths but can be trailed following the transitions of the character storylines, so they don't create a new level of divergence. We can observe that the first storyline (already given in the starting narrative) starts temporally at two places at the same time, but these two parts can be read following the storylines of two main characters (the princess and the prince). The other three storylines used in the story are practically linear and follow the scenes where some concrete character appears. The initial setting of the experiment provided three storylines. Subjects only added two storylines, one of them being the linear continuation of a previous one (thus being presented as one single storyline in the figure). To sum up, most of the users included their created scenes in one existing plot storyline, but the creation of new plot storylines was very low.

As a conclusion according with this observations and the analysis done in the previous section, plot storylines are

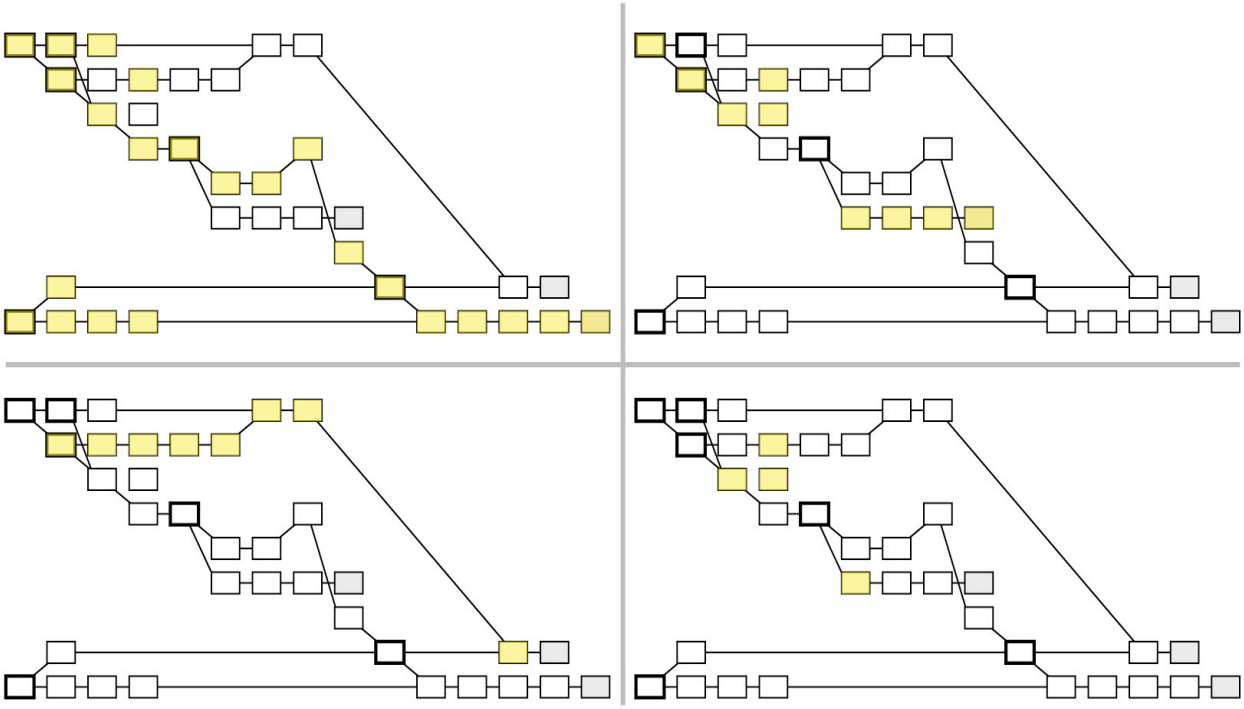


Figure 5. Plot storylines in the narrative produced with CrossTale

regarded as much useful as character storylines when reading, but they are largely more abstract, thus difficult to use when creating. While using a character implies the unconscious continuation of his/her storyline in the narrative space, the use of plot storylines needs to be deliberately planned by the user. Future investigations should focus on understanding deeply which concepts can relate scenes forming storylines, how to make easier to the creators find this relations (which can suggest new storylines), and consider if those relations should be automatically created (as in the case of the character storylines).

C. *Evaluating the consistency preservation rules*

In order to evaluate the consistency separately, we conducted an isolated experiment using two groups of ten people. The control group (group A) used CrossTale with the consistency constraints enabled, and the second group (group B) had these constraints disabled. Apart from this, both groups were exposed to the same experimental conditions: they were introduced to the use of the tool, and they contributed to the narrative one subject at a time, starting with the same set of initial scenes. The focus of the experiment was to evaluate the impact of the implemented system of rules in the congruence preservation and the user experience.

The tests performed in the end of the experiments revealed that users of CrossTale with consistency preservation rules perceived a slightly higher consistency level than users without constraints (3.8/5 vs. 3.4/5). The most remarkable observation was that the perceived consistency level seemed to decay more quickly over each contribution without the usage of consistency constraints (Figure 6). An optimistic interpretation of this phenomenon could be that enforcing a certain notion of time and space logic through the scenes (which was the purpose of the constraints) tends to produce more consistent results. Adding the constraints also seems to have affected the user experience of users who felt limited all the time (as seen during the video codification, where they keep complaining almost every time a constraint block pops up).

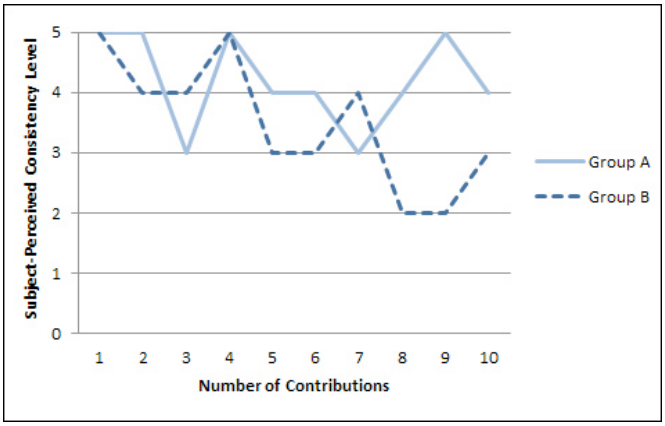


Figure 6. Perceived consistency level in the second experiment

Therefore, we expose an interesting situation; constraining scene composition to a specific outcome range way may lead to more consistent results while hampering the authoring process and negatively affecting its user experience. One possible answer to balancing the exposed tradeoff might be switching the nature of the introduced trigger from an enforcing one to a less intrusive recommending system. This way we can inform contributing subjects about the potential incoherence of their creation, maybe preventing them from introducing conflicting scenes that later users would want to correct.

D. Final comments on the CrossTale evaluation

The results of this experiments show that the concepts and design of CrossTale, as a prototype for interacting with narratives, are highly appreciated by the subjects. However, they also point out several issues that need to be addressed in future versions. In particular, the level of context awareness when users interact with one single scene in the informative space, the use of storylines when authoring narratives, and the degree of creative intrusion produced by the consistency constraints. We cannot neglect the repercussions of each one of those areas into the other: the ability to access the information and to mentally locate it in the whole narrative space, or the difficulties integrating a scene in the storyline structure, can condition the consistency level perceived or produced by the user, disregarding the actual consistency level of the complete informative space.

In addition, social interaction between different authors remains indirect: users cannot communicate directly and the authors' profiles and their contributions are not discernible in the current design. Future versions can include more support for this aspect and study its effects on the user experience and collaboration.

VII. DISCUSSION

The nature of shared narratives presents several challenges over how the inherent information is constructed, presented, and accessed. In a sense, non-linear interactive storytelling has always faced challenges for having to reconcile the sequential nature of narratives with the reader ability to explore between different threads of reading (the paradox of coping "storytelling" with the "non-linear"). In this work we provided a first grounding basis for addressing these challenges and developing shared narratives as a new kind of media. Our research is a first step for consolidating a standardized system for sharing and collaboratively constructing narratives, given we extracted, understood, and evaluated the user mental model associated with this interaction.

Several use cases can be provided exemplifying our vision of shared narratives as a new kind of media. The focus of our work can be easily illustrated using the case in which our current study is based: the collaborative generation of fiction worlds. The first chapters of this work described how, since the apparition of the World Wide Web, internet communities of literature amateur practitioners have dedicated their conjoined efforts to develop and catalogue fiction sharing common narrative spaces, using tools as forums or wikis to organize the large amounts of interrelated information produced. The main issues those communities have to face are the difficulty to navigate and comprehend grand quantities of interrelated information, and maintaining coherency when lots of authors expand and/or modify those interdependent sets of data (e.g., maintaining the coherency of the biography of a character that appears in several stories created by different authors). With tools implementing the interaction and data-management principles proposed in CrossTale, we would be able to develop systems that largely facilitate the creative process, ensuring that the collaborative efforts work together and empowering creativity rather than endangering it.

Our studies have been developed working within the fiction genre (concretely fantasy tales), with amateur and/or non-professional authors. This setting for the study and the experiments reflected our focus on the emergent online communities of literature and fiction aficionados. But we can discuss how this paradigm of authoring and exploring vast narratives could be applied to other genres or other contexts of use. Of course, this would require following new lines of research in order to study their particularities

As we previously introduced, with the development of the information technologies and the raise of the mass-oriented cultural products, the professional sector of literary creators dedicated to fiction has started to use computerized tools, as Celtx, to develop their creative tasks. Some of these tools try to deal with our studied difficulties: organization and exploration of complex informative spaces, and congruence preservation. Certain among them (as Celtx) have developed the status of on-line, social tools, aiming for a multi-authored model. Assuming that research is conducted about the mental models and the interaction needs of a different standard of users as professional creators are, this scenario could largely benefit from our developments. Tools following the CrossTale paradigm for interacting shared narrative spaces could prove very useful in the field of commercial vast narratives [14], as long-running TV-series or especially complex trans-media fiction franchises, which involve lots of interrelated, multi-authored information.

VIII. CONCLUSIONS

In modern literature and fiction worlds, it is common to have multiple stories set in a complex chronology inside a common setting, such as in fiction franchises where narratives are constructed through the contributions of multiple professional authors. Tools based on the CrossTale interaction model would be capable of organizing all this encyclopedic knowledge in a structured narrative space that suits better the temporal, causal, and multi-lineal nature of a narrative, empowering the authors to contribute easily to expand the vast fiction worlds and empowering the readers to explore them naturally. With such tools, narrative spaces grow organically and collaboratively; the proactive role of participants consequently diffuses the mono-directionality of the author/audience relation. In that sense, non-linear interactive narratives can become a new kind of media of its own, suitable for creation, collaboration, information sharing, and learning.

By experimentation, we learnt how users perceive and procreate the narrative space in a unitary and consistent way, how they mentally structure the informative space in terms of time and place, and navigate it following structured sequences of character and plot-related scenes. This model was used as the basis for designing a functional prototype, CrossTale, which was subsequently evaluated with users. These evaluations show the success of the adopted approach in supporting complex interactions with narrative spaces, which assimilate its non-linearity. It provides a validation for further investigations on the potential of shared narratives as new media.

We can summarize the approach used as working in two fronts: the user interaction with the informative space, and the coherency computation of the contained information. Concerning the interaction when creating and exploring a shared narrative space, the critical aspect revealed to be how to provide a mean to obtain meaningful information when exploring a complex net of causal-related scenes or story parts. The use of the "storylines" mechanism is a first successful step towards this objective of providing meaningful "reading paths/orders", but further developments should be made to approach some relevant issues (e.g., the simplicity of suggesting character storylines versus the abstract concept of "plot storylines", which has to be consciously appointed by authors).

About the preservation of consistency during collaboration, our experiments pointed that consistency between all the story elements and scenes is the main conception that readers use to understand the narrative space, and one of the main concerns when expanding the space by adding new scenes. The experiments seem to indicate that implementing computational rules help to raise consistency but can also undermine the user experience. Thus, we have to choose carefully what rules determine the consistency of the informative space, which of them should be only suggested, and which of them should be strictly followed to ensure that consistency.

IX. FUTURE WORK

This work has several limitations inherent to the nature of the experimental settings and the prototype. The pilot experiment was not designed as a strict experience for testing concrete aspects, but was used as an observation to extract information about how participants reacted and interacted with a collaborative narrative space. For this reason, direct comparisons between results of the pilot experiment and the prototype experiments should be taken carefully. While the pilot experiment was conducted in a large wall where all the informative space was present, access to the information using CrossTale is done through a common computer screen and mediated by the designed visualizations. This implies that, although mechanisms as storylines have been proven useful, its effectiveness is conditioned to the existent limitations of the interface design.

Regarding the prototype nature, the visualizations used have functional limitations (e.g., visualizing all related scenes to a selected one). One important limitation was the aforementioned difficulty, when reading, to locate the actual scene in relation with the global set of scenes. Other improvable design issues, mostly usability-related, were identified during the evaluation (e.g., the composition view is not user friendly). Finally, the development of the experiments in a controlled environment does not reflect intimately interactions with shared narratives, nor the collaboration phenomenon (performed in an indirect way through the experiment), as ought to take place online during a greater amount of time.

Some aspects related to narrative composition remained outside this study. In our experiments, the literary traits of the narrative space were somewhat pre-defined, especially the main characters (prince, princess, witch, etc.) and places (tower, castle, woods, etc.). This discouraged users to think about expanding the literary reach of the narrative space with few exceptions. In a collaborative creation processes, as online social role-playing games, some people perform the role of content generators, adding story elements (characters, objects, places, etc.) to the informative space. Such behavior should be further studied in the future.

With this model and prototype as a starting point, our future step consists of addressing some issues detected during the experiments and conducting more focused experiments about the impact of the storylines device in the construction of the story and its resulting consistency, and how a recommendation system could better empower the consistency preservation without disrupting the creative process. Conducting those experiments with a larger number of users interacting and evaluating the resulting narrative during a larger period of time will better cope with a community co-creative process, and would allow us to study the nature of the resulting interaction and narrative structure under those conditions, as well as the potential of shared narrative spaces to empower long-term collaboration. It will also provide large quantities of data relative to the outcome of the continuous interaction of users in a multi-user deployment.

With those experiences we will refine our knowledge of the interaction factors and try to discover new factors that can alter the user experience. We will determine which features are more useful or which ones need improvement, distinguishing between the tasks of creating and reading (e.g., the use of plot storylines, which have been proven useful to read but not very used while creating). We also pretend to discover factors external to the interface that can alter the experience and the behavior of the creators (e.g., starting the experience with a pre-established set of scenes and storylines could alter which features the users will use or how the narrative will grow). Those long-time experiments will also determine how the level of consistency evolves at long term, when large amounts of contributions are made, and compare the outputs of using or not consistency rules. Finally, we will also be able to find relations between those mentioned interaction factors and how they affect the consistency found (e.g., starting from a consistent set of storylines could help to reach a more consistent narrative space after several contributions).

Next steps of this study are in the direction of evaluating which theoretical models of narrative (as those proposed by

Propp [17] and Campbell [15]) could help to structure the informative space and refine our understanding of the needs of creators and readers. Those models would lead us to discover which elements can be used to determine storyline relationships between the story fragments, and which elements can be used to compute the consistency of a creation. With this knowledge we will be also able to develop features for adding user-generated story elements (as characters and places) leading to a complete system for generating and maintaining shared narrative spaces.

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