

Writing Consistent Stories based on Structured Multi-Authored Narrative Spaces

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Abstract

Multi-authoring is currently a common practice in the field of contemporary storytelling but producing consistent stories that share a common narrative space when multiple authors are involved is not a trivial task. Inconsistencies, which are not always well-received by readers are sometimes expensive to fix. In this work we attempt to improve the consistency of stories and narrative spaces by introducing a set of rules based on a formal model. Such a model takes into account the reader's concept of consistency in storytelling, and acts as a framework for building tools to construct stories grounded in a common narrative space with a reinforced sense of consistency. We define a model (the Setting) and deploy it through a tool (CrossTale); both based on previous research, and discuss some user evaluation, with an in-depth analysis of the results and their implications.

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1 Introduction

The evolution of digital interactive media and information technologies has been instrumental in the development of systems that bring together authors and readers to compose and consume multi-authored stories through multiple media. In this context, the audience is not only interested in rich narratives, but also wants to participate in their development by adding and sharing their very own creations, compositions, and ideas. Nowadays people actively publish and share thousands of creative works (blogs, stories, songs...) on the web, often related to other original creations through relations that range from mere inspiration to direct referencing. Some of the works may be further developed by more authors, who expand their content, structure, and knowledge value through original creation and composition processes. On the other hand, there is an emerging interest to support collaborative creation, composition, and consumption of multi-authored narratives that may grow in a shared information space for prosumers and professionals alike. We use a basic definition of information space: "The set of concepts and relations amongst them held by an information system" [14]. We believe narrative spaces are information spaces that ground all media based on the same characters, situations, plots or other casually interlinked entities, hence introducing a certain degree of consistency to the set as a whole. Narrative spaces are especially worth analyzing when dealing with collaborative storytelling since they establish many of the rules for the interaction among authors. The authors' awareness and interpretation of the narrative space will heavily



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condition their interaction with it. Fans often expand the narrative space of their favorite entertainment franchises by introducing their own stories deeply rooted in a well-established narrative universe and its mythology, creating rich networks of fan-fiction (Fanfiction.net, referenced later, gathers hundreds of thousands of users around hundreds of franchises) that coexist with the official material. Also, Web and information technologies provide momentum to complex entertainment franchises created by dozens of authors to span across multiple media. In this context, there are certain tools that support readers and writers who are contributing to well-established narrative spaces. Articy Draft [1] and Celtx [5] are both collaborative tools meant for creative story development and represent good examples of this emerging trend. Such tools may be created by the same company delivering the content, but this content is often the result of a collaborative effort undertaken by an author community. It is worth noting that tools do not merely intend to support the construction of a story in the sequential, traditional way. They provide mechanisms that allow for free, divergent exploration of all the related information, supporting the non-linear growth of narrative spaces.

There are some examples of narrative spaces worth mentioning. Fanfiction web site [8] is devoted to fan-developed stories within the narrative space defined by specific franchises, and provides a good example of amateur and professional authors creating stories in the same narrative space. Most of these stories, however, do not take into account the contributions of their fellow fan authors, only the original, canonical one. Another example is the website that holds most the information related to the *A Song of Ice and Fire* book series in its many articles [19]. It is fed with content from multiple contributors, properly structured and published in a readable way. The site also publishes articles that cover most of the books related to the canonical narrative space and a text-based roleplaying game that allows players to introduce their own creations (e.g., characters, locations, and other elements around the original canonical narrative). Players can interact with each other while expanding the original setting. This site has the approval of the author of *A Song of Ice and Fire* who is known to be vocal against common fan fiction developed without consent. On the other hand, he created *Wild Cards* [12], a book series written by multiple authors under his editorial control. Chris Crawford's *Storytron* [7] is an interesting approach to developing a commercial tool that would allow users to design interactive stories. Although it is currently on-hold due to problems regarding the learning curve (i.e., the complexity of building a whole interactive story with the tool), this approach is interesting in terms of decomposing the narrative space into a set of unitary elements, and defining the logic that relates them. *Storyjacker* [10] is another interesting example closely related to the tradition of the *Exquisite Corpse* writing technique. This game proposes that its players first read a flash fiction (roughly between two or three hundred words) created by another writer with an explicit editorial challenge attached to it. Players rewrite the text answering the challenge and pass the result to the next player, introducing a new challenge of their own. While this approach is a game, the writing dynamics of its multi-author design are interesting and not very far away from what we propose in this paper.

In this paper we try to understand if there are people interested in writing stories collaboratively in a consistent way and provide them with an appropriate tool for that purpose. First we discuss our focus on enhancing consistency, especially how it is perceived by authors and readers, followed by a brief state of the art of previous research on multi-authored narratives for similar scenarios. Next we describe some users' experiments we conducted. These experiments were designed to test mechanisms developed to increase narrative consistency. We then analyze and discuss the resulting experimental data. Finally we discuss these findings in relation to the approach proposed and introduce future research.

2 Supporting Narrative consistency

Complexity can easily scale with the developing size of narrative spaces, possibly increasing the difficulty of reading and authoring stories based on them. Each element in a narrative space, such as a character, location or event, is linked to other elements in the same narrative space through causal relations, providing a sense of continuity and consistency. Modifications introduced to the narrative space may cause contradictions in the logic of the network of elements and causal links. This often leads to plot holes that may compromise the story's global consistency, sometimes invalidating the primary causal links that represent the foundation of fundamental plot threads, and potentially hindering the experience of authors and consumers. Stories containing plot holes also tend to have a bad reception amongst sophisticated readers [17].

If consistency is a key factor when dealing with multi-authored storytelling, some sort of mechanism designed to monitor and enhance its presence could result in a better experience for its readers. This work pursues a suitable method to assist multiple authors in developing narrative spaces with enhanced consistency. This might lead to stories which are more satisfactory to develop collaboratively in these narrative spaces and are also more enjoyable to read. When analyzing narrative spaces and their unfolding stories, we distinguish between two kinds of consistency measurements:

- Firstly structural as the level of agreement among the elements of the narrative space with respect to each other. This can be measured if the narrative space is mapped to a computational structure of some sort by validating the narrative space information against a formal model.
- Secondly reader-perceived as the level of consistency associated by readers to a specific story. This is most often obtained by asking readers to rate it after having read it.

We think this distinction is necessary because of the subjective nature of some stories along with the existence of some literary techniques, such as the use of biased narrators that describe reality through perception and language. Having two different measures of consistency is invaluable when trying to relate both kinds of consistency. By analyzing the content of a narrative space and mapping it to a computable and evaluable structure, we can provide some recommendations or guidelines to increase the structural consistency of a narrative space. To some extent, starting with Propp and his structural approach to narrative [16], the field of semiotics is grounded on similar principles and has been an active discipline for decades. Its theoretical foundation, specifically the syntactic branch that deals with formal structures, has been a source of inspiration for our work. Deconstructing a narrative space into a computational structure based on a suitable model can be a challenging discretization process. We do not propose a model that attempts to do this. Instead, the model we propose is based on observations regarding the author and reader perception and interpretation of consistency. Every author has a personal way to tell stories. This means that the perception of a story's consistency depends on the technique and structure of its discourse – not to mention the influence of genre. Readers may find a story consistent or inconsistent regardless of the raw material from the narrative space used by the author. Also every reader's perception is heavily influenced by factors such as his/her cultural, academic and social background, which can be difficult to control and keep track of. The most obvious way to measure the user-perceived consistency of a specific story is to ask different readers to rate it. There are other more indirect methods, such as asking specific questions to check if the reader understands the story or to observe the reading procedure, trying to encode it into meaningful data. We have found these measurements difficult to operationalize and correlate to the reader-perceived consistency level. Our goal in this research is to determine

whether monitoring and enhancing the structural consistency of a narrative space implies that stories based on it are perceived as more consistent by readers.

3 Related Works

We now analyze related literature and discuss its implications for our goal. Meehan's TaleSpin is a system that generates stories via carefully crafted processes that operate at a fine level on story data [13]. It was one of the first attempts to model narratives as computational systems. Since it automatically generates stories, it holds a certain notion of computational causality and consistency. We also pursue a formal model with such notions, but Meehan's approach seems too constraining to support an open definition of a story. Brenda Laurel's doctoral dissertation described a complex framework for drama management [11] and is considered by some as the beginning for the many successful approaches that deal with structured narrative spaces. While it is meant for abstract depictions of large narrative spaces, it also provides a systematic representation for them. A key factor is its ability to introduce highly dynamic narrative structures. These structures support complex stories that hide the formal complexity from readers, something we wish to introduce in our approach. Thue [18] proposes an interesting approach that formally structures the story, favoring consistency monitoring and analysis. Player Modeling is a simple concept that attempts to personalize the story through several profiling techniques, enabling some of the user's personality traits to have certain impact on the resulting experience. Understanding the reader's perception of consistency is a concern we share. Some other approaches use a strictly formal definition to model stories. For instance, Cavazza proposed a character-based approach [4] that was adapted and improved by Pizzi to model a part of *Madame Bovary* [15]. This line of work is grounded on planning and the field of artificial intelligence. Interestingly enough, it deals with complex aspects of human nature such as emotions and feelings. The AI planning used in [15] is concerned with optimality, seeking to reach a target with economic operations and may not be adequate for our approach. We believe storytelling should encourage causal links, but not necessarily in an optimal way. They represent, however, some of the most intricate and complete attempts to discretize the narrative structure into a formal model, a goal we also pursue. Next we discuss some existing formats and recent tools that allow modeling narrative entities independently from their story, that keep track of the flow of complex events, that impose constraints or rules to preserve consistency, that keep track of plot meta-data (such as character motivations, feelings or the literary theme and mood), and that are suited for collaborative development of a story. This discussion inspired the conception of our tool.

- Traditional scripts are often created by a single or a couple of authors. Large media franchises and episodic shows sometimes need to become heavily interrelated. *Game of Thrones* [2] is a good example of a TV show that has heavily interrelated scripts written by multiple authors. To some extent they represent one of the most popular instances of a multi-authored narrative with a strong need for consistency.
- There is a certain tradition of background books in rich fiction series, providing concept art, character profiles or even maps depicting fictional lands. These books, far from narrating a story in the traditional sense, describe a specific part of a fictional universe. We found these works interesting because they represent a set of characters, themes and plots in their original, protean form, not necessarily attached to the linear context of a traditional tale. They are often written by authors who were not creators of the original concepts, and represent an example of collaborative authoring.

■ **Table 1** Multi-Authoring Narrative Supports Comparison.

	Traditional Script	Background Book	P&P RPG Source Book	Wikipedia/Wikia
Atomic Narrative Elements	Not formally	Yes, clearly differentiated	Yes, clearly differentiated	Yes, clearly differentiated
History Log	Sequence is implicit on its description	Yes, mostly inside individual element descriptions	Yes, mostly inside individual element descriptions	Yes, mostly inside individual element descriptions
Consistency Constraints	No	No	Yes, enforced by the game's rules	No
Plot Meta-Data	No	Yes, mostly inside individual element descriptions	Yes, within plot meta-data	Yes, only attached to individual element descriptions
Suited for Collaborative Development	No	No	No	Yes

- RPG books, such as ADD Monster Manual [9] or Vampire: The Requiem Coteries [3] are interesting examples of narrative entities modeled independently. They provide a growing organic framework for authors to build their own adventures and share them with friends, adopting the role of a live storyteller in tabletop gaming sessions. The source material in these books can be used to enrich the session experience by introducing new characters, object or plot threads. While fairly similar to background books, RPG books provide guidelines that allow content to be used in the arbitrary context of a game with rules, which introduces a high degree of formality to the information.
- Certain tools such as Wikipedia or Wikia are effective means of storing and organizing data from a specific narrative space. Although they are commonly used to structure already-existing background information, they represent some of the most popular tools that support collaborative writing. Their capability to deal with individual entities such as characters or locations is the trait we find more interesting. On the other hand, entities commonly depicted as linear, such as stories or plot threads, are not very intuitive to understand and follow using these tools. As shown in table 1, most of them possess some of the traits we introduced earlier, but no tool has got all of them as far as we know. Incorporating existing mechanisms that seem appropriate is part of our efforts to design a tool with all these traits.

4 Experiments

We carried out three experiments to understand better narrative spaces and the stories based on them in terms of user perception. For each of them we introduce its purpose, any tool specifically designed for it, the experimental design in depth and the most significant results.

4.1 Experiment I: Understanding the Sharing of Narrative Spaces

Our first experiment aimed at understanding how users perceive a narrative space and its associated stories while contributing and navigating through it. We intended to understand their mental model and to measure it. Some arbitrary conventions were introduced, such as an initial set of scenes already connected or a limited set of characters and objects. This was done to encourage participation, providing a certain sense of narrative immersion and to reduce the creativity required from subjects in order to participate. A fairy tale was chosen,



■ **Figure 1** A Story Wall.

including its most canonical elements (e.g., a king, a Princess, a castle, and a dragon among others) along with others far away (e.g., a robot, aliens, and a starship among others).

4.1.1 A Collaborative Story Wall

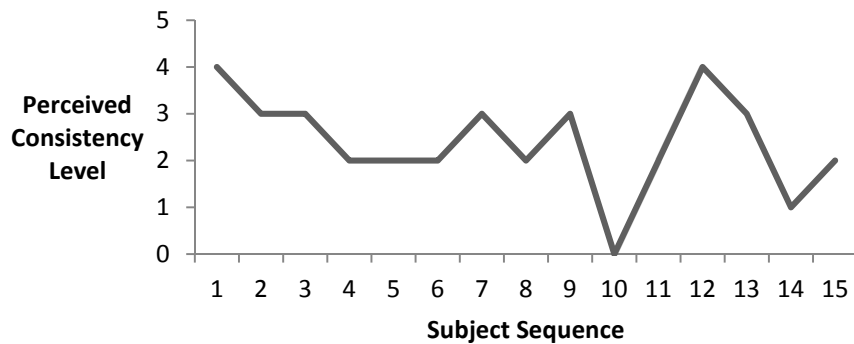
A large glass wall was used as a space to develop and visualize a collaborative narrative (figure 1) composed of scenes and transitions. Our purpose was to provide a canvas for authors to freely interact with the story. The scenes were sheets of paper with a collage of images (obtained by mixing characters and props picked from a set) and text written to describe the scene more explicitly. Scenes could be added anywhere on the wall and connected by transition arrows drawn on the glass, as a directional indicator, providing a sequential order by connecting scenes. The experimenters provided an initial story as a starting point for users who, in succession, could modify what was on the wall: change or delete scenes, alter the structure (erasing and drawing transition arrows, and moving scenes to new positions), and place their own scenes in any point of the unfolding story. We introduced 7 initial scenes narrating the beginning of the kidnapping and rescue of the Princess.

4.1.2 Experiment I in Detail

16 subjects were invited to participate in the experiment one after another sequentially. There was no special consideration in the demographics involved. A non-imposed average elapsed time of 12 minutes was measured.

Subjects were asked to read the existing narrative which was the result of the accumulative modifications made by previous subjects on the initial set provided. They were also interviewed after they finished reading the existing narrative on how they've had chosen to read the story (order, objects and concepts they had followed, etc.), along with their opinion on some specific matters such as the literary value and consistency perceived.

Next they were offered the possibility to contribute to the narrative, and allowed to modify or delete previous scenes, to alter the structure of the story structuring (erasing and drawing transition arrows, and moving scenes to new positions), and to place their own scenes at any desired point. Finally all subjects answered a series of questions designed to learn more on how they interacted with the story, such as the nature of their contributions (according to them) along with their driving motivation or purpose. We also asked some open questions on some subjects such as if it was a fun experience or if they would enjoy doing the same with their friends through a social network.



■ **Figure 2** Story on a Wall reader-perceived consistency level.

4.1.3 Results

The story resulting from the experiment contained 29 scenes connected through two main branches that converged towards their end. Each participant added either one or two scenes to the growing narrative. No subject eliminated scenes from previous participants, but modifications on existing scenes were common: half of the participants inserted their scenes between existing ones and/or altered the direction of arrows; over one third created convergence between two or more isolated branches (for example two characters gathering at one point, or one event affecting the story of another author). A few subjects claimed to focus exclusively on solving inconsistencies during the authoring phase of the experiment. Maintaining consistency in the evolving narrative was stated as the principal reason for 8 out of the 15 contributors. The notion of conflicting scenes was stated 4 times as something disliked in the interviews. According to subjects all of the changes made to previously existing elements were for the sake of consistency. Other contributions were centered mainly on extending existing plot arcs instead of creating new ones. Consistency seemed to be key in user motivation and overall experience. The subject-perceived level of narrative consistency (figure 2) tends to be on the middle-high portion of the scale but decays slowly. As the initial story is different for each user, the results cannot be easily compared but subsequent experiments allow for comparison. In this experiment we were mainly interested in observing the interaction between authors and the story.

According to the interviews, the literary value of the narrative concerned little the subjects. Interestingly, individual scenes and small narrative branches had greater entertainment value than the overall narrative. Since the sequence of events can only be guessed through the spatial layout of the scene and the arrows network, some conflicting notions appeared on what was happening before, after, or simultaneously to a given scene when dealing with parallel stories. This suggested that scenes could be arranged in some sort of linear organizational structure to provide an improved sense of sequence and causality. Our close observation of how scenes related with each other and how participants authored existing characters, revealed that each character was considered the same entity throughout the whole narrative, almost always labeled with the same name. The experiment also showed that the authors faced a complexity which scaled very strongly if they tried to maintain the structural consistency of the story. The more scenes it contained, the harder it was to introduce new material without contradicting or violating existing established facts. On the other hand, the decreasing reader-perceived consistency of stories containing a large amount of scenes indicated that the reading process became more difficult as well. Some people were motivated by the unfolding implicit collaboration, and nobody stated openly to be bothered by it. In fact,

contributing to the narrative was not mandatory but all of the subjects added scenes, and they actively searched for an interesting entry point and modified the whole context, changing and rearranging scenes connected to their contributions, instead of just attaching them to the end of a story thread. More than half of the subjects expressed their interest in repeating the process later and many of them returned after their contribution to see how the narrative was evolving. A good number of people who just happened to pass by stopped to read the whole story, many of whom asked to participate in subsequent iterations of the experiment.

4.2 Experiment II: Measuring the Impact of Consistency Constraints

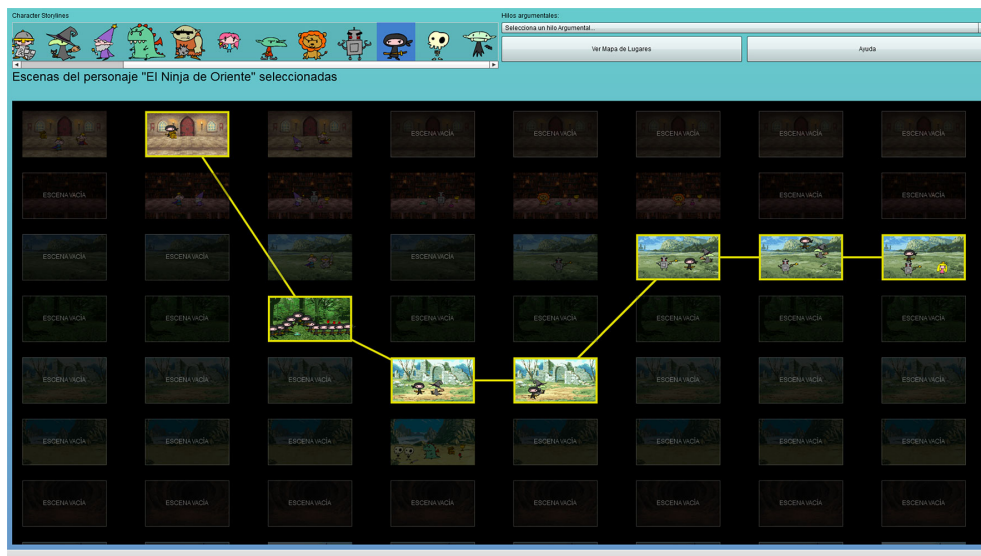
The purpose of the second experiment was to measure the impact of an underlying formal model to user contributions and their overall interaction with a multi-authored non-linear narrative. This formal model was designed to provide structural consistency to the narrative space, hopefully reinforcing key factors that enhance the production of stories that are perceived as more consistent. We introduced some constraints into the interaction to prevent subjects from creating scenes that somehow violated the rules proposed by the underlying model. We used a platform we developed, [6], to be used on a connected laptop, which meant changing to a much more private environment.

4.2.1 A Setting that provides an Underlying Consistency Model

The Setting tries to provide an underlying formal model that resembles the author's mental construction of a narrative space. We used data from the previous experiment to map their understanding of the story into an assessable and measurable model, through a process that can be found in our previous publication [6]. The Setting serves to monitor and enhance the consistency of the stories unfolding within it. It provides a common ground for authors to interact by building stories in the same narrative space. Its informal definition is the following:

- The Setting contains timeframes and locations on a grid.
- Timeframes have an implicit order.
- Every location is at a certain distance of other locations. The distance from A to B is the minimum number of locations needed to go from A to B.
- Every scene takes place in a location and contains one or many characters and zero or many objects.
- Scenes can belong to plot storylines or character storylines.
- Storylines contain one or many scenes.
- Character storylines contain all the scenes that contain a specific character.
- Plot storylines contain all the scenes tagged to design a specific plot.
- Characters may only appear once per timeframe in a scene.
- Characters may only appear once in the same scene.
- Characters may not move between non-adjacent locations (distance > 1) in a single timeframe.

These rules were designed to provide a certain sense of consistency, which can be measured, monitored and enhanced, on the basis of the results of the Story on a Wall experiment, attempting to predict and enforce the factors actively pursued by users through their contribution. Our goal was not to evaluate this definition as a generalist model capable of describing any narrative; instead we wished to measure the impact of using a formal model in a multi-authoring scenario in terms of the consistency of the resulting stories.



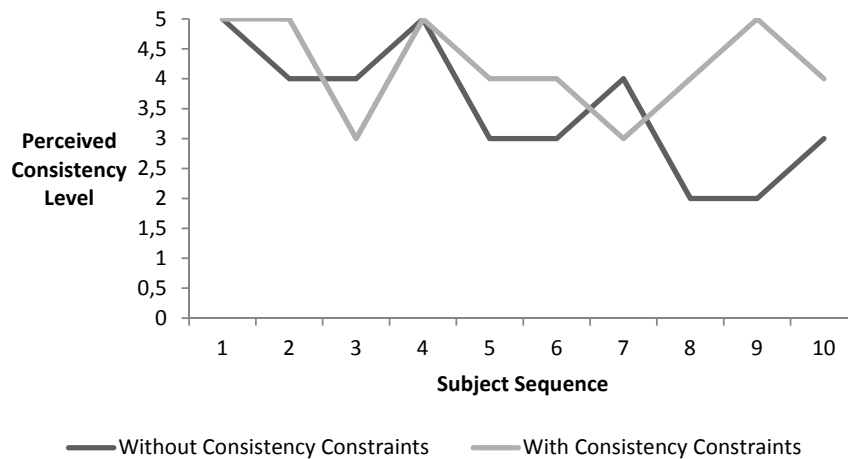
■ **Figure 3** CrossTale Interface.

4.2.2 Introducing the platform

CrossTale (see figure 3) is a software prototype whose main window follows a distribution similar to that of Story Wall, adding the rules imposed by the Setting. In fact, its main context is a dashboard with two axes, one for time and one for place. Users can scroll at will to navigate the dashboard. By selecting existing scenes they can view their images and read the descriptive texts. Specific characters and storylines can be selected, enabling users to read all the scenes involving that character or storyline in a sequential order. The grid also highlights scenes belonging to the selected entity and connects them with an arrow line to reflect their sequential order. There is also a secondary context that enables users to create scenes, providing a set of components (characters, objects and plot storyline tags) along with a visual representation of the location where the scene takes place and a text box to introduce the description. These scenes are added to one of the Setting timeframes and locations and are treated as an integral part of the narrative space. Violations of the Setting were not allowed in this experiment, and the user got a message requesting him/her to resolve the conflict before saving the scene (in the third experiment users could save scenes that violated the Setting, but users were warned before).

4.2.3 Experiment II in Detail

20 subjects of similar characteristics as those in the first experiment took part. Two groups of 10 were created randomly. The control group used the tool to read and contribute to the existing narrative, and the experimental group had some consistency constraints based on the Setting. The use was sequential, as each user found the story in the situation left by the previous one. No time limits were provided and the average time of the users was 20 minutes. A CrossTale prototype was created with an initial set of scenes describing the start of a traditional fairy tale. The 8 initial scenes introduced were almost identical to the ones used in the previous experiment, introducing a Princess, her kidnapping by a witch and the Prince trying to rescue her. Each subject was asked to read the story which was composed by the initial scenes provided plus the contributions made by previous subjects. No specific method



■ **Figure 4** CrossTale reader-perceived consistency level with and without consistency constraints.

was imposed. The story could be read completely or not. Reading character storylines could be a strategy amongst others. A brief interview was conducted to understand how users read and understood the whole scene set regarding the storylines. Then they were asked to add one or more scenes to the existing ones. After they were done, a second interview was conducted to understand what kind of additions and modifications they had made, their motivations, the intended influence on the previous state of the story, and any other relevant details of the interaction between the subjects and the story. The whole experiment was recorded for further coding and observations. The subjects were aware of the collaborative nature of the tool, but did not have contact with the rest of the subjects before, during or after the experiment.

4.2.4 Results

Results were analyzed independently for each group. It appears that subjects were not very concerned with reading the whole narrative before interacting with it. Users only read a fraction of the existing content. No user read the whole story. The most common interaction recorded during the reading phase involved the user selecting one or two storylines and reading its content before moving on to the contribution phase. The perceived consistency (figure 4) was steadily rated high in both groups, with a slight tendency to decay towards the end in the group without constraints. The difference did not seem very significant. Both groups ended up with a story composed of 28 scenes and 10 storylines. The average scene contribution was 2 scenes per user. Most users placed their scenes inside one and only one storyline. No user modified scenes created by other authors. The rating of the user experience was positive (average 4.4 out of 5) as well as of the application design (average 4 out of 5). We asked subjects if they would use CrossTale regularly with an average 3.6 out of 5 and if they would like to have a similar tool to create and share narratives in the context of a social network, with an average 3.7 out of 5.

The focus of the experiment was to observe if the introduction of consistency constraints derived from the Setting caused any interesting effects. The most remarkable observation was that the perceived consistency seemed to decay more quickly over each contribution for the group without constraints, although the resulting data isn't very significant. This could mean that enforcing certain notions of time and space through the scenes tends to produce more consistent results, supporting our initial hypothesis. A larger subject group

in future experiments could validate or refuse this claim. Adding the constraints seems to have an annoying effect on the experience of users who felt limited all the time (as seen during the video codification, where they complained almost every time a constraint blocking message popped up). This might be caused by the way messages themselves are displayed in CrossTale. It could be an interesting line for future research. Joining the data from both groups also revealed some interesting facts. The use of a computer program to conduct the experiment might have affected the user experience, limiting the user's freedom when compared to the previous experiment. The story in this experiment was read on a screen and embedded inside a software program instead of being on a glass wall. Subjects were less inclined to interact with the existing scenes; no user modified scenes created by other authors. Subjects spent less time interacting with the narrative (the decreased time could either be an indicator of a less pronounced learning curve, a good interaction design or a decrease in the motivation of subjects). Also, according to the interviews, they were less concerned by narrative inconsistencies. As previously mentioned, the story was now stored in a computer program. We believe this might have caused users to be less aware of the story as a whole and therefore less concerned with its global consistency. In fact, the reader-perceived consistency of the narrative was larger for both groups of users compared to the previous experiment. This might also be related to the fact that users never read the whole story. Users aren't concerned with the consistency of scenes they haven't read. We chose to follow the same cumulative mechanism as in the first experiment on both groups. This was done to gain some insight on the evolution and scalability of the story while comparing the results with the previous experience. We are aware that this decision prevents us from comparing subjects' individual performance in terms of consistency. The following section describes an experiment where this was done.

4.3 Experiment III: Measuring the Usage of Storylines

The third experiment explored the use of storylines further. Namely, we were interested in measuring certain aspects such as the number of storylines read by subjects, the degree of comprehension after reading, the performance when creating new storylines and their consistency. Moreover, we wanted to cross measures of the reading and contributing phases and find any significant correlations.

4.3.1 Experiment III in Detail

This experiment was fairly similar to the previous one. The main difference was that user contributions were not cumulative, every subject found the same initial set of scenes and there was only one group. Every subject started their contribution with the initial 12 scenes we provided. The story was the same fairy tale. The initial scenes introduced 3 main storylines that explained the events through the Prince, Princess and the witch's own viewpoints. CrossTale was used with the same rules derived from the Setting, the derived consistency constraints from the Setting were always active; its application was not enforced, only warning messages existed. There were minor usability refinements to CrossTale. We provided users with the ability to zoom in and out (using the mouse wheel) when viewing the scene grid. We also allowed users to scroll through the scene grid by dragging the mouse anywhere, not only the scrollbars. These additions were introduced to provide more visibility and accessibility to the existing scenes inside CrossTale. 16 subjects of similar characteristics as those involved in the previous experiments took part. An average time of 10 minutes of involvement with the system was measured. The experiment began with each subject

reading the story. CrossTale provided several mechanisms to do so: reading individual scenes, following specific storylines according to plot threads or characters. Users were free to read only a part if they wished. The interactions with the reading interface were registered, and a brief interview was conducted afterwards to analyze their reading experience. The next phase was the contribution. Every subject was asked to add more scenes to the same existing story if they wanted to. Their interaction was registered and a brief questionnaire was administered. This questionnaire was used to rate the user's general impression of the story when contributing to it. Subjects were asked to rate the warning messages, the story in terms of consistency and amusement through Likert scales, and also to propose one or more titles. In both phases the proceedings were run by a collaborator not directly involved in the research, who coded the interactions as well. Unlike the previous experiments, modifications to the scene set were not cumulative between subjects, so the consistency measurement was done through a 4 person jury evaluation of each subjects' contribution.

4.3.2 Results

Regarding the reading phase, most subjects read the existing scenes through the usage of storylines. Readers selected an average of 7.77 storylines to read. 83% of them were read from start to finish. 43.59% of the initial character storylines were read and 1.38% of the initial plot storylines were read. The average contribution per subject was 2.6 scenes. The number of scenes read seems to be correlated with the number of plot storylines used. There is a medium-high correlation between the number of titles for the story proposed by subjects and the number of characters mentioned in those titles. Also there's another medium-high correlation between the number of plot storylines referenced in the proposed titles and the amount of plot tags used later during the authoring phase. There's a positive correlation between the number scenes created, the number of storylines read and diversity of characters used in the created scenes. Very few message warnings about violations of the Setting rules were displayed (Warnings appeared in 24% of the composed scenes). Of these warnings, only 17% made the authors change the story. The resulting inconsistency level measured was an average of 1 inconsistency per contribution, or 0.46 inconsistencies per scene. Another interesting observation regarding consistency is the following; inconsistencies didn't increase in proportion to the number of scenes introduced inside a story.

Subjects seemed generally more inclined to use character storylines to read the provided story. There's a tendency towards a character-driven exploration of the story, possibly related to semiotics and some of its most popular theories. Nearly no subject read scenes without using storylines. We believe they proved to be a good mechanism to explore non-linear narratives such as the one we created in this experiment. Some users made extensive usage of the tool to create a large amount of scenes, which allowed us to briefly analyze the scalability of the system in terms of consistency. The number of inconsistencies remained stable during each user's session. In those cases, having the same author for all the contributions also ensured a more accessible and scalable development. We believe the small size of the initial narrative, along with the improvements and refinements to the CrossTale user experience were also instrumental for this to happen. This also could explain certain measurements, such as the average reduced time for each subject's interaction with the story. While these measurements might make it difficult to correlate the structural consistency of the narrative space with the consistency perceived by reader, the jury evaluation and our qualitative analysis of the stories suggest some major critical inconsistencies were avoided thanks to the warnings. Since we lack more evidence to sustain such a claim, we are already pursuing new experiments to provide more data in this direction. It is worth noting all elements tagged as

incoherent by the Setting's rules were not considered very incoherent by the jury evaluating the consistency of subject's resulting narrative.

5 Discussion and Conclusions

This research is about how people collaboratively write narratives and the role played by consistency in this writing. A medium term goal is to provide a useful tool to support it. In this section crucial issues emerging from the three experiments are discussed together with considering other interesting points for the near future research.

5.1 The Role of Consistency

Consistency appeared as a relevant factor during collaborative narrative composition, and it influences on the way stories are read and written in multi-authored scenarios. Let us recall that in the first experiment, authors introduced quite a few modifications to the overall story when it was necessary to maintain the consistency of the plot arc they were developing or to correct a discontinuity in the overall narrative consistency. Consistency provides stories with a sense of causality and makes them more accessible for new authors and enjoyable for readers.

We believe there is a certain cultural common knowledge of what is consistent and what represents a plot hole, defined by Ryan [17] as an inadvertent inconsistency in the logical and motivational texture of a story. In our model, a plot hole is a discontinuity in the cause-effect logic of the story discourse. Further experiments are needed to validate this hypothesis of the relevance of causal links.

However, in the second and third experiments authors were not as clearly concerned by consistency as in the first experiment. We believe this is due to the experimental settings, as the use of a more focused and constraining software prototype meant incoherencies were less visible to the users. The introduction of an underlying formal model with its own rules, and of reading mechanisms, which were absent on the first experiment, probably led to the reduced interest in providing consistency. CrossTale ensured consistency preservation in an effective way, and reduced the users' concerns.

However, consistency is not the only issue worth tracking when building stories collaboratively: the lack of visibility of scenes or the constraining effect of the model on creativity were not our focus in the experiments and should be further studied.

The distinction between the two types of consistency has been an effective way to formulate our research. The Setting provided an objective measure of consistency based on our model, and its impact in the perceived consistency level could be assessed.

5.2 Monitoring and Enhancing Consistency through the Setting

The Setting aimed at dealing with the user's concerns about consistency observed during the first experiment. These concerns seemed to mean that time and space limitations had to be enforced, and therefore, the Setting only deals with these aspects of stories. It established a framework for developing narrative collaboratively, with a clear interpretation of what is consistent and what is not. Forcing users to follow the Setting rules during the scene composition process was not a very popular design decision among authors, but the stories built under these conditions apparently provide better reading experiences. Therefore we illustrate an interesting situation; constraining scene composition under a Setting-like model may lead to more consistent results while hampering the authoring process. No

specific observations were made on creativity aspects, but we feel that the Setting could easily decrease the creativity of the stories it supports. This should be properly tested in subsequent experiments.

The Setting in the second experiment proved to be a double-bladed sword: authors were aware of some of the things they needed to take into account that might have ignored so far, but they also felt less able to express their creativity due to the constraining nature of the consistency rules. The implementation of the Setting in the third experiment is more successful; authors were always aware of violations to the Setting rules, but they could react in different ways. Some deliberately ignored the warnings, while others (the majority) prioritized such incoherencies and solved them before anything else. Ultimately, we believe there is no formal model valid and complete for all possible narratives. Our future attempts to provide support and guidance in building consistent multi-authored stories will probably involve the authors in the construction of their formal model. What might be consistent in one narrative space, such as involving magic characters, might be inconsistent in others, and there is no one better suited to establish these discriminations than the individuals who are creating the stories. Future experiments could even introduce inconsistency generators, based on approaches that generate events and situations, possibly reducing the user-perceived consistency but maybe providing some inspiration to the authors.

It is important to remark that the results coming from experiments where the modifications to the narrative persist and those where every subject deals with the same exact set of scenes are not directly comparable.

Another aspect of multi-authoring is group dynamics. The Setting essentially stated the game rules, which each author had to follow to enter into the game of story creation. On the other hand, each author introduced modifications to the narrative space that needed to be respected by subsequent authors, meaning that the learning time needed by the following author increased. A possible improvement could be to provide better communication amongst authors to support their coordination. This could improve cooperation during narrative composition and introduce specializations such as committing specific authors to preserve consistency by stating the fundamental consistency rules and reorganizing structured content.

5.3 Very Human and Causal Storylines

Human-generated stories within a narrative space, as those observed in the first experiment, are not random. Most contributions followed existing plots, commonly associated with a character or some abstract concept, such as a motivation or a specific theme. The introduction of formal storylines in the second and third experiments was meant to reinforce the sense of computational causality and continuity, trying to predict the authors' behavior to ultimately enhance the user experience. After analyzing their use during the experiments, it is safe to say that they meant a difference to the results. The reader has to follow the clear cause-to-effect relationship made explicit. The story exists in a specific region of the narrative space. Users embraced this storyline mechanism to explore and understand the narrative space, and in most cases avoided the free scene selection in favor of the sequential reading order provided. They also used this mechanism to link new scenes into existing storylines or even to start new storylines from scratch to propose new ways to read the content of their creations. This might have been one of the key reasons for the increase in the reader-perceived consistency measured in the experiments that used CrossTale.

We believe the use of storylines as tools to communicate stories is fundamental in the exchange between a storyteller and its audience. From the Setting computational point of view, storylines are not necessary for the narrative space to exist. However, without them, it

is rather information with no narrative quality. Even if storylines did not formally exist in the Setting information architecture, any story introduced by human beings would probably has cause-to-effect relationships.

Another interesting finding that we will probably introduce in future attempts to map a story to a formal model is that readers prefer storylines based on characters to those based on plots, as they chose the former almost always. Apparently, in the context of a non-linear story, users find more natural to follow specific characters instead of plots. One possible explanation is that in most of our stories (and in many stories found on contemporary media) a character only appears in one plot with a main role. While s/he could appear (seldom) in additional storylines, the character would then have a minor role. Some of the most popular Semiotic models [16] are built around characters and their roles, rarely depicting meaningful entities that display human-like behavior. We will explore this approach in the future.

5.4 Conclusions and Other Future Work

Narratives are highly subjective, as any product of an artistic discipline. There is an implicit notion of causality in any story. Our experiments are not exceptional. Scenarios involving cooperation between authors often suffer from discontinuities in their causal relationships, which produce less satisfactory stories for their readers. We believe consistency plays a fundamental role and we presented experimental data that supports our belief. Our approach introducing a formal model that imposes consistency constraints derived from the narrative space was tested; showing it was capable to monitor and increase the structural consistency of the multi-authored narrative space as intended. This apparently translated into stories with an enhanced reader-perceived consistency. However, the negative reaction from authors when facing constraints imposed by the model requires further exploration. We believe some media (such as TV, films, comics amongst others) have the difficulties of collaboration amongst multiple authors discussed throughout the paper, and we plan to extend to them the methods introduced.

There are also some possible paths for future work that deal with some secondary factors observed. Regarding creativity, subjects from all experiments seem to perceive scenes created by authors with a background in communication or arts as generally more creative but not necessarily more consistent. The relation between creativity and consistency is not clear at all in our observations. A more specific experimental design, possibly involving subjects with specific backgrounds and narrative expertise, could shed more light into the matter and maybe provide some details on the hypothetical correlation between creativity and consistency.

On the other hand little attention was paid to the interaction and aesthetic design of CrossTale. This is an interesting line of research that deals mainly with usability and user experience, potentially improving the CrossTale results.

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