Interaction and Participation in Collaborative Storytelling Systems

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"One describes a tale best by telling the tale. You see? The way one describes a story, to oneself or to the world, is by telling the story. It is a balancing act and it is a dream. The more accurate the map, the more it resembles the territory. The most accurate map possible would be the territory, and thus would be perfectly accurate and perfectly useless. The tale is the map that is the territory. You must remember this."

— Neil Gaiman, American Gods

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Abstract

Storytelling is one of the oldest models of cultural expression in human history. Thanks to the evolution of information technologies, the Web 2.0 paradigm has impacted in this field: some modern audiences actively participate in their favorite narrative worlds. We define Shared Narrative spaces as *informative spaces concerning narratives created, developed and maintained through the collaboration of multiple authors*. Our research aims to understand the perception of SNS using a HCI (human-computer interaction) lens, and to define the determinant factors affecting users' interaction (exploration, comprehension and contribution) with them. We approach the issues of multiple authoring as an opportunity for collaboration through a storyline paradigm grounded on classic narratology, and use it to examine the users' perception and exploration of SNS. We propose an analysis framework that suits the comparative analysis of narrative systems of very diverse nature, which allows us to study the interplay of fundamental HCI aspects. Finally, we lay out the bases of a general model to approach the design of a wide range of collaborative narrative systems.

Resum

La narrativa és un dels models d'expressió cultural més antics de la història de la humanitat. Gràcies a l'evolució de les tecnologies de la informació, el paradigma Web 2.0 ha impactat en aquest camp: algunes audiències modernes participen activament en els seus mons narratius preferits. Definim els Espais Narratius Compartits com els *espais informatius relatius a narratives creades, desenvolupades i mantingudes mitjançant la col·laboració de múltiples autors*. La nostra recerca pretén comprendre la percepció dels ENC des de la òptica de la HCI (interacció persona-ordinador) i definir els factors determinants que afecten la interacció dels usuaris (exploració, comprensió i contribució). Plantegem una aproximació als problemes d'autoria múltiple tractant-la com una oportunitat de col·laboració a través d'un paradigma de "línies narratives" basat en la narratologia clàssica, i l'utilitzen per examinar la percepció i exploració realitzades pels usuaris. Proposem un "framework" apte per l'anàlisi comparativa dels sistemes narratius de naturaleses molt diverses, que ens permet estudiar com s'hi interrelacionen els aspectes fonamentals de la HCI. Finalment, establim les bases d'un model general per abordar el disseny d'un ampli ventall de sistemes de narrativa col·laborativa.

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1. INTRODUCTION

1.1. Research context and motivation

Storytelling is one of the oldest models of cultural expression in human history. Traditionally, it has been associated with the oral and written media (from the Epic of Gilgamesh, the first great work of literature, to modern best-sellers), the first channels of information transmission. From those early days of communication to nowadays, narratives have been influenced by both cultural and technological evolution, taking a wide range of varying forms of cultural products, as the modern cinema or television series.

Despite all these changes, those kinds of classical narratives share some traits inherent to their traditional medium: linearity, which suits the temporal causality of classical narratives, and mono-directionality, since they are created by an author or a group of authors to be experienced by a passive audience. In spite of that, several studies and experimental works about how to experience narratives in a participatory and/or non-linear way were done, exploring the limits of those traditional media (from, Moholy-Nagy "total theatre" [1] and Borges' tales, to the more recent examples of pen-and-paper roleplaying games and "choose your own adventure" books).

Is in those last decades, thanks to the evolution of information technologies and digital media, new opportunities for creating and experiencing narratives in new ways have appeared. Audiences can participate interacting with the narratives, exploring them (*exploratory* participation [2], which allows for non-linear forms of storytelling) and even altering them (*ontological* participation [2], which defies the traditional notion of mono-directionality). The Web 2.0 paradigm stressing user-generated content has impacted in the field of storytelling, some new kinds of modern audiences have appeared, such as online fan communities, eager to actively participate in the study, composition and expansion of their favourite narrative worlds [3, 4]. This thesis aims to make contributions in this area.

1.2. Approaches to Interactive Storytelling

Interactive storytelling has been contemplated from multiple perspectives. The wide range of options offered by the possibility of interact with the narrative was the focus of pioneer works as the ones by Brenda Laurel [5], who contributed to the foundations of the whole Human Computer Interaction (HCI) field.

From this point onwards, studies on this field deepen in the analysis of the different kinds of interaction users can develop with narratives, as the categorization proposed by M.L. Ryan [4]: Ryan establishes the axis of *internal* vs. *external* participation (whether the user fulfills or not the role of an internal agent in the storyworld), and the axis of *exploratory* vs. *ontological* participation (whether the user is able to alter the storyworld or not). Despite this, the examples of combinations of those different modes of interaction provided by Ryan always conceive a pre-authored narrative system (opposed to the direct input of narrative content by the user), even in the case of an external-ontological interaction mode, which is the closest to the role of an author (Ryan exemplifies this case mentioning the "hypertext" / "choose-your-own-adventure" narrative as cases where the reader is also a "co-author" through choosing between different story developments, bur never mentions a direct "narrative input" / "creative activity" from the user).

On the other hand, other relevant figures on the field of interactive storytelling, such as Chris Crawford [6], have delved on the study and development of tools for authoring interactive stories [7]. The multiplicity of choices that users can make in an interactive story demands for a wide range of outputs that the story has to produce as a result of the user interaction (i.e. results of the actions made by the user in the case of a videogame-like system, new pieces of story in the case of an hypertext narrative, etc.). This could be one of the reasons for the relevance of the authoring aspect, and also for the suitability of automatic generation of narratives.

Meehan's Talespin [8] is one of the first examples of an Artificial Intelligence based story generation system. Related with this, several authors [9,10] have contributed to the study of the computational models better suited to automatically produce narratives. Some of these models

(as [11]) are based on the classical models developed by the researchers of the narratology/semiotics field [12, 13], which have also informed the development of some human-authoring tools [14].

But, to the best of our knowledge, the study of authoring of narratives and the study of interaction with narratives (from an HCI perspective) tend to be contemplated as two isolated fields, since the last one tends to focus on the study of the "final audience" of the narrative, and does not consider the author as a "user". An exception to this, and a first step towards our goal, could be the studies of vast narratives (as [15]). As we introduced at the beginning of this chapter, not only transmedia fiction franchises have changed the model of how narrative worlds are constructed, but also the 2.0 paradigm has blended the roles of "producer" and "consumer", resulting in the appearance of new modalities where audiences collaborate to create in their shared storyworlds.

Thus, we take one step further and define shared narrative spaces (SNS) as informative spaces (i.e. the set of elements and relations from an information system [16]) concerning narratives created, developed and maintained through the collaboration of multiple authors. Thanks to this multi-authorial participation, those narratives can grow from single traditional stories to vast narrative spaces, a large set of narrative information units that grow organically to form a non-linear network of related stories that share a common narrative setting. The specific focus of this thesis is the study of some aspects of SNS.

1.3. Research questions, main results and structure of the thesis

Our research questions aim to understand the perception of this kind of spaces using a HCI lens, and to define the determinant factors affecting users interaction (exploration, comprehension and contribution) with SNS. We introduce and discuss them next.

1) How do users perceive SNS?

Classic semiotics [12, 13] gives us an insight of how traditionally narratives are structured, but the classic perception of how narratives work is challenged when we turn them into non-linear

structures accommodating contributions of multiple authorships. For approaching the study of SNS, we first need to detail the role of the notions of temporality, cause-to-effect relationships, consistency and semantic relationship, in the perception of the users exploring this non-linearity.

2) How do users explore them and how this affects comprehension and engagement?

Closely related with the previous question is the matter of how a shared narrative space is explored, and how this is affected by the perception of the narrative space. Studies on hypertext fiction [17, 18] approach how users interact with narrative structures once decomposed and turned into non-linear informative spaces, and which problems arise. We want to deepen into this understanding, detailing how the aforementioned notions mentioned in the previous question affect the way users decide to navigate a non-linear structure, and how this impacts on the final gained comprehension of the narrative content, and the enjoyment of the "reading" experience.

3) How do users contribute to SNS, and how the exploration mode (and other factors) affect this development/contribution?

Several case studies have approached how the specific interaction models of a wide range of narrative systems work [19, 20, 21]. Our intention is to synthesize and develop both those studies and our previous knowledge into a general model that takes into account all the different (internal and external) factors that mediate the user experience with the narrative space, and explain how they impact on both the exploration, the interaction/collaboration, and the nature of the final created content, in terms of structure, semantics, consistency, etc.

Each chapter of this thesis intends to deepen in one of those research questions, each one adding to the next. This work is structured as follows: Chapter 2, which includes [22], is the most exploratory chapter. It is dedicated to study how users perceive shared narrative spaces, and to define the set of aspects and issues that we will extend in the next

chapters. We examine the use of shared narrative spaces as a collaborative medium through a prototype tool. Although we present a first insight of traditional narrative structures from the narratology field [12, 23, 24], the development of this first study, following a research trough design [25] methodology, bases its design on empirical observations and the related HCI works on tools and interfaces for digital storytelling [26, 27, 28].

The purpose of this prototype-driven study is to define the adequate system concepts and design to represent and interact with non-linear narratives, and to gain understanding of the interaction aspects of shared narrative spaces and their implication on designing systems supporting multi-authored storytelling. The most critical aspect observed is the difficulties inherent to obtaining meaningful information when exploring a complex net of causal-related scenes or story parts. The use of the *storylines* mechanism (to organize and navigate it following structured sequences of character and plot-related scenes) revealed to be a first successful step towards this objective.

Complementary research on consistency perception and preservation is also presented: consistency between all the story elements and scenes is the main conception that readers use to understand this kind of narrative space, and one of the main concerns when expanding the space by adding new scenes. Implementing computational rules help to raise consistency but can also undermine the user experience. In the next chapter, we will relate these two lines of investigation: we observe how easing the process of exploring and understanding the narrative space, we can facilitate contributing more consistently to it.

Chapter 3 is devoted to the examination of how users explore non-linear narratives from a HCI perspective, and how the exploration modes impact on the users' comprehension of the contents of the narrative space.

In this chapter we approach a more formal model for structuring a non-linear narrative space, following the idea of a character-based approach which has been adopted both in the field of generative models [29, 30, 11] and human-authored systems [14, 31, 32]. Following the findings of our previous chapter, in [33] we propose an experimental interaction model directly based on the *narrative programs* semiotics concept [12, 13] to structure the narration in character storylines and to present a way to

connect them meaningfully. The purpose is to facilitate the navigation of non-linear narrative spaces and to increase the contributors' awareness of the other authors input. We implement this model into a prototype to test the reader's comprehension of the story and to analyze the contributions of those who expand it. The analysis presented shows how readers naturally explore the narrative space through storylines associated with the character narrative programs, which is an intuitive way of exploring that seems to overcome some of the handicaps of classical hypertext narrative [17, 18]. Those characters with longer and more defined narrative programs are regarded as the "main characters". Instead of exhaustively reading all the narrative space, comprehension is achieved through the ability to identify these key characters and scenes and to understand their relations with other storylines. This comprehension leads to contributions with a good level of consistency.

We complement this chapter with [34], a different use case on interaction and comprehension of non-linear narratives, presenting the field study of the usage of an app containing a storyline-based locative narrative. We review how different interactive proposals have approached the coupling between non-linear narrative structures and physical points [35, 36, 37], and study the interaction model focusing on player's exploration of these interlaced locative narratives, working on the interdependence of three specific aspects: the narrative design, the interaction elements and the distribution of the narrative contents on the physical space. We explore how these elements affect the users' exploration mode, and how this affects story comprehension and engagement. The study confirms how users can explore and combine multiple storylines by focusing on a main character storyline as a backbone and exploring the crossing stories as deviations. This is especially encouraged by narrative-focused storylines that share plot, characters and style, while the design and the disposition of narrative points can graduate the difficulty of finding linearity and cause-to-effect perception in a space where multiple narrative pieces are scattered.

In Chapter 4 we study how users contribute to and develop shared narrative spaces, and how this contribution is affected by the system design, the exploration mode, and any other factors [38]. We propose a framework to analyze collaborative storytelling systems, made of a set of parameters divided into six conceptual areas. Four of them (context,

process, content and control) [39] relate to the systems and two (process and output) to the results of the collaboration. Through this framework we can study more precisely these different factors of the systems, their interplay, and how they impact the creators' performance. We also present a controlled extended-duration field study on collaborative storytelling, and we use this framework to comparatively analyze this study and other relevant experiences (both from our previous studies [40, 19] and from related research [20, 21]) in the field of co-creation of shared narrative spaces.

Our comparative analysis presented explains how the scale and nature of the built narrative (from small linear stories to a complete storyworlds populated by multiple storylines) impacts on the complexity of the task, but also the perception of the narrative space and its desired consistency. We also detail the kind of complex information structures and interaction mechanisms it demands. At the same time, we point at storyworld building as an opportunity for massive authorial participation, a kind of collaboration that is difficult to perform in smaller co-creative experiences. As a result, we use the conclusions of this analysis to propose a general human-information interaction model for collaborative storytelling systems. This model is divided in three interaction levels (a space for the narrative setting informative elements and its relations, a planning level to explore and interact with the story structure, and a plot development level), and is intended to inform the design of a wide range of narrative systems, to better support co-creation and address their usual barriers, turning them into new opportunities for collaboration.

Finally, chapter 5 summarizes our conclusions and the contribution of our thesis, and states some future work in the field of interactive storytelling studies.

2. PERCEPTION OF SHARED NARRATIVE SPACES AND DEFINITION OF THEIR PROBLEMATICS

This chapter presents an exploration of shared narrative spaces as a collaborative medium, seeking to understand their interaction aspects and how these aspects impact on the design of systems for multi-authored storytelling. This first explorative study is contained in the publication:

> *Colas, J., Tapscott, A., Moghnieh, A., & Blat, J. (2013). Shared narratives as a new interactive medium: Crosstale as a prototype for collaborative storytelling. International Journal on Advances in Telecommunications Volume 6, Number 1 & 2, 2013.*

This work, which is an extended version of [41], introduces the general concepts of interactive storytelling [6] and the kind of interactions, according the related works [2], traditionally performed with narratives. It also introduces a first iteration of the related context in which we will develop the concept of "shared narrative spaces" (which will be refined in future chapters), based on the examples of transmedia works and vast narratives [15], and the 2.0 web paradigm.

The presented study is divided in two parts. First, an analogic experimental design is used to explore the mental model of the users participating in a shared narrative space, helping us in defining the adequate system concepts and design to represent and provide interaction with non-linear narratives. Then, we present a prototype tool that implements the main ideas derived from those findings, and we perform both a usability test and an analysis of the results of the tool's usage as an informal co-creation activity.

One of the multiple findings of this work has to do with consistency and its central role on how users understand a non-linear narrative space and interact with it. In this sense, besides the presented results on this chapter, we offer complementary research focused on consistency preservation in Annex I:

Tapscott, Alan., Colás, J.; Moghnieh, A., and Blat, J., (2013). Writing Consistent Stories based on Structured Multi-Authored Narrative Spaces. In OASIcs- OpenAccess Series in Informatics , vol. 32. Schloss Dagstuhl-Leibniz-Zentrum fuer Informatik.

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

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.

2.1.1. 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.

2.1.2. 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.

2.1.3. 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 for 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.

2.1.4. 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.

Figure 1. The settings and development of the pilot experiment

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.

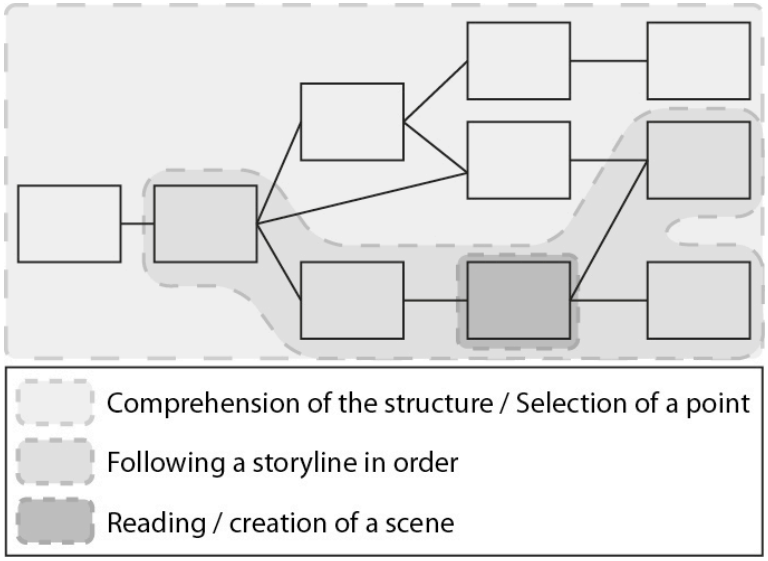


Figure 2. Viewpoints related to the interactions with the narrative space

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.

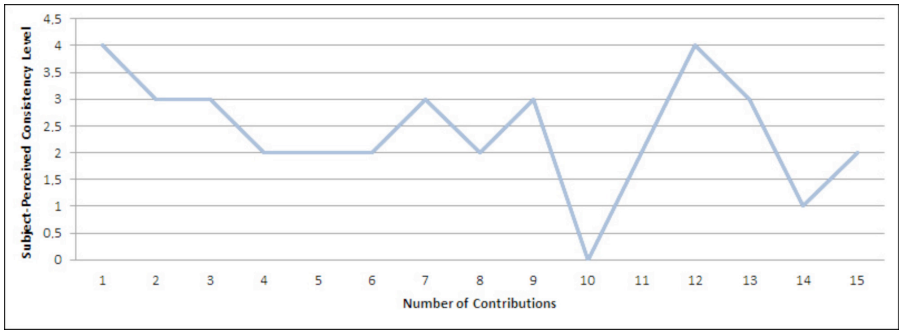


Figure 3. Evolution of the user-perceived consistency during the pilot experiment

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.

2.1.5. Prototyping shared narrative spaces

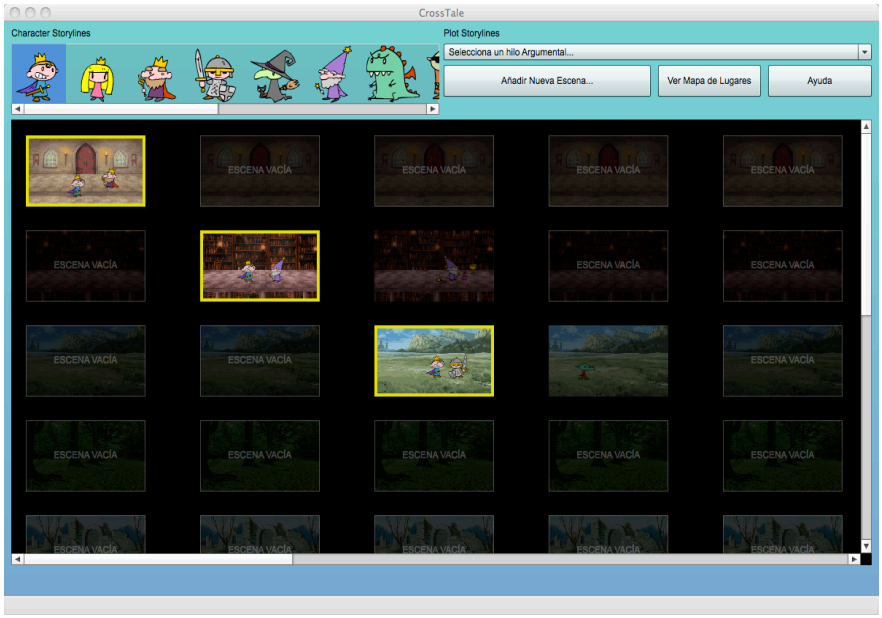
The resulting interaction factors extracted from the first experiment were transduced as a set of implications (Table II) for the design of information systems that support interacting with shared narrative spaces. We developed a prototype named CrossTale based on those design implications to reproduce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

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.

2.1.6. 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.

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

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 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.

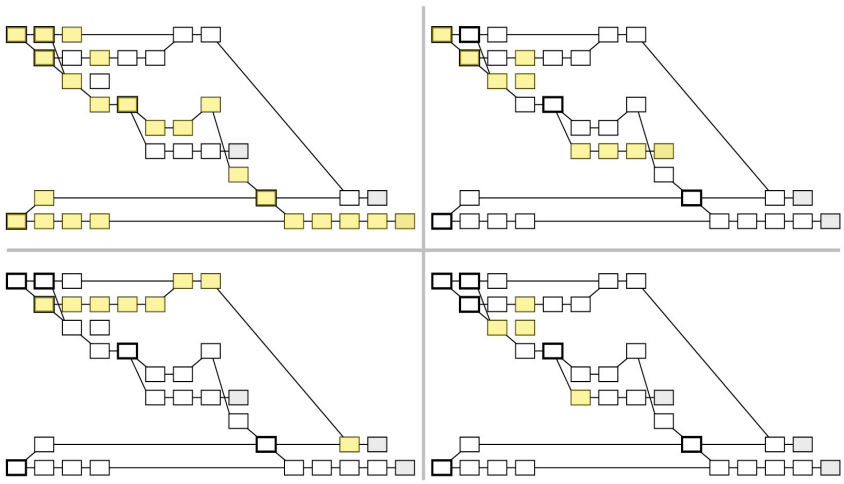


Figure 5. Plot storylines in the narrative produced with CrossTale

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

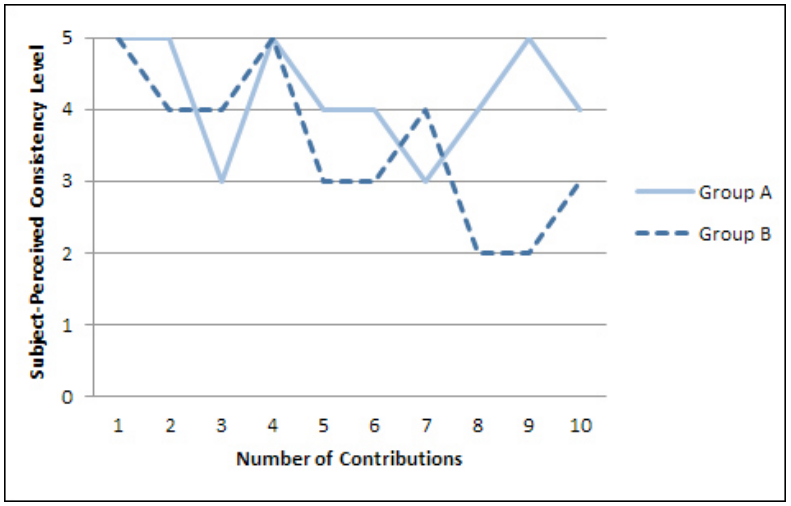


Figure 6. Perceived consistency level in the second experiment

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.

2.1.7. 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.

2.1.8. 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.

2.1.9. 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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3. EXPLORATION OF NON-LINEAR NARRATIVES AND ITS IMPACT ON COMPREHENSION

This chapter has two main focuses. First, the study of reader/user exploration of a non-linear narrative space and how this exploration mode impacts on its comprehension. Second, how reading and comprehension impacts on the contribution to the narrative space (although this is more exhaustively explored, along multiple other involved factors, in the fourth chapter of this thesis). The chapter is divided in two sections containing, respectively, the following papers:

> *Colás, J., Tapscott, A., Moghnieh, A., & Blat, J. (2015). An interaction model based on Narrative Programs to improve understanding and contribution to non-linear narratives. MMEDIA.*
>
> *Colás, J., Tapscott, A., Righi, V., Moghnieh, A., & Blat, J. (2016, September). Yoway: Coupling Narrative Structure with Physical Exploration in Multi-Linear Locative Narratives. In Games and Virtual Worlds for Serious Applications (VS-Games), 2016 8th International Conference on (pp. 1-7). IEEE.*

The first section proposes a continuation of the previous chapter work, and conceptually builds upon its results by directly connecting its findings regarding the observed interaction model and the shared narrative space to the theoretical groundings of classic narratological studies [24, 12, 13]. In parallel with some developments on computational models for narrative, which had used those classical models to develop their own practical applications [11], we do so in the field of HCI by proposing a human information interaction model based on the semiotics concept of "narrative programs" [13] to facilitate the meaningful navigation of non-linear narrative spaces through character-driven connections or "storylines". This model is tested through an experiment with a prototype, in which we analyse how the readers perceive and navigate the story space, test the reader's comprehension and examine the contributions of the users who expanded the initial story. We discuss these results putting them in relation with the idiosyncrasy of standard hypertext fiction navigation [17, 18].

The second section complements the study of non-linear exploration with another perspective. This work presents the design of an interactive-storytelling app based on locative narratives, and a field study of its usage. This allows us to explore a different use case on interaction and comprehension of non-linear narratives, in which we study the interplay between the narrative design, the structure of the narrative contents (in this case, coupled with physical space) and the interaction design. First, this subsection presents the field of locative-narratives [42], relevant to our app, and explores multiple approaches of how to deal with the fragmentation of storylines when hyperlinking is substituted by the physical scattering of the different parts of the narrative space [35, 36, 37]. Then, we propose a storyline-based approach similar the one presented in the previous section, but adapted to physical spaces and implemented in a geolocated narrative app. We conduct a field study of the usage of this app with real users. The study allows us to interpret how the abovementioned factors affect the users' exploration mode and the impact on story comprehension and engagement. From this work we remark the similarities between the exploration mode through storylines performed by the users in desktop based interfaces and in locative narratives, drawing a parallelism with the findings from the previous section.

3.1. An Interaction Model Based on Narrative Programs to Improve Understanding and Contribution to Non-Linear Narratives.

Collaborative creation of stories poses new challenges to the authoring task. Being able to comprehend a large non-linear information space and to take into account inputs from other creators is important to contribute meaningfully and consistently. This work presents a model based on the classic semiotics concept of "narrative programs" to structure and present the information with the purpose of making non-linearity more accessible, facilitating contribution, and inspiring creative opportunities. We introduce a prototype that implements this model, and use it in an experiment to explore how users read a non-linear story, understand it, and contribute to it. Results show how users identified the main characters and related them to their narrative programs achieving high levels of comprehension, which the correspondence between comprehension and

contribution consistency was, and that the users expand the narrative from multiple points of view.

3.1.1. Introduction

The traditional mono-directionality of storytelling is challenged by media concepts such as Transmedia (to combine different channels to create different narrative experiences in the same narrative universe, understood as the self-consistent fictional setting where the stories take place [1]), or by narrative "prosumers" (proactive consumers) who demand to actively participate in the development of those narrative universes (for instance in fan-fiction websites [2], where followers of a movie, TV series, novel series or other fiction franchises share their own stories taking place in their original universes). Nevertheless, the new types of narratives can grow into larger and more complex structures and pose new challenges to the creative authors, whose different contributions must deal with the specific requirements of the narrative genre, such as thematic and logic coherence and cause-to-effect connectivity [3].

Using a Research Through Design [4] approach, in previous works [5, 6] we identified that tools to support collaborative authoring require 1) providing the interaction mechanisms that allow the user to expand a story at any point of space and time, and 2) to empower the user to have a comprehensive view of all the large narrative space.

Comprehension (the fact of being able to understand the narrative content and to establish logical relations) can be a key factor for the creator to contribute meaningfully and consistently, as its lack when multiple users collaborate in the same space and not take into account the other contributions leads to narrative inconsistencies [6] (i.e., parts of the story enter into contradiction with other parts), while psychological studies have highlighted comprehension as a factor for good authoring performance in terms of structure and consistency [7].

On the other hand, authoring in digital storytelling has been approached from diverse angles: some works close to automatic generation, as the ones by Pizzi and Cavazza [8] or Swatjes and Theune [9] propose authoring as a co-creation between generative Artificial Intelligences (AIs), which will grant the correctness of the information, and humans.

Some researchers have worked with children and tangible interfaces for the creation of emergent fairytales [10, 11], where the systems try to respond consistently to the improvised actions of the kids. Most of the state of the art of interactive storytelling presents authoring tools that use graphs for organizing the non-linear narrative structures [12, 13, 14]. The collaborative online experiment by Likarish [15] pointed out the need of tools that provide the authors with the necessary information when contributing to multi-authored spaces.

In this paper, we propose an interaction model to facilitate the navigation of non-linear narrative spaces and to increase the contributors' awareness of the other authors input. Our model uses the "narrative programs" concept [16, 17] from narrative semiotics (the field that studies the creation of meaning in narratives) to structure the narration in character storylines and to present a way to connect them meaningfully. We turned this model into a prototype, Proppulsion, which is used in an experiment to test the readers' comprehension of the story, and to analyze the contributions of those who expand it.

This paper is structured as follows. In Section II, we review the related work on information models for storytelling systems. Section III introduces our model based on Narrative Programs for presenting and exploring narrative spaces from the perspective of the character roles and their relations towards other characters. In Section IV, we introduce Proppulsion and explain the setting and development of the experiment, followed by the presentation of the results in Section V. In Section VI, we discuss our findings: we point at how users identified the main characters relating them to their narrative programs and used their storylines as a backbone for exploring the whole narrative; how users who achieved greater comprehension also seemed to achieve greater consistency in their contributions; and how the system encouraged them to expand the story from multiple points of view. Finally, Section VII briefly summarizes our main conclusions and indicates some future work.

3.1.2. Information models for Storytelling

The study of narrative information models has been usually approached with the goal of building intelligent generative systems that automatically produce narratives. Computational models to be processed through AI are

far from our goal of interaction models aimed at being understood by authors, but it is convenient to indicate some of their aspects that are relevant for our approach.

Bailey [18] divides automatic story generation models into author models (imitating the human processes of authoring), story models (following a structural grammar) and world models (populating a setting with agents whose interactions result in a story) and proposes a model based on the reader's perspective. For Riedl and Young [19], generative systems can be categorized within a framework that balances plot coherence (author-centric systems) with character believability (character-centric systems). Mateas and Sengers [20] define story-understanding systems as those that *"seek to model the processes by which a human understands a story"*.

From our perspective of narrative information models intended to support the interaction of human authors, we distinguish two types of models, depending on whether the story content is produced automatically or by an author.

Among the models for automatic generative systems, some are plot-based, when the system follows a set of rules to generate the story that has a certain semiotic structure; others are character-based, when the model is used to generate the actions of a set of characters and the narrative emerges from those actions, as in Cavazza's work [21]. This vision of the narrative, as the result of multiple characters each following his/her own narrative programs, helps to form our vision of a multi-linear story. Gervás [22] uses an implementation of the formal model of Propp's morphology of folk-tales, from which we draw some basic concepts in the next section. Some systems using generative models can be interactive as well, as Mateas and Stern Façade [23], where a user takes part in the story as a character and the system has to generate storyworld events and respond to his/her actions.

Other models support authoring systems, where one or more users perform the role of author. A lot of examples come from the field of authoring systems for interactive narratives, as Storytec [12], Scenejo [13] or Narrative Threads [14]. Those systems present the users tools to produce narratives and, as in classical hypertext narratives, they have to deal with non-linearity, since the author needs to build a changing

structure that varies depending on the choices of the player. Quite a few of them (including [12, 13, and 14]) use graphs to represent those configurations. Hartman et al. [24] use Propp's structures to build those graphs.

How readers understand a narrative is useful not only for AI systems, as Matheas et al suggest for "story-understanding systems", but for the design of authoring systems as well. Also, classic semiotic models reflect how stories are understood from a human perspective, and this has been used for generative systems to build stories, but not so frequently for helping humans to deal with them. In this paper we adopt some of their notions.

In the context of collaborative non-linear storytelling, the distinction between author and consumer profiles is less clear. Authors do not prepare non-linear structures that will be experienced linearly by a reader, but read and then contribute to a global, multi-storyline structure that can be explored in many ways. We discuss next how we apply ideas from classic semiotics models, which help to understand and conform linear narrative structures, to this non-linear potentially ever-growing information space, in order to facilitate the authors to comprehend it and fit in it their contributions.

3.1.3. An interaction model based on "Character Narrative Programs"

In Propp's morphology of folk-tales [16], the story is driven by a concatenation of actions (called functions) of the main protagonist to reach his/her goal. The other characters perform simple functions within this chain depending on their roles in the story (rewarding the protagonist for acomplishing his/her goal, helping the protagonist in his/ her quest, being an antagonist trying to defeat the protagonist plans, etc.). Greimas revised these concepts in his semiotics theory, where he defined Narrative Programs as the selection of events linked together revealing a direction or an intentionality to form a coherent narrative, thereby providing the narrative with meaning [17].

This resounds with findings of our previous work [5], where users of the CrossTale interface found useful exploring and creating collaborative

stories through linear paths, which we call storylines. We saw that users mainly perceive storylines as character-driven, and that plots that follow the development of a character were preferred.

In this paper, we reinforce our approach by adapting the Narrative Program concept. Each character has his/her own narrative program, i.e., his/her own goal and associated storyline. When a character has a role in another character's storyline, the two storylines cross. For instance, in a classical tale, from the protagonist perspective (the prince), a wizard can be a "helper character" in his mission to save the princess, but in a multi-storyline narrative, the wizard is also the protagonist of his own storyline, and he helps the prince as part of his own narrative program.

Readers/authors can re-arrange the narrative space around a selected character storyline to explore and understand how the existent narrative programs connect, getting a consistent "bigger picture". On the other hand, this multiple-points-of-view approach to the narrative space could encourage creators to develop different character storylines, generating opportunities for rich contributions.

Next, we define each classical semiotics concept we use in our approach, explain how it relates to previous computational and interaction models for narratives and how we apply it in our proposed model.

A. Main and Secondary Characters

In Propp's approach, the main character's narrative program is the leitmotif of the story, while multiple secondary characters appear within this storyline. Plot-based systems built on classic semiotic models follow this. Character-based systems can have multiple protagonists depending on the complexity of the agents' (characters') actions. Authoring focused on reader's interaction tends to put the reader/player in the place of the main character, while multi-author systems let authors control one or more characters [11], without distinguishing between main and secondary ones. Our approach presents the user (both reader and author) an explicit multiple-points-of-view exploration through the use of character-driven storylines. Each character performs as the main protagonist of his/her storyline, while the others are presented as secondary and defined by their

relation with the protagonist's narrative program, described by the secondary character's role on it.

B. Narrative Programs

The main character undertakes multiple sub-tasks to accomplish his/her goal, creating a chain of events. Secondary characters' narrative programs usually refer only to their roles in the main story. Some plot-based systems also use the protagonist's narrative program as the story central structure. Character-based generative systems use narrative programs as agents' goals, and their planning steps become action sequences. In authoring systems the narrative program tends to be implicit, as it is developed by the authors' decisions. In our interaction model based on narrative programs, when focusing on a single character, his/her actions in the overall narrative space are presented in a linear and coherent sequence as the main plot of that sub-story.

C. Character Roles

Each character has a role or a small set of roles. Traditionally, they are always defined in relation with the protagonist (helper, antagonist, quest-giver, etc.), so that one could talk about "absolute" roles. In authoring systems, the roles of the characters are implicit in the story description. In character-based generative systems, roles are implicit in the character's goals through their relation with those of the other agents; thus roles are "relative" to those of other characters, as each character is the protagonist in his/her storyline and plays different roles in the others' storylines. Our approach makes explicit this notion of relative role.

D. Time and Space

In classical tales morphology, time is relative to the development of the main character story, while space is lightly considered. Some systems use a discretization of time (e.g., character-based systems using planning perform cycles of actions) or discretize space in finite "places" (e.g., [11]). Previously [5], we used a loose discretization of time in frames, while places were a list of settings. Users understood time in a vague way, contextualizing each scene depending on the semantic relation with the nearby ones, while place was just considered as an ambient accessory. In

this paper, each scene has a global reading order, so that there is an implicit global sequence of scenes when a sub-set is chosen to read. Time is, and implicitly put, in relation between storylines when they cross. Space is not considered as a specific object but implicit in each scene description.

To sum it up, our model draws from the classic semiotic elements of character narrative programs and roles but puts them in a multi-linear context, where each character can work as the protagonist of his/her own tale. It uses this structure to present the non-linear information to the reader so that s/he can explore and understand it in terms of the relations between the multiple stories. We aim at helping the readers achieve a better comprehension and suggest them new ways of contribution as authors.

In the next section, we present a small first experiment with this model to observe the kind of exploration encouraged by its use, to determine if readers can get a good comprehension of a non-linear story that has to be read in a fragmented manner, to test how comprehension helps them to achieve more consistent contributions, and to observe the kind of contributions elicited.

3.1.4. Experimental setting

The interaction model we propose was implemented into a basic prototype we named “Proppulsion” (Figure 1). It reads a JSON (JavaScript Object Notation) file containing the story (a set of ordered unitary scenes, characters, and the definition of relations between them in each scene) and presents it through an interactive interface. There is a row of characters’ icons at the top of the interface (in randomized order so that a hierarchy among them cannot be presumed). By clicking on one of them, the character’s storyline (i.e., narrative program) is shown, as the series of scenes where s/he has a role presented in temporal order. The user can read it sequentially by using the “previous” and “next” buttons or in a desired order by selecting the titles of the scenes. In each scene, the interface shows a list of the secondary characters and their role with respect to the narrative program of the current protagonist’s (i.e., the character chosen) in that scene, defined by a colour code as “helper”,

"opponent" or "other". At any moment, the user can switch to another character.

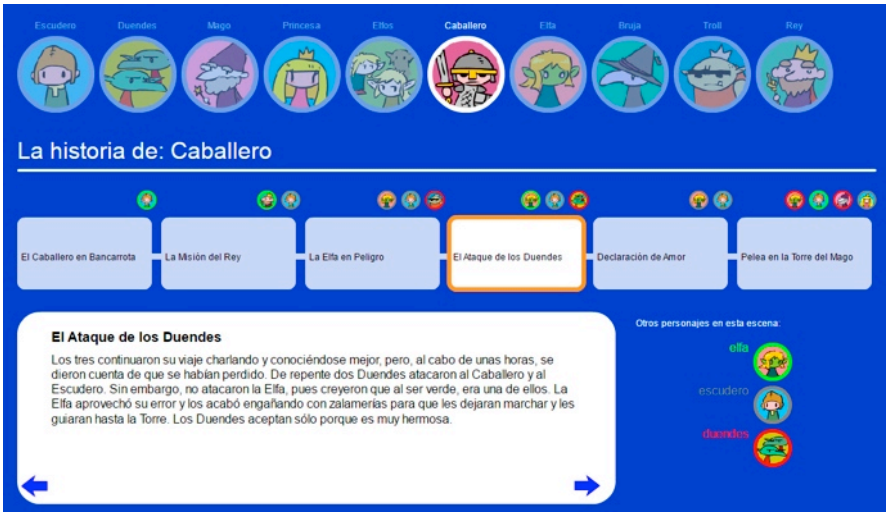

Figure 1. The Proppulsion interface.

The experiment with Proppulsion was double blind: an external author created the story, a fairy-tale with 10 typical characters, each having different objectives, and 13 scenes. The story was written from a third person, omniscient point of view, and revolved around the kidnap of a Princess by an evil Wizard who wanted to seduce her. The Wizard's wife, a Witch, wanted to recover her husband with a love potion, but her plan backfires. The King offered a reward to recover the princess, and a Knight and his Squire volunteered. An Elf maiden also wanted to find the Princess to kill her, tricked by the Witch, and she needed a dagger from the Troll. The Squire, the Knight and the Elf, who had most of the scenes, met halfway the adventure and helped each other, but the conflict arose when the Elf threatened to kill the Princess. The Troll, the King, a group of Elves, and a group of Goblins appeared only briefly. In the end, each character had his goal, and each character sub-story crossed at some point of his/her line with some of the other ones. 17 subjects of diverse ages and backgrounds took part in the experiment. They did not know precisely the goal of the experiment. It was conducted individually in two phases.

The first phase focused on reading / understanding. After signing a consent form, the subject received a brief introduction to Proppulsion interface and content. Then, s/he was asked to take as much time as s/he

wanted to read, in any desired order. During this phase, we measured the reading time, kept a log of the characters and scenes selected, and mouse-tracked subjects' navigation. At the end of this phase we asked a series of questions discussed later.

The focus of the second phase was authoring / contributing. Subjects were offered to freely write more scenes for the story, indicating at which point of the narrative the scene was placed. The time taken for contributing was measured and a shorter questionnaire was asked at the end.

In the first phase, we asked subjects about "perceived easiness of reading", "perceived comprehension" and "perceived enjoyment" through some Likert scaled questions. We also asked the reader some questions to test his/her understanding of the story (such as who was the protagonist/s? or the main plot/s), and his/her method for reading (How did you choose what to read?).

We measured the reader's comprehension quantitatively, borrowing Tanenbaum's strategy [25], where it was tested through a questionnaire after users had read a non-linear story in a partial, non-chronological way. The external author prepared a set of questions on her story asking the subject to relate different events. A panel of judges who had read the story selected a test from them. When answering the test, subjects were allowed to return to read the story. The same panel of judges scored the answers, and we tested the agreement of the judges on the resulting scores by measuring the Cohen-Kappa coefficient of inter-rater reliability [26]. We also measured the time taken to answer those questions, and the time employed to read when answering.

In the second phase, the judges rated the contributions in terms of consistency (if the events fitted with the rest of the story), and the agreement of the judges was also tested. The perceived ease of contribution was measured with a questionnaire using Likert scales too.

3.1.5. Results

Two subjects of the 17 took too long to complete the experiment (+ two times the standard deviation) and their results were excluded from further

analysis. The time results were normally distributed with a confidence level of 84%. Table I summarizes the quantitative results of both phases.

Table I. Quantitative results

	Exp. total time (sec.)	**Initial reading time (sec.)**	**Compr. test time (sec.)**	**Reading time during compr. test (sec.)**
Mean /sd	1373.60 / 341.06	457.20 / 102.34	253.67 / 97.75	66.13 sec / 71.38
	Total time contrib. (sec.)	**Time writing (sec.)**	**Time reading when contrib. (sec.)**	**Total reading time (sec.)**
Mean /sd	257.00 / 141.81	328.67 / 242.49	72.33 / 57.43	552.27 / 90.69
	Perc. ease of reading (/4)	**Perceived compr. (/4)**	**Enjoyment (/4)**	**Compr. test result (/4)**
Mean /sd	3.11 / 0.53	3.07 / 0.36	3.49 / 0.49	3.32 /0.39
	Consist. of contrib. (/4)		**Perc. ease of contrib. (/4)**	
Mean /sd	3.67 / 0.30		2.83 / 0.43	

For the two items rated by the panel of judges (comprehension and consistency of contribution), we excluded the judge with the lowest item-total correlation and achieved a moderate agreement in the scores (For the compr. test, percentage of overall agreement Po: 0.583332, free-marginal kappa: 0.444443; for the consist. evaluation Po: 0.619047, Free-marginal kappa: 0.492063).

A. Navigation and story/character perception

People understood the story from a character-centric point of view, and viewed it as a multi-character tale. When asked about the plot, all subjects referred to specific characters and their goals, and 14 out of 15 pointed out that there were multiple stories in one. Plots are regarded as implicit in the character storylines.

When asked about who was/were the main character/s, people chose those characters with long and defined narrative programs. Table II shows that the characters appearing in more scenes are those more often chosen as

protagonists by the readers. Characters who do not appear on the table were not mentioned by any subject and appear only in one or two scenes. The number of scenes is not the only factor for relevance. While the Knight and the Squire appear in the same number of scenes, subjects mentioned the Knight twice than the Squire. This could be due to the Knight having a mission, as defined in Proppean terms (a quest giver, the King, gives him a quest, to rescue the Princess, in order to obtain a reward), while the Squire acts as his helper.

Table II. Characters by mentions, scenes and uses

Character	*Mentions as Protagonist*	*Scenes in the Story*	*Times used in Contributions*
Elf maiden	*12*	*7*	*5*
Knight	*10*	*6*	*3*
Squire	*5*	*6*	*0*
Princess	*3*	*4*	*5*
Wizard	*2*	*2*	*2*
Witch	*1*	*3*	*4*

B. Reading patterns and story comprehension

The analysis of the logs shows that subjects quickly identified the main (longer, protagonist-based) storylines, focused on reading them linearly, and then backtracked to read the secondary character's stories non-linearly, despite the random order of the icons. In the questionnaires, subjects explained that they liked to read this way: first understand a single story and then read the related characters stories to understand their relationships with the main plot(s).

40% of the subjects selected all the characters, and read all the scenes of the storyline of each character: in the end they read the whole story. The other 60% only chose part of characters; 75% of them read all the scenes of the characters they selected, while the remainder 25% only read some scenes of each character they had selected.

Subjects achieved a high degree of comprehension (3.32 points out of 4). The comprehension of those who read it entirely was slightly better (avg. 3.533, sd. 0.1902) than those who did not (avg. 3.1844, sd. 0.4275) but

this difference was not significant (T-Test t(13)=1.8614, p=0.0854). The direct observations seem to indicate that reading one storyline gives enough information about the related storylines to be able to understand them without exhaustive reading.

People taking longer to read at the beginning of the experiment seemed to need less time reading when answering the comprehension tests (Pearson's correl. coef.: 0.4544), while the reading time did not seem related to the comprehension achieved (correl. 0.1311).

C. Reading impact on contribution

Half of the subjects contributed to the story. People with better comprehension did not perceive the contribution task as easier, quite the opposite (Correl. -0.5633 between comprehension and perceived ease of contribution); neither did they contribute more quickly than others (the correlation between comprehension and contribution time is a weak 0.2495). It seems that people with higher comprehension are more concerned about the complexity of the story they have to contribute to. On the other hand, those with better comprehension needed to read a lot less when contributing (correl. -0.9094 between comprehension and reading time during contribution).

The judge-rated consistency of contributions was high (3.67 points out of 4). It is quite remarkable that there is a strong correlation (0.8120) between comprehension and consistency of contribution, which seems to indicate that people with better understanding of the story create scenes that fit better with the existing events.

D. Interest of the contributors

An analysis of the contributions indicates that there is an interest in expanding the stories of the characters considered "main characters", but the authors also expand the stories of the characters regarded as "secondary" (see Table II).

3.1.6. Discussion

In some way, our proposal relates to the traditional hypertext storytelling, as it challenges the reader to navigate a non-linear story and the author to build its structure. Proppulsion readers interact with the narrative on interpretative (understanding the story) and functional (manipulating the interface) levels, but not on an explicit one as hypertext readers do when their elections alter the story (using the interactivity levels of Salen and Zimmerman [27]).

Pope [28] discusses how hypertext fiction, although still commercially produced (e.g., Storyspace [29]), does not appeal to a wider audience, pointing as problems unsatisfying hyper-linking, random plot structures, and lack of closure, while Berstein [30] described similar problems as lack of coherence, causality, and closure. Pope highlights the interface as an influential factor in reading enjoyment, and fulfilling the reader's expectations to add purposefully to what has already been read.

Unlike this perception of hypertext fiction reading as hard, our experiment revealed that the subjects perceived the non-liner story as easy to read and understand. In consonance with our previous CrossTale experiments [5, 6], following storylines proves useful for reading the nonlinear narrative space. Associating storylines with the character narrative programs resulted in a quite natural way to comprehend the story, with readers characterizing them as having one protagonist accomplishing one goal. The temporal, thematic, and cause-to-effect qualities the Narrative Program seem to be a useful tool to achieve this "meaningfulness" that Pope and others demand for hypertext narrative links.

The reader-perceived "main characters" of the story are those with longer and more defined narrative programs in terms of classic semiotics: characters that receive a mission and follow a series of events to accomplish their goals, finding helpers and opponents on their path. The classical narrative roles still apply to the protagonist perception, but the "multiple-points-of-view" perception prevails: in our story, the elf is an anti-hero character that acts as an antagonist of the knight, since their missions are opposed and she becomes a traitor, but she is regarded as the main protagonist along the knight since she has also a defined goal and takes lots of steps towards its accomplishment. It would be interesting to

experiment with different stories combining different characters and roles in unexpected ways, to deepen on this understanding of how readers recognize main characters. People identify those characters quickly, and they use those main storylines as the backbone of their navigation.

Reading all the scenes of all characters, or spending more time reading, were not decisive factors to raise the comprehension level. Comprehension seems to be achieved through the ability to identify key characters and scenes and to understand their relations with other storylines, rather than through an exhaustive processing of all the information in the narrative space. With those key events the reader's mind can establish connections and fill the gaps in the story, as in Tanenmbaum's experiment involving non-linear stories [25]. Then, making explicit the relations between characters in each part of the story (i.e., their roles in the main character narrative program) empowers the subjects understanding.

Subjects with higher levels of comprehension needed less time for contributing and achieved higher levels of consistency with the previous story, which is consistent with psychological studies on the effect of comprehension in authoring tasks [7] and reinforces our hypothesis that, in a collaborative context, enhancing the comprehension of the readers will enhance their ability to contribute.

Non-linearity seems to encourage expanding the story from different character's points-of-view. Although the "main characters" are used regularly, people also expand the stories of characters regarded as "secondary". We hypothesize that those "secondary" characters can become "main characters" for the future readers, encouraging participation. Berstein's Thespis [30] proposed a theatre-inspired system in which each author acts as an autonomous character. Some multi-user tangible interfaces [11] also take this approximation, each author developing one character in the story. Our proposal differs in that any number of writers can develop any number of characters, but in this experiment, as in previous ones [5], it seems that it is usual to concentrate on one storyline at a time.

Finally, compared with Crosstale [5, 6], the proportion of subjects who became contributors after reading was smaller. The experiment demanded

subjects to complete a long series of tests after reading and this might have disrupted a possible creative task. Also, Crosstale presented a visual scene editor that might have made the contribution task more appealing.

3.1.7. Conclusion and future work

This model to represent and interact with non-linear stories based on the classic semiotics concept of Narrative Programs, focused on human authoring, represents a quite different approach from most current models based on semiotics, which are oriented towards automatic generation, although it shares some aspects of those which pay attention to readership.

The resulting exploration and development of multiple point-of-view storylines within a larger narrative space resounds with traditional hypertext fiction, plagued with reading issues. The experiment with our small prototype shows that we seem to have avoided the issues, with pleasurable reading and proficient comprehension, based on reading through connected storylines. This understanding led to contributions with a good level of consistency, featuring largely, but not exclusively, the main characters.

We intend to use larger narrative spaces to determine how comprehension (and engagement) scales as a massively-authored narrative grows, and whether contributions preserve consistency and the overall meaning. We also intend to see which non-obtrusive support can be automatically provided to authors, in addition to more visual means of contributing.

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3.2. YoWay: Coupling Narrative Structure with Physical Exploration in Multi-linear Locative Narratives

Locative narratives can implement different modes of coupling of the physical space and the narrative content, impacting how the user experiences and understands the story. Narrative causal relations are difficult to maintain when the user can freely explore the physical environment. In this paper we focus on multiple interlaced narratives, and the relation among narrative design, physical space and interaction, and its influence on the players' exploration mode, story comprehension, and immersion. We conducted an in-situ user study with YoWay, a locative narrative app that presents three intertwined historical fictions in the Glòries area of Barcelona. Results show how users were able to combine linear navigation with simultaneous exploration of spatially close contents from interrelated storylines, achieving a good understanding of the story and engaging with the experience.

3.2.1. Introduction

Studies suggest that the proliferation of location-aware technologies can change the way in which people perceive the environment surrounding them. Such technologies enable to augment public spaces with location-specific digital information, thus functioning as *"interfaces to public spaces, that is, systems that enable people to filter, control, and manage their relationships with the spaces and people around them."* [1]. Theorists claim that simply attaching digital information to physical locations might not be enough to generate meaningful experiences of urban spaces [2]. Storytelling and gamification are two elements that are often used to trigger deeper experiences. In this respect, we can distinguish between location-based mobile games (LBMG) and locative (or location-based) narratives. LBMG as GeoChaching [3] enable players to engage in new way with the urban context, thus enhancing/altering their experience of the physical environment. Locative narratives, such as location-aware tour guides, present stories linked to the specific environment where they take place, augmenting physical spaces with the narrative experience, often enhanced with gamification aspects. For instance, REXplorer [4], a location-based game targeted at tourists,

combines stories, historical events and game mechanisms, such as quests, to engage the users.

Most previous works focus on games that present a single linear story (e.g. [5]) or multiple independent narratives (e.g. [6]), and so far, little is known about how people experience multiple locative storylines. The bulk of work that seeks to understand user's exploration and comprehension of multiple intertwined stories mainly deals with desktop-based games and interactive media (e.g. hypertexts). However, the experience of a location-based narrative through a mobile device presents additional aspects that influence how people explore the stories, how they reconstruct fragmented pieces of a story and the story comprehension. For instance, the distance between points of a locative narrative might influence people's trajectories, thus resulting in a different linear or non-linear reading/listening of the story. Additionally, locative narratives can couple the physical space and the narrative elements in diverse ways, which might impact story comprehension and engagement [7][8][9].

This paper contributes over previous works on location-based narrative games by focusing on player's exploration of multiple interlaced locative narratives, working on the interdependence of three specific aspects: the narrative design, the interaction elements and the distribution of the narrative contents on the physical space. We explore how these elements affect the users' exploration mode, story comprehension and engagement.

3.2.2. Related work and Research Questions

A. Coupling between physical space and narrative

In previous location-based narratives research, we identify two aspects that characterize the coupling between narrative contents and physical space, and that we consider worth differentiating: i) how the significance of a physical location is mapped to the narrative contents, ii) how the narrative points that make up a locative narrative are laid out on top of the physical space. The former has been the focus of previous studies, considering it key in determining user's immersion and engagement in the narrative [7]. The main criteria to map location to narrative have been i) to mention an environment object in the narrative, ii) to narrate a scene that takes place in the user location and iii) to portray the same atmosphere

(e.g. noise and lighting conditions, architectural style) of the narrative original location [7]. How the narrative is segmented and distributed on top of the physical space has been mostly overlooked in previous studies, despite being implicit in all locative narratives. We consider this aspect particularly relevant in determining the physical trajectory of the user (e.g. how does user move across different narrative points?) and how this affects how the narrative is consumed (i.e. in a chronologically linear or non-linear way). Previous examples of locative narratives have either presented a single narrative scattered through a set of physical points, each presenting one fragment of the story [5][8], or staged multiple independent narratives specific to each single physical point [10][6]. Both distributions constrain how users experience the narrative: either as a single linear story or as a set of weakly related points. We think this is due to the nature of the narrative structure itself, as discussed next.

B. Narrative structure and contents

When designing locative narratives, the distribution of narrative contents across the physical space might impact on the user's perception of the causal relations amongst those contents, which is needed to perceive them as a congruent storyline [11]. Giving the player freedom to visit any point of a locative narrative in any order causes a problem similar that the one appearing in traditional (desktop-based) interactive narratives and games: free interaction with the storyworld can cause the player experiencing the story in an incongruent way, affecting the comprehension [12].

A large number of examples (e.g. [10], [6], [8]) avoid this issue by reducing the narrative contents to independent, modular micro-narratives. Those systems work as a kind of narrative-driven guides to a location. The story narrated at a location has only some thematic connection with the story at another one. This limits the narrative, which is reduced to a collection of anecdotes without continuity between points or long narrative arcs. However, this does not prevent causal issues, as for example in Riot! [6], where users could hear a series of scenes of a riot that had taken place one hundred and seventy three years earlier, as the authors explained: *"there is one scene where rioters play a piano and another scene on the opposite side of the square where you hear them dragging the piano out of a house. The writers wanted to ensure that if*

you had already heard the piano playing scene then you would not hear the piano dragging scene because it would not make sense".

Paay et al. [5] present a narrative game that addresses the cause-effect issue by leveraging on the genre chosen for the story. The narrative is about a historical murder mystery, set during World War II and situated in and around the streets of Aalborg. The users follow one of two single linear storylines by visiting different physical points and reconstructing the facts. As discovering cause-effect relations is part of the detective/player's goal, the detective genre works satisfactorily in interactive narratives.

In this paper we aim to understand how to solve this challenging issue without constraining the interaction to one single linear locative narrative. We explore the implications of free embodied exploration of multiple linear storylines with different geographical layouts and narratives, and try to understand how users react to the differences of each storyline, and how they recompose the facts of parallel storylines.

C. Interaction aspects

When the narrative contents are distributed across the space, the interaction modalities (i.e. the way users can access the content) require careful design. If multiple autonomous micro-narratives are available in a single physical location, how does a user access one of them? Different strategies have been used to automatically provide some content among that available at a location, such as recommender systems [10], random selection [6] or choosing it on the mobile screen [8].

In cases like Paay et al. work [5], where the narrative is composed by several interrelated scenes, interaction is designed in a gamified way. The user is presented with a series of tasks or riddles that s/he has to solve to move from one point to the other. In this way, the user is encouraged to experience the narrative in a logical order. We encouraged this way of playing as well, through introducing in each narrative point the clues for discovering the next "logical" point of the current storyline. But the user may also complete the story discovering all its points in whatsoever order. Our challenge is to reconcile the linear comprehension of a single narrative with the possibility to experience multiple simultaneous

storylines distributed across different physical points, and understanding how this takes place.

Within a scenario of multiple interrelated locative narratives, we specifically address the following research questions:

1. Which strategy do users adopt to move through the different points of multiple interrelated stories? Do users follow multiple stories simultaneously or do they complete a story before moving to the next one? Do users go through the stories in a linear or a non-linear way?

2. How do narrative contents and physical distribution of the narrative points affect the way in which users navigate through the different stories?

3. Do the aforementioned aspects impact on story comprehension, immersion, and engagement?

3.2.3. YoWay design

To address these research questions, we conducted an in-situ user study with YoWay, an Android app that presents geo-located audio-stories. For the purpose of this study, we designed three intertwined linear audio-stories (A, B and C) set in the Glòries Square in Barcelona. Each story is composed by 4 or 5 narrative points (NPs) located in separated physical points, following the layout represented in figure 1.

Story A is educational and sci-fi. It serves as a tutorial on how to play the game, and it also provides an introduction to the physical setting, which is shared with the other two stories. A narrator, talking directly to the user, explains that the mobile phone can sync with the past, and guides the user to visit the places, while providing historical information about the area back in 1919. Stories B and C are noir audio-fictions of events set in the historical setting and location of 1919 Glòries. Both present the same characters, but each one has a different protagonist. Another intertwining element is that the two protagonists meet at a couple of NPs, thus making two interlacing plots. Following those stories, the user can solve a

mystery, revealed in the last NP of each where the fate of its protagonist is discovered.

As for the physical distribution of the 4 or 5 points on the relatively large Glòries square (some 140 square meters), story A makes the player tour the whole square, while B and C routes are shorter in distance and most of their NPs are concentrated in the same half northern part of the square. B points are linearly laid out but C points are not, and if the user listens story C in chronological order, s/he would need to do some backtracking (see figure 1).

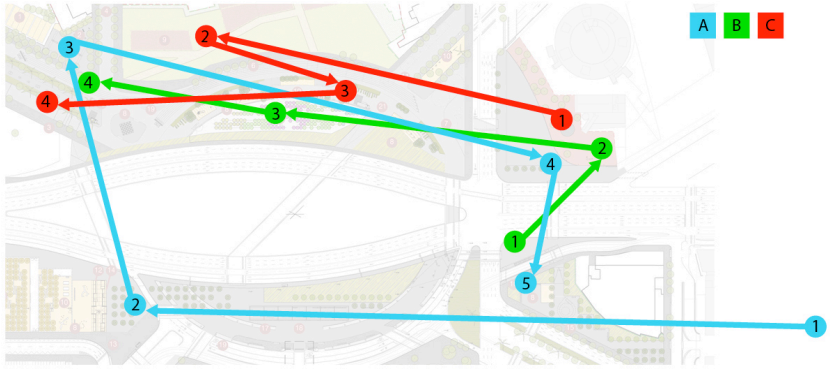

Figure1. The three YoWay stories geographical layout

The physical and fictional places are strongly related. The stories interrelate two environments: the real one, which is the physical space of Glòries where the users move, with the virtual one, which emerges from the narration and represents Glòries in 1919. The real environment is represented by the current configuration of the square. It is a large, mostly empty, transitional space, which is currently undergoing a dramatic architectonic change. It is the intersection of three of Barcelona's main arterial roads, and contains some important landmarks: the Design Hub, the Agbar Tower, the Farinera, the Glories Mall, the Encants Market, etc. The virtual environment described through the audios represents the 1919 version of Glòries square. It references real elements that were part of it in 1919, such as La Farinera factory, the train station, or the soccer field. Some as the factory are still visible landmarks today. Other elements, which are not present anymore, are placed in current spaces thematically related, i.e., the old soccer field was referenced in the newly constructed sports equipment area, and the old train station (whose railroads run

underground today) was referenced in the nowadays tram station. Thus, some of the current landmarks work in a metaphorical way. Historical elements of the audio-story were reinforced using sound effects (like the sound of a steam train) and music of that period, to evoke the atmosphere of that time.

Each story has a sequence of NPs, each point containing a segment of the audio, which is unlocked when the user physically reaches the location. The user is shown the first point of the story, but then has to listen to the clues in the audio-story to guess which the next NP (in chronological order) is among the multiple NPs indicated on the map. The interface also shows an old picture of the area and a few text lines with some historical information. The goal is to unlock all the points, and unveil the whole story. At the top of the screen, a graphical representation of all the NPs of the storyline is shown as a row of grey numbered stars. When an NP is unlocked the corresponding star is highlighted in yellow. This way the user is aware of the story completion in a linear or non-linear way, and is free to navigate the storyline in any order. Selecting one story on the interface highlights the NPs belonging to it, but the user still can see points from the other nearby stories. The user can also switch the current story at any moment and then visit points from the others. Thus, s/he is not only able to solve a story in a non-linear order, but s/he can also choose to play the different stories sequentially or intertwining the experiences. The whole content can be experienced in a single play session, taking between one and two hours depending on the exploration mode, but the game can also be stopped and reprised another day.

3.2.4. Description of the study and methods

A. Users

Users were recruited through an on-line promotion sponsored by Les Glòries mall, which is located in the same square where the locative narrative takes place. A website was created where people were invited to download the app. It also contained an explanation about the game and the possibility to download more detailed instructions about how to play it. The participants could download the app and play the game at any time within a period of a month. They all played the game without any interference and presence from an experimenter. The users that tested the

game during the months of August 2015 and answered an on-line questionnaire on the website received a free ticket for the mall food court. Finishing the game was not required to receive the prize, nor answering the questionnaire in any "correct" way.

B. Data and measures

To address our research questions we collected two types of data: the log of users' activity captured by the app, and users' answers to the questionnaire.

1. Log Data

For each user, we logged the time frame at which each point of the story was unlocked. This information allowed us to build the exact path followed by the participants and discover the order in which the stories were reconstructed.

The logs were analysed by producing a graph that quantifies the number of users moving from any two specific points. Then we processed all the logs through a script that counts the repetitions between the point sequences of all users' routes, revealing the most relevant patterns among users' paths.

2. Questionnaires

The questionnaire was structured into four main sections. The first one aimed at classifying users with respect to their previous knowledge about the social and spatial context of Glòries square. We were interested in understanding whether the participants with a previous knowledge of the settings would experience differently the narrative. The second section contained a set of Likert-scale questions aimed to discover the motivations and internationalities behind the users' navigation mode, asking them if they intended to play the stories one by one or combining them, and if they visited the points in temporal order. The third section was used to assess the user's comprehension of the story and narrative immersion. We measured comprehension through a set of multiple-choice questions on the story setting (historical information about the square) and the most salient events narrated in the fiction stories. To measure narrative

immersion and emotional involvement, we used the same questions adopted in (Karapanos, 2012). In the final section the user was invited to give its opinion on the experience. We correlated the answers to the questionnaire with the user's path in order to analyse whether the way of exploring the stories influenced the comprehension, immersion and engagement.

3.2.5. Results analysis

A. Groups and demographics

50 people downloaded the app, 20 of them played it in-situ and answered the on-line questionnaire. Analysis of the data logs revealed that approximately one third of the participants played in groups of two or three people (some using different phones, visiting the same points at the same timestamps, and others sharing a phone), so those groups were considered as a single user when we performed the route analysis statistics.

We divided the participants into three groups depending on which stories they played:

- Group 1: those who only played totally or partially story A. 11% of the participants.

- Group 2: those who played stories A and B, but not C. 33% of the participants.

- Group 3: those who played all the stories, totally or partially. 56% of the participants.

Table 1 details the participants' demographics. Interestingly, the most notable difference is that people with more previous knowledge of the area (usually living or working on it) were prone to explore more stories (i.e. Group 2 and Group 3).

Table 1. Players' demographics

	Average age	Smartphone experience	Likes fiction	Lives or works around Glòries	Previous knowledge of the place	Previous historical knowledge
Whole sample	29.9	2.88 / 4	3.11 / 4	60%	2.61 / 4	1.77 / 4
Deviation	7.08	1.02	0.9	-	0.91	1
Group 1	22	3.5	3	50%	2.5	1
Group 2	29.6	2.3	2.6	50%	2.33	1.5
Group 3	31.7	3.1	3.4	70%	2.8	2.1

B. Route analysis

Figure 2 shows the density of the paths between the different points of the three stories (the thicker the lines, the larger the number of participants who moved between the two points). We complemented this statistical analysis with the results of the pattern analysis and the answers to the questionnaires. This allowed us to determine the strategies users adopted to explore the narratives.

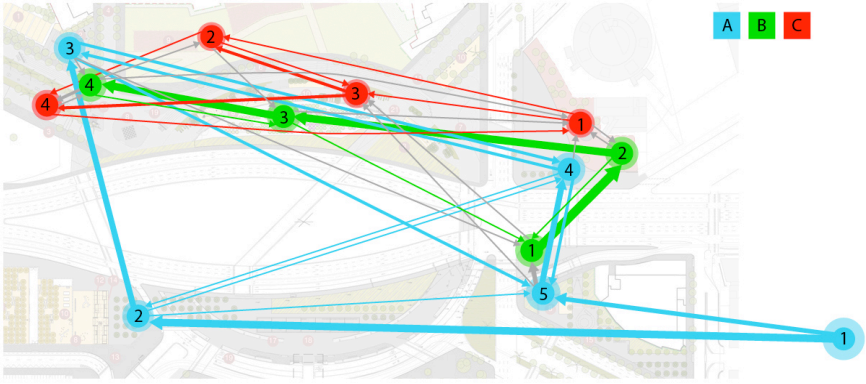

Figure 2. Density of users' playing routes

All users started with route A and then passed to B and C. Route A was followed linearly but with some point-skipping. These deviations happened when the next point of the route was too distant and other points of the same route were closer. 90% of the users jumped to story B only once they completed story A. Story B had a linear and short route and all participants from group 2 followed its NPs in order. Among the users of group 3, 25% of them finished story B in order before exploring story C, the other 75% tended to intertwine stories B and C in a more-or-less geographical proximity driven way.

In conclusion, users tended to follow the linearity, but in the more intertwined and fiction-focused routes B and C, users' paths combined points of the two, usually moving on the nearest point of another story. The results of the questionnaire confirm that this behaviour was intentional. We discuss possible motivations of this behaviour in the section VI.

	I tried to play stories one-by one	**I tried to play stories simulta-neously**	**I played stories till the end**	**I tried to visit points in correct order**	**It was easy to find the points**
Whole sample	3.33 / 4	1.5 / 4	3.28 /4	3.17 /4	3.11 /4
Deviation	0.77	0.785	0.96	0.92	0.76
Group 1	3.8	1.7	3.5	3.6	3.5
Group 2	2.5	1.5	3	2	2
Group 3	2.83	1.17	3	2.83	2.83

Table 2: answers to part two of the questionnaire

C. Immersion and comprehension

Table 3 summarizes the results of the questions about narrative immersion and story comprehension.

	Measured immersion	Questions about story A	Questions about stories B and C	Questions about story C	Total questions hit rate
Whole sample	2.8 / 4	69%	54%	39%	56%
Deviation	0.5	39%	50%	50%	39%
Group 1	2.93	25%	0%	0%	8%
Group 2	2.92	84%	34%	0%	44%
Group 3	2.53	70%	77%	70%	73%

Table 3. Answers to part three of the questionnaire

The users experienced a medium-high level of immersion (2.8/4) independently of the number of stories played.

Since stories are interrelated, there was some information common to all the stories and some information exclusive to one story. We divide comprehension results in three sections: i) those questions regarding the geographical and historical setting, which are presented exclusively in story A; ii) those questions about the characters and fictional events that could be answered by listening to stories B and/or C, and iii) those questions about information that are given only in story C, but not in B.

It comes as no surprise that people who played fewer routes did not give correct answers about the story on the non-played routes. People who played all the stories solved better the setting-related questions that could be answered only playing story A, so it can be stated that they consolidated their understanding of the setting, although it has to be taken into consideration the fact that some of those players were people with more previous knowledge of the place.

D. Linearity vs. non-linearity

Finally, we decided to divide group 3 into those who played stories B and C independently (25%) and those who explored them combined in a non-linear way (75%).

	Measured immersion	**Total question hit rate**
Whole sample	2.8 / 4	92%
Deviation	0.5	12%
Linear exploration	2.93	100%
Non-linear exploration	2.92	89%

Table 4. Immersion and comprehension of the subjects of Group 3 divided by exploration mode

For these two modes of exploration we found near-equal levels of immersion and similar levels of comprehension, the second group being slightly lower. According to the answers to the questionnaire, people who explored stories B and C simultaneously did not consider this a barrier for maintaining the causal logic of the story. In this case the concept of linearity could be tied to the individual storyline they are following linearly, while secondary storylines are subordinated, as we will explain in the next section.

3.2.6. Discussion

We designed an experience that gamified the exploration of three intertwined narratives with variations on its geographical layout and narrative content. Blythe et al. [6] point that this kind of experience is composed by *"interpenetrating layers.[...]the experience of the technology, the experience of the content, the experience of the place and the experience of the sum of these parts: the experience of a situated narrative."* Our experimental setting and analysis focused on the interrelation between the geographical, narrative, and game design aspects, how they affected the exploration mode, and how this impacted on the understanding of the story and the users' engagement.

A. Interaction design and spatial navigation

People followed the stories mainly ordered and in a linear way. This might be due to the fact that the game design encouraged users to find the different points in order, with the clues given in each NP leading the user to the next consecutive NP.

The first story covered a large portion of the square and used real landmarks to situate the user and explain him/her how the virtual space representing 1919 was. It has to be noted that in the second and third stories indications to find the next NPs were subtler and referenced only the items in the virtual space (e.g. a football field that no longer exists). However, it seems that, mostly, users did not have trouble navigating them, pointing that they had seized a mental mapping between the physical and the virtual space.

Story A was played mostly in order. Analysis of the paths and the questionnaires answers, which stated their intention of following the story in order, suggest that deviations were primarily errors produced by the long distances between some of the points.

Users who engaged in routes B and C did it once route A was completed. Most of the users who played route B also played route C. Route B was travelled mostly in order, while route C was usually explored in a non-linear way. This can be explained partially by route B being geographically simpler than route C, which required some backtracking to be completed and introduced a NP in a virtual place that had not been referenced in the other stories.

Analysis of the logs and the questionnaires also show that these routes were often combined simultaneously by players interested on mixing multiple storylines while following the linearity of the overall plot. Route analysis shows players swapping from NPs of one route to the other, and seems to indicate that proximity of the NPs was an influential factor for choosing the point to visit. To explain why many users combined the two routes in the exploration, and why this did not occur in the case of route A (which also had geographically near NPs), we cannot neglect the influence of the narrative nature of their contents, which we discuss next

B. The role of narrative in the exploration mode

Content also influenced the way of exploring. Stories are traditionally understood as cause-and-effect sequences that demand being experienced in a linear way. This aspect encouraged players to follow the clues leading to the next NPs in order. However, when users are presented with complex forms of non-linear narratives, new possibilities of exploration appear.

Story A was introductory and had a narrative style different from the other two, with one character addressing the player directly and instructing him/her to follow the clues. On the contrary, stories B and C were presented as two audio-fictions following the points of view of two different characters on parallel events. While almost all users completed story A before starting playing the other two, the combination of stories B and C was possibly encouraged by those stories being narratively intertwined, similar in plot, characters, theme and tone, and with considerable narrative overlap (e.g. the stories of the two characters crossed at multiple NPs). This behaviour can be explained by deepening on how people explore and understand multi-linear narratives, which we detail next.

C. Exploration and comprehension

Studies of non-linear storytelling in classic interactive media, like games and hypertextual narratives, point towards the difficulty and the importance of finding logical causality and narrative connection between their different parts [13]. Previous studies with desktop applications [14][15] indicate that non-linear, multi-character stories are better explored following linear character storylines, but readers do not need to follow all of them exhaustively to understand the story. Usually, readers adhere to a single character storyline and follow it linearly to grasp the sense of cause-effect needed to understand a narrative, taking deviations to experience nearby parts of other intertwined narratives, which they can understand from a partial reading filling the gaps with the information from their primary storyline.

The results of our study reinforce this view, applying it also in the field of locative narratives: path analysis reveals that route C was explored more

partially than the others, and that a significant number of users did not attempt to explore it in order. Results show users starting with routes A and then B, following them mainly linearly, and switching from B to geographically near points of route C. Analysis of the questionnaires shows a greater intention of combining storylines in this group of users.

Users experiencing B and C storylines scored high marks of story comprehension. Although most users experienced story C non-linearly and some of them did it only partially, their comprehension scores remained nearly as high as the users who experienced the two routes one-by-one and exhaustively. Overall, the non-linear exploration mode was proven useful to get a good understanding of the story and its geographical and historical setting.

D. Immersion and engagement

Results of the questionnaire revealed that users had a medium-high sense of immersion during the experience, which points towards a successful use of the coupling between the physical and the virtual worlds. We did not find significant differences on immersion levels between those who experienced some or all the narratives, nor between those who explored the routes linearly or not.

As engagement is concerned, it has to be noted that 89% of the users played at least the first two stories, and that 56% played the three stories completely or partially, taking a variable amount of time, between 40 minutes and two hours, in an architectonically difficult zone due the current infrastructural works taking place on it. The factors mostly enjoyed by the users were, according to the questionnaire, unravelling the fictional story and discovering the history of Glòries Square. On the other hand, the fact that the group of users who played all the three stories had more people living or working near the zone suggests that maybe an initial level of previous knowledge of the location is useful to encourage people to play.

3.2.7. Conclusions

Interaction and game design, physical place and narrative contents are interdependent elements that influence the experience of locative

narratives. Design can encourage the user to find linearity in a space where multiple narrative pieces are scattered.

The results of our study show that disposition of narrative points can vary the difficulty of following the storylines linearly, and also influence how users move from a story to another one. Our results suggest that the narrative content can facilitate the mental mapping between the physical and the virtual (fictional) spaces.

Narrative content of the presented stories also influenced the exploration mode. A game-like writing style (e.g. giving specific directives) can make the user focus on following the instructions, while narrative-focused storylines that share plot, characters and classic literary style seem to encourage player to explore and combine multiple storylines. In this latter case, results show that users jump from one story to another by following an ordered single storyline as a backbone and exploring the crossing stories as deviations. This exploration mode serves to maintain the perception of linearity and cause-to effect.

3.2.8. Limitations and future work

The experiment was designed in a way that allowed participants to interact with YoWay when and how they wanted, without feeling observed or being questioned by the researchers, who had no visible presence and could not interfere. We believe that this enabled us to have more realistic results than in a controlled experiment, where users could feel compelled by us to complete the whole game despite their motivation or enjoyment of the experience, to play in a certain "correct" way, or to provide a positive opinion. On the other hand, we believe that conducting direct observations and interviews would have allowed us to deepen in the particular users' motivations for exploring the narrative in a certain way, and the impact of the narrative on the players' choices. Also, although the limited number of participants allowed us to analyse in detail their individual playing routes and questionnaire answers, a future study could largely benefit of a much larger pool of subjects to draw more statistically significant conclusions.

We would also like to explore more deeply how the nature of different urban environments would suit different narrative contents, and how this

would impact on the users' experience. Repeating the experience in a wider range of use cases, such as historical city centres, monumental areas, commercial areas and not historic neighbourhoods, would allow us to inform the creation of suitable narratives (varying in content, style and structure) and interaction modes, and how the topology of the physical space influences the distribution of the storylines and their narrative points.

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4. ANALYZING INTERACTION MODELS FOR CONTRIBUTION ON SHARED NARRATIVE SPACES

This chapter is devoted to study how users contribute to and develop shared narrative spaces. We explore how this contribution process is affected by external factors to the design of the co-creation activity, the system's interactive mechanisms design, and the information structures contained in it. The impact of all these factors inthe users behaviours during the exploration and collaboration to narrative spaces is examined. This study is contained in the publication:

> *Colás, J., Tapscott, A., Righi, V., Moghnieh, A., & Blat, J. (2017), Interaction and Outcomes in Collaborative Storytelling Systems: a Framework, a Field Study, and a Model. Computer Supported Cooperative Work (CSCW), 1-36.*

In this work, we propose a framework to analyze collaborative storytelling systems, composed by a set of parameters divided into six conceptual areas. Four of them, based on Magerko's PC3 Framework [39], relate to aspects of the nature of the system (context, process, content and control). We develop two more aspects (process and output) related to the results of the collaboration, meant for the precise study of the previous factors, their interplay, and also how they impact the author' performance.

In the previous chapters we presented a couple of prototype-based controlled experiments, reduced in time and number of participants, and also on the scope of the developed narratives. In this work, we are interested on how our previous findings (on the perception of the narrative space, the perceived role of consistency, the navigation and comprehension, and the participation) can vary influenced by the alteration of the nature of the used narrative systems. For this purpose, we examine a variety of systems diverging in purpose, process nature and scale, as described next:

First, we present a controlled longitudinal field study on collaborative storytelling in a real-use case. This experience is performed by 80 students of an interactive storytelling course during three months. It is the

refinement of a previous experience documented in [40]. This controlled study allows us to make observations and perform direct questions to the participants of a co-creative activity extended over time.

Also, we performed an extensive data analysis of the SCP site [43], a real, ongoing on-line co-creative community of literary fiction. The extensive report of this work, and further investigation on its implications on collaboration and canonicity of the developed content, can be found in Annex II:

> *Tapscott, Alan. (2017). Large-Scale Collaborative Story Worlds: Formalizing Content and Author Dynamics. Unpublished manuscript.*

Finally, our study also triangulates the results found in the reports of multiple on-line co-creative experiments and field studies that use well-known structures of the 2.0 web (as wikis [20] and social networks [21]) as the basis of their narrative systems.

The existing literature shows how multiple ad-hoc models have been elaborated to fit the specific narrative systems studied or developed (e.g. [27, 28, 31]). Applying our framework to a pool of diverging experiences, we present an extensive comparative analysis which takes into account all the aforementioned factors and studies their interplay and how they affect the performance of the users and the created narrative output. Drawing from the conclusions of this analysis, we propose a single, general human-information interaction model for collaborative narrative systems, intended to inform the design of systems that support co-creation and address the usual barriers of SNSs turning them into new opportunities for collaboration.

4.1. Interaction and outcomes in collaborative storytelling systems: A framework, a field study, and a model

In the last decades, advances in interactive information technologies have facilitated collaborative fiction writing, which has become widespread and large-scale. This paper proposes a framework to analyze collaborative storytelling systems, made of a set of parameters divided into six

conceptual areas. Four of them relate to the systems and two (process and output) to the results of the collaboration. Through this framework we can study more precisely these different factors of the systems, their interplay, and how they impact the creators' performance. We also present a controlled extended-duration field study on collaborative storytelling, and we use this framework to comparatively analyze these observations and other relevant experiences in the field of co-creation of shared narrative spaces. As a result, we propose a human-information interaction model for collaborative narrative systems, intended to better support co-creation and address the barriers of this kind of systems turning them into new opportunities for collaboration.

4.1.1. Introduction

Currently, collaborative authoring of stories is a common practice thanks to the evolution of information technologies and digital media. The Web 2.0 paradigm stressing user-generated content has been replicated in the field of storytelling, with some new kinds of modern audiences, such as online fan communities, being eager to actively participate in the composition and expansion of their favorite narrative worlds. In the context of amateur creators, some fan-fiction communities (as *Fanfiction.net*) engage in developing derived narratives, which are set in the context of their preferred fiction franchises. Other aficionados devote their time to categorize and document the narrative elements of those fictional universes using tools that range from wikis (e.g. *Wikia.com*) to far more complex visual and interactive representations (as Emil Johansson's *LOTR Project*, http://lotrproject.com). On the other hand, both amateur and professional authors also engage in the creation of their own shared fictional universes (as the *SCP Foundation*, http://scp-wiki.net; or Martin 2012). Tools to properly articulate those complex information spaces have also appeared (as *Articy Draft*, by Nevigo, http://www.nevigo.com; or *Celtx*, http://celtx.com).

By *shared narrative spaces* we mean informative spaces (i.e. "the set of elements and relations from an information system", according to Newby 1997) that concern narratives created, developed and maintained through the collaboration of multiple authors. Within this multi-authorial participation, the resulting narratives can be single linear traditional stories, but most frequently become vast narrative spaces, made of a large

set of narrative information units that grow organically to form a non-linear network of related stories that share a common narrative setting. From the restricted concept of collaboratively-created narrative as a unitary and cohesive piece built by several authors (e.g., a four-hand written book), the meaning of the concept can be enlarged to encompass multiple formulations, such as sets of narrative media connected by thematic, conceptual, plot, character or setting relations. But to accommodate that vast amount of contributions from different participants while keeping a narrative output which is meaningful in some way can be a challenging task.

This paper focuses on understanding the relationship between systems and collaborative fiction writing. Namely, it intends to analyze the different factors involved in the collaboration process that takes place through interactive fiction-writing systems, as well as how these factors interplay with each other, and how they impact on the participants' performance and the produced narrative.

To analyze collaborative storytelling systems and multi-authored narratives from this perspective, we propose a framework made of a variety of parameters, grouped into six conceptual areas, namely, *context, content, process, control, performance* and *output*. The former four areas broadly relate to the system itself, and are inspired on the PC3 (*process, context, content, control*) framework proposed by Magerko (2014) as an analytical lens to describe narrative (interactive) systems, which meant a significant progress with respect to the multiple dichotomies proposed by Koenitz et al. (2013). We provided specific parametrizable aspects in each area, directly related to HCI concerns such as interaction and information design, so that measures are possible. The novel two areas, which group measurable parameters as well, refer to the collaboration process and the actual results that the collaborating authors produce, and reflect the special emphasis on comparing how the different aspects of system and process design impact on the users' performances and the resulting narratives. Magerko's concepts were aimed to build a conceptual lens to analyze systems. Our framework contains specific measurable parameters, and extends the analytical capabilities, but especially turns it into a tool to understand and map the implications of system design with respect to collaborative writing.

Indeed, the framework is used in this paper to analyze an extended duration field study on collaborative storytelling that we present and discuss as well. This field study complements, through being smaller but more controlled, large-scale experiences on co-creation such as the SCP creative community, on which we have been performing a parallel analysis (Tapscott et al., 2017, article in preparation). Through the study we were able to observe, and keep track of, the continuous interactions of the participants as well as to analyze the resulting narrative, and to directly inquire the authors about their performance and perception of the tasks, allowing us to perform a richer analysis of the interactive system and the collaboration. The use of the framework to analyze the field study allows us to compare its underlying model, which we make explicit, with those of previous relevant experiments and observations in the field of collaborative narrative (Mason and Thomas, 2008; Likarish and Winet, 2012; Colás et al. 2013, 2015). The detailed comparison of similarities and differences within each relevant area of the framework leads to understand better which are the key aspects (in terms of the task nature and context, the design of the system and its associated informative elements) that mediate the resulting collaboration process and impact on the development of the created story, and in which ways this impact takes place.

Finally, we use the conclusions of this analysis to propose a general interaction model for collaborative storytelling systems. While several specific *ad-hoc* models exist on the field of digital storytelling, our model draws from the comparative analysis of all the aforementioned experiences and is intended to inform the design of a wide range of narrative systems. This model is divided in three interaction levels for addressing the story development, the narrative space organization and the common development of the informative elements, which supports better the collaboration among the participants and transforms the issues arising from having large numbers of participants into new co-creation opportunities on vast narrative worlds.

In what follows, we first present the related work on analysis frameworks for narrative authoring systems. Then, in section 3 we explain our analysis framework, defining its six conceptual areas and the aspects of each of them, presented as analysis parameters. In section 4 we introduce our field study and define its components using our framework. Section 5 describes

the setting of the field study. In section 6 we present and discuss the results of the study, and we synthesize them in a model. In section 7 we use our framework to develop a comparative analysis of the results of the study, triangulating them with relevant experiences on the field of collaborative storytelling systems and our previous works. Then, we conclude this analysis with the proposal of a general model of information interaction for collaborative storytelling systems. Finally, section 8 presents the conclusions and future work.

4.1.2. Related work: analysis frameworks for narrative generation systems

Previous approaches have focused on taxonomies of groupware writing in more formal contexts (Lay and Karis, 1991; Posner and Baecker, 1992) based on surveying practice, on the features of common information spaces (Bannon and Bødker, 1996) with a communities of practice lens, or more recently on tools supporting authoring of narratives (such as Scenejo by Spierling et al., 2016). Taxonomies help us to study the different contexts for co-creative activities and the different strategies for collaboration that people adopt, while studies based on specific tools (collaborative or not) focus on evaluating the information elements and interaction mechanisms that suit the context needs.

There are a number of factors that can make a system supporting collaborative writing more or less successful, where this term needs to be more precisely defined and measured (we do it later). In previous research, we discussed and analyzed how the specific information design of some experimental systems we created impacted on the exploration of the narratives, their comprehension by users and the contribution performance when authoring (Colás et al., 2013, 2015). Thus we take a complementary approach, where the focus is on the interplay of systems and resulting co-created narratives. In this paper we aim at better structuring the factors used to analyze narrative systems, in order to gain an understanding of how mechanisms designed influence the performance of the users and the nature of creative result, a view informed on the comparative analysis of a varied collection of systems with different information and interaction designs, including our own. Thus, the analysis framework should support both the analysis of the system and its outputs, and, more importantly, how the former influences on the latter.

An important set of work has focused on practical analysis strategies rather than a more theoretically structured one. Before turning to this work, we discuss the more conceptual aspect. An important inspiration is Magerko's PC3 framework (Magerko 2014), a formal lens for the theoretical analysis and comparison of narrative interactive systems, intended to be suitable for a wide range of systems, from AI driven generative systems to performative acts such as narrative board games or theatrical experiences. PC3 is more powerful to understand the interplay of systems and outcomes than previous categorizations, such as Koenitz et al. (2013), proposing a series of axis of dimensional opposite concepts to classify systems. PC3 only aims at discussing systems, and is less prepared to analyze outcomes, and their interplay. Our framework includes *performance* and *output* as two extra analysis concepts, on the actual performance of this activity and its resulting narrative output.

To better understand and evaluate systems and output, a conceptual lens is not enough, and within each of these concepts we propose practical specific parameters for their definition and measuring. The parameters introduced are grounded on previous research more focused on practical methods we discuss next. Szilas et al. (2014) proposed a series of quantitative measures to analyze procedurally-generated interactive narrative stories, focusing on the player exploration, which, despite being very specific, inspired the definition of the parameters for describing the *interactive nature* of the output of the creative process. Other researchers have dealt with the general aspects of collaborative design and collaborative writing. We adapt and integrate some elements of Ostergaard's taxonomic classification of collaborative design (Ostergaard and Summers, 2003) to analyze collaborative design experiences, which refer to the context of the experience, the team composition and the methods of communicating and approaching design, in the aspects of the *context* area, and also in their *process*-mediated equivalents. Collaborative writing is a traditional field of study in human-computer interaction, which regained relevance due the rise of Internet fiction-writing communities and the popularization of tools like Google Docs (http://drive.google.com; Wang et al. 2015). The studies of Posner about collaborative writing (Posner and Baecker, 1992) defined an influential taxonomy, which led Neuwirth et al. (1994) to define a set of interaction parameters for computer supported collaborative writing. These works are the basis of more recent ones such as Lowry's et al. (2004) taxonomy and

nomenclature of collaborative writing, which we adapt for the definition of *collaboration* aspects.

4.1.3. Definition of the concepts and of the analysis parameters

Our taxonomy of concepts and aspects aims to provide a tool to analyze the processes and interaction mechanisms of different collaborative systems for the creation of narratives, and the implications on both the users' performance of the creative activity and the nature of the resulting output. Based on the literature review and our previous empirical experiences of analyzing collaborative/ interactive systems for storytelling, we present next our proposal of analysis parameters and their definitions, along with the proposed categories and/or analytic measures to determine or describe each one of those factors. As we explained, the aspects to analyze and their measures are grouped in six conceptual areas: four of them relating to the analysis of the system and the environment, while the other two analyze the results.

1.**Context**: defined by Magerko as "the social elements of system use and the intended purpose of the system" (Magerko 2014, p. 108). We propose specific aspects to describe the setting and conditions in which the activity is performed, and the factors non-associated to the specific system, plus the description of the purpose in relation with the users' motivation and knowledge, as defined by Ostergaard (Ostergaard and Summers, 2003).

1a. *Participants*: profile and demography of the subjects.

1b. *Team composition*: how the participants are organized; if they work as individuals or a pre-established team, or group of teams; which are the roles and relations.

1c. *Participants distribution*: how the participants are distributed physically and temporally (if they are able to interact in person or remotely, in a synchronous or asynchronous way).

1d. *External communication*: what channels of communication (external to the system) the participants have. Which are the modes (verbal, written, etc.) and intentions of the communication.

1e. *Goal of the task*: purpose of the creative task, such as creation as a recreational activity, or as a part of an academic or commercial project, etc.; and, if the task is part of a greater one, i.e. sketching or planning a plot for another creative product.

1f. *Motivation*: Why the subjects feel compelled to participate and create.

1g. *Nature of the task*: definition and level of novelty, abstraction and complexity of the creative task from the point of view of the participants.

2. **Content**: "the combination of story elements and story structure that combine to define a space of possible story experiences" (Magerko 2014, p. 106). We divide it on the description of the nature and organization of the information elements, plus the description of the specific (if any) pre-created elements contained in the system.

2a. *Elements*: the main informative elements present in the process, the narrative elements they represent (character, places, location, objects, plots, scenes), their nature (textual, multimedia, etc.), and which associated meta-data they have.

2b. *Information structure*: how the informative space is structured; how the story and its associated information is composed through combinations of elements, which parts, sub-parts, hierarchies and element relations exist.

2c. *Seed*: description of the eventual pre-existing content before the beginning of the process, with details if there is a given "narrative setting" or "storyworld" (as a pre-set of descriptive information elements) and/or narrative content development.

3.**Process**: described in Magerko's framework as "the actions that can be executed in the multi-agent story creation system between and within the agents involved" (Magerko 2014, p. 105). Applied to the description of an interactive digital system, the process describes the tool, how it works and the expected set of actions in which the users can partake in order to fulfill the creative task. We adopted the language of the HCI field to describe its

different aspects, and included aspects dealing with the participant-related aspects described in the context than can be mediated by the process.

3a. *Interaction levels*: list of the interactive spaces or interfaces presented by the tool (or the procedure, if we are dealing with a more abstract, non-strongly technology-mediated system), and their associated purposes.

3b. *Visualization*: how the tool visually presents the informative material; specification of the representations and visual metaphors, and which information is revealed in each context.

3c. *Exploration*: how the users can explore (navigate and read) the informative elements of the space (both single elements and structured story information). It can be specified as the set of explorative actions that users can perform in each interaction level / interface, related to which informative elements.

3d. *Interaction*: how the users create and alter the informative space. It can be specified as the set of creative or modificative actions that users can perform with each informative element in each interaction level.

3e. *Process-mediated Team Composition*: if and how the tool and/or the procedure allow different roles to interact differently and/or in different levels.

3f. *Process-mediated Participants Distribution*: how the tool and/or the procedure require the users to be distributed physically and temporally (if it allows face-to-face or remote interaction, in a synchronous or asynchronous way).

3g. *Process-mediated Communication*: if and how the tool and/or the procedure allow the users to communicate among them, in which modes (verbal, written, etc.) and with what purpose.

3h. *Process Collaboration*: how the user can interact with the performance of other users: it could be directly or indirectly, through communication or through interaction with the informative space created by other participants.

4. **Control**: “is related to the function of the narrator in traditional storytelling [...] The agents in control ultimately dictate where the story goes” (Magerko 2014, p. 106). We define it as the rules implemented on the system in order to direct or manage the story-telling aspects of the process performance.

4a. *Temporal-spatial framework*: how the tool approaches the aspects of intra-storyworld time and space in its presentation and interaction possibilities.

4b. *Consistency preservation*: if the tool proposes some method to approach and/or control the story consistency during contribution.

4c. *Exploration and Interaction rules*: if the system possesses some other kind of rules or restrictions to the exploration and/or manipulation of informative elements.

4d. *Collaboration rules*: if the system possesses some other kind of restriction to the communication and/or exploration and/or manipulation of other users’ informative elements.

5. **Performance**: development of the process. How users in the specified context carry out the specified and control-mediated creative process. For most of the aspects in this area, we are interested on how the users approached the actions defined by the process.

5a. *Exploration performed*: how people explores (navigates and reads) the informative space; what, when and how the users explore the content (in which order, which parts, linearly or not, exhaustively or not).

5b. *Creation performed*: how people contribute to expand the narrative content, through which interfaces and actions; quantity and nature of the contributions (which kind of informative elements created, how they were interrelated). When (inside the process temporality) and where (on the informative space) users choose to add their own content. Which strategies adopted to create (brainstorming, drafting, reviewing).

5c. *Communication performed*: if there is direct interaction with other users. Through which channels (internal or external) and with which purpose.

5d. *Collaboration performed*: if there is direct or indirect interaction with the other users' content and creative activity. If and how users take into account the contributions of other users and/or the seed material. Which strategies are adopted to contribute alongside with other users (single contribution, sequential contributions, parallel contributions, reactive contributions, etc.)

5e. *Perception of the informative space*: how users understand the narrative space in terms of information organization and plot/element/ temporal/causal relations.

5f. *Comprehension*: if (and how) users understand the narrative information. Perception of their own comprehension (which could be different from the actual one).

5g. *Engagement*: to which degree participants find fun to participate, and are motivated to do it. How this is affected by the nature of the contents, the perceived difficulty of the task, and other factors.

5h. *Consistency concern*: if and how users take into account the seed and the other users' created information, being or not concerned by the consistency of their own contribution. How they perceive the consistency of the already existing information and if they are concerned by it.

6. **Output**: the information space created, resulting from the users performing the specified, control-mediated creative process.

6a. *Structure*: the resulting organization of the narrative information: its form, linearity, distribution, physical connections, and quantifiable information pieces.

6b. *Interactive nature*: the resulting nature of the narrative space, if is meant to be experienced mono-directionally, can be explored, interacted and/or altered. In the interaction case, how much

diversity, frequency, range and variability of choices/interactions it has.

6c. *Literary aspects*: Which is the resulting style or styles, and genre or genres, how they are used, and how they vary (from the setting to the user created parts). Which degree of cohesion of the informative space exists.

6d. *Element relations*: how different narrative information elements (characters, items, places, etc.) appear, how they are reused or connect different parts of the story structure.

6e. *Plot relations*: How the plot or plots develop and interact. How related plots (if any) connect. Which plot elements appear, coincide, are reused, or connect different parts of the story structure.

6f. *Consistency*: the measured, objective consistency of the story space and the variation across its different parts.

4.1.4. An extended-duration field study on creation on a shared narrative space

As indicated earlier, we had previously run some small-scale experiments (Colás et al., 2013, 2015) and discussed how some specific system design traits impact on partial aspects of narratives. We also carried out an analysis of large-scale collaborative narrative sites (Tapscott et al., 2017, article in preparation). We ran a field study of collaborative fiction writing extended in time to explore in depth and in a more integral way the implications of both the creative task and the information interaction mechanisms defined on the resulting performance of the activity. Moreover, the use of a framework such as the one discussed should allow us to improve the precision of the analysis of the results, facilitate the triangulation with our previous work, and to introduce in the discussion the comparison of other systems and results. In particular, to be able to understand better how the different aspects in terms of purpose and information interaction mechanisms of a narrative system (those related to PC3 concepts) interact and influence on those related to *performance* and *output*: users' activity and produced contribution, respectively. Based on

our previous experience, we aimed at the highest simplicity and transparency of the interaction methods proposed, and the minimal amount of performance control or other mediation mechanisms, as this should help a more refined analysis.

We turn now to describe the design of the field study, using the proposed framework to gain in precision:

The **context (1)** in which the activity is performed takes advantage of the development of a real academic activity: the *participants (1a)* are first year computer-science college students in a three-month course on interactive storytelling. The *goal of the task (1e)* for the students (working in four-person *teams (1b)* without specific roles assigned) is to design their own game narrative, with the possibility of developing their own story in the context of a provided shared narrative setting (including elements from the provided storyworld in their stories, or also including elements developed by other teams). The tasks the participants are instructed to do are meant to help them in developing their story step by step, which then they will use to design and implement their project. The *nature of the task (1g)* is somewhat new for most of the students, who are not used to engage in creative activities, posing a medium level of abstraction and difficulty. Setting aside the engagement that some participants can experience within a creative activity, the *motivation (1f)* for participating is result oriented, in order to accomplish the course task. Teams developed their tasks face-to-face (during seven sessions in a classroom) and mostly remotely *distributed (1c)*, the *communication (1d)* being also both face-to-face and through their preferred remote communication channels. This field study intended to be much closer to the actual Internet creator communities (e.g. *Fanfiction.net*) than our previous, short-time experiments.

Regarding the **content (2)**, we established a simple taxonomy of informative *elements (2a)*: narrative elements are *granular* informative objects representing the main items of the narrative world. Due the character-driven nature of the narrative informative space (Propp 1968; Greimas 1983) they mostly represent character individuals or groups (as factions), but they can also represent places, objects, events or other type of concepts. *Structurally (2b)*, they function as granular information elements, as they are meant to be adaptable to different nature or levels of

abstraction; and elements can reference and/or include other elements, which is useful to establish the specificities of the narrative setting (Tapscott et al.; 2014), (e.g. relations between characters, factions sharing characters non-exclusively, places who include or connect to other places). Authors' contributions are a higher level kind of informative element, functioning as story fragments of relatively short length, compared to chapters or to traditional dramatic acts. The use of hypertext *links* between elements, and between contributions and their referenced elements, is akin to the way informative relations are presented in media as hypertextual narratives and wikis. This use of hypertext links structures has proven useful to develop stories with multiple participants in previous experimental observations as the Wikinovel *A Million Penguins* (Mason and Thomas, 2008), and also in the real use cases of communities engaging in narrative co-creation using a shared setting, such as the *SCP Foundation*, which we studied in parallel to this study (Tapscott et al., 2017, article in preparation).

The system contains a pre-created narrative background or *seed (2c)* when it is presented. In order to encourage participation and interaction with the already existing information, the selection of the seed theme was made based on the most successful themes proposed by the students of previous years. Indeed, the seed was an apocalyptic situation in the University facilities. The use of the university as the main stage of the events provides a known environment to the creators, and the post-apocalyptic genre allows introducing original content in a less demanding way than, for example, a historical setting – used in one of our previous experiments on co-creation (Tapscott et al., 2016), in which people might have been felt discouraged to participate due the richness and complexity of the historical seed proposed. Figure 1 presents the structure of the content, accessed through the interfaces and interaction mechanisms detailed next in the process description.

The **process (3)** is designed to provide the participants with a direct and transparent access to the information elements. We aimed at understanding how users interact with the content, minimizing the interferences that might be produced by a more complex interface and system (e.g. rich visual representation, selection of metaphors, etc.). To this end, we used Google Docs, which has been proven to be a sufficiently powerful tool to enable cooperative work and communication (Sun et al.,

2014) while being simple and familiar. A transparent process is opposed to one that enforces heavily the actions of the creators, as we had carried in some previous work. The process simplifies analysis by reducing its different actions to conceptual transformations that participants can perform directly creating or editing informative elements presented as textual items in the system. We can then observe directly the emerging co-creation process performed by the subjects, and through our measures of the performance and the output parameters, understand better their actual interaction related to co-creation.

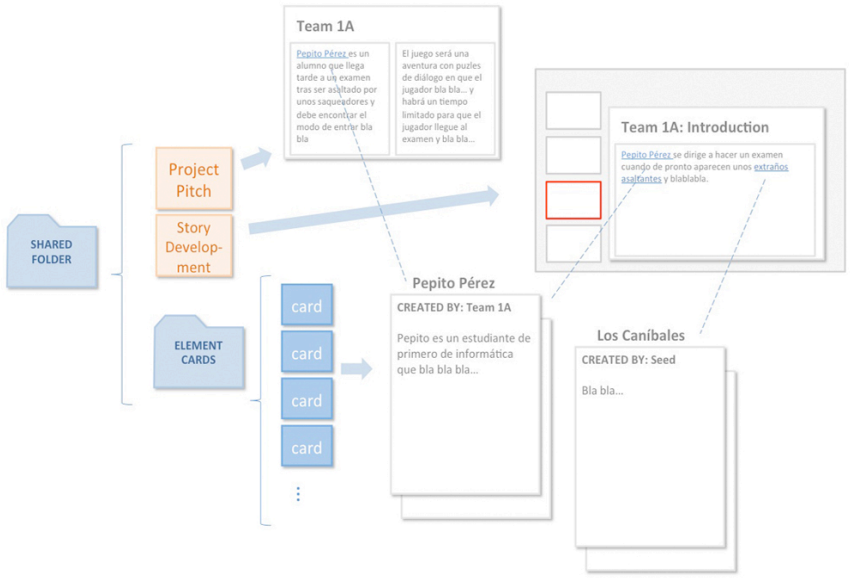


Figure 1. Document structure of the field study

Specifically, the different parameters of the *process* are: general vs. specific *contexts of interaction (3a)* with the narrative (i.e. global vision of the story vs. specific edition of its scenes), as for example in *CrossTale* (Colás et al., 2013). In this case, we have three informative areas with their sub-interfaces for edition (see Figure 1): A pitch document where each team has a single space to define its project; a plot document working as a navigable ordered series of scene elements, each element being an editable scene; and finally the nuclear informative elements (element cards, representing characters, places, etc.) grouped in their own general informative area (a cards folder) and presented as editable single text documents. All those elements are *visualized (3b)* using basic desktop metaphors: folder and text documents in case of the element cards, and

slide series for the plot document. Users can *explore (3c)* searching visually through this folder documents / slide series, plus they can also explore the informative space by following the hyperlinks connecting the text in the slides with the element cards, and the element cards between them. As for the list of *interactions (3c)* the participants can perform, they can: create and modify any element card, create links (connecting cards or linking to cards from the pitch or plot document text), write and modify their own pitch slide, and create, modify and rearrange their own scenes inside the plot document. As for the mediation of *team composition (3e)* (in terms of assignation of roles and specific interactions), *distribution (3f)* and *communication (3g)*, the process did not enforce or restrict any modality to the participants, besides Google Drive allowing for remote concurrent edition and communication, plus the participants were allowed to use all the external communication channels they needed. Regarding the *process collaboration (3h)*, while intra-team collaboration was not mediated, following our previous research we envisioned each participant team story as a storyline within a major setting (Colás et al., 2013, 2015). This means that teams were expected to collaborate with other teams trough referencing their informative elements, but not directly altering their stories.

Again, in a similar way to the process, the field study presents minimalistic **control (4)**. *Exploration (4c)* and *collaboration (4d)* was minimally restricted, besides the rule that allowed participants to separately add, but not to modify or eliminate information to other teams' contributions. No restrictions were implemented for *consistency preservation (4b):* since previous experiences showed us how enforcing consistency seemed to diminish the creative engagement of the participants (Tapscott et al., 2013), giving freedom to the participants should allow us to better understand their own processes of understanding and managing consistency in the storyworld. On the other hand, we maintained the capability of ordering the scenes as a way to control the temporal logic of the narrative through a non-forced device: allowing the rearrangement of the contributions in a *temporal* (but not spatial) *framework (4a)*. With time being one of the important pillars of storytelling (Chatman 1980), a series of works have used the timeline metaphor to collaboratively add events to a single canonicity (Ajanki et al., 2013; Batrinca et al., 2013), but there are also experiments pointing that hard-binding scenes to strict temporal marks is not always suitable for

creators to establish their temporal logic (Tapscott et al., 2016), so we left open this possibility with the aim of understanding how participants perceived and interacted with this information model, and to triangulate with the findings of previous experiences.

We have described the field study using the first four concepts of our framework analysis, which are related to the narrative system nature. In the next section we describe the setting and the procedure for the development of the field study. In the following sections, we present the results of this study and discuss them in terms of the participants' **performance (5)** and the **output (6)** of the creative process and how the first four concepts influence the last two.

4.1.5. Field study setting and procedure

The field study was conducted in an interactive storytelling course, lasting a term and attended by first year computer science students. The field study was structured as a workshop of seven sessions of 2 hours. The students had to plan and develop a short storytelling-based game, shaped as a visual novel or a graphic adventure. The 95 participants were divided into 4 seminar groups, each with six or seven 4-student teams (although exceptionally some teams had three or five students), making a total of 26 teams. Each team had to deliver its own game at the end of the term. The first and third authors of this paper were the course instructors. The development of the narrative of the game was mandatory, but the participation of the students, including post-activity questionnaires, was voluntary and without impact on the marking. Informed consents were used.

As indicated and argued earlier, a tongue-in-cheek, post-apocalyptic situation in the university facilities was given to the students as a narrative background. Whether original stories had to adhere to it and to what degree was optional (a couple of groups did not use it), but recommended. This seed included several interrelated student factions, and a purposefully vague explanation of the events that had led to that post-apocalyptic situation.

The seed was made available as a series of documents within a Google Drive online repository. It contained a collection of element cards, each

one consisting of a single text document, describing a character, a character group (i.e., a faction), a place, an object, or other type of element. Its description could contain hypertext links to other element cards, in the same way as a wiki article. We also provided a story development document in the form of a timeline, using a slide presentation, in which each slide presented a "chapter" or event of the overall storyline. This document presented the major plot points regarding the general situation and the actions of the factions and characters involved.

Each team was asked to deliver progress updates editing the online documents at pre-scheduled dates. The first milestone was a draft of its pitch document, summarizing the project plot, and the creation of at least three new element cards, including links to its own cards and/or those of the seed in the pitch document. For the second milestone each team should provide the introduction and part of the its plot core, presented as slides in the story development document, with at least two more element cards, and possibly more links. In the third and final milestone each team had to finish the core as well as the denouement. Both the story development document and the pitch document were unique files shared by all the teams, each contributing with its own part. During the whole experience the teams were able to see all the content on the online repository, and they were encouraged to read and comment on any content be it part of the seed or created by other teams.

At the end of the term, the teams were asked to answer a questionnaire about their performance, choices and perception of different aspects of the experience, as detailed later.

The analysis of the content produced and the interactions performed was based on the lecturers' observations and the coding of the Google Drive history logs. For each document of the online repository, Google Drive logs the accesses and changes performed throughout the editing period, with timestamps of each action, which allowed us to code the accesses to each online document by each team and their edits with their timestamps. We present the analysis next.

4.1.6. Study results

In this section we present the analysis of the results of the field study, namely, the coded content, the coded activity logs, and the answers to the questionnaires of the participants who filled them in.

The analysis of the information objects created and modified (in terms of their quantity, nature, relations, etc.) provides *output* and *performance* measures, the two conceptual areas we added to the analysis framework. Indeed, the nature of the information elements, complemented with their deeper qualitative semantic analysis (which we carry out within the discussion section), is directly related to the structure, literary aspects, plot and element relations and consistency parameters of the *output*. On the other hand, this analysis of the created information space, complemented with how the participants carried out the activities, which is provided by the system logs (how and when the participants accessed, modified, and commented the information space), are measures of the exploration, creation, collaboration and communication aspects of the *performance*. The participants' perception and comprehension of the informative space, their engagement with it, and their concern about consistency can be extracted from analyzing of the answers to the questionnaires, and complements the *performance* analysis.

After presenting the results of the analysis, we discuss them in subsection 2 in terms of the *performances* of the participant teams and the *output* they generated. In subsection 3 we formalize these results of the discussion.

4.1.6.1. Analysis of the results

A. Element cards

A total of 89 cards were created, making an average of 3.56 cards per team (stdev 2.08). The predominant type was *character* (52 cards, 58.4% of total), followed by *character group*, and *place* (both 15, 16.8% each). *Object*, *event* and other types of cards were minimally used (4, 1 and 1 occurrences).

There were 36 post-modifications to the own team's cards: each team made 1.5 modifications on average. There was only one modification of a seed card, namely, adding information related to the team elements. No team modified any card of the other ones.

A total of 70 *links* were included in the cards. This means an average of 2.9 links by team (stdev 4.6), and an average of 0.78 links per card (stdev 1.05). 60% of the links (42) were to cards of the same team, 38.5% (27) to seed cards, and there was only one to a card of another team. 70.3% of the links to seed cards were to cards of the *character group* type. The only link to a card of other team was of the same type.

Each team received an average of 0.65 comments on their cards, and made 0.52 comments on other team's cards (71.4% of all comments) and 0.39 comments on setting cards (28.6%). No team made comments on their own cards. Comments on other team's cards were made mostly on *character* cards (46.8%), but also on other types of cards. 88.8% of the comments on seed cards were on *character group* cards.

B. Pitch documents

Each team made an average of 3.26 modifications (stdev 2.14) to their pitch. In total, 68 links to cards were created in the pitch documents, an average of 2.61 links per pitch (stdev 1.79). Most links were introduced between the first and second editions of the pitch (1.41, stdev 0.84). The predominant types of the linked cards were *character* (35, 51.4%), then *character group* (21, 30.8%) and *place* (6, 8.8%). There were minor occurrences of links to *objects* and other types of cards (but none to *events*).

80.8% of the links (55) were to cards of the team itself; 19.2% (13) were to cards of the seed, and there were no links to cards of other teams. Most of the links to the own cards were to *character* ones (60%), while most of those to setting cards were to *character group* elements (84.6%).

Each team made an average of 1.61 comments (stdev 1.41) to other teams' pitch documents, and logically the average number of received comments per team is the same (stdev on comments received per group being 0.98).

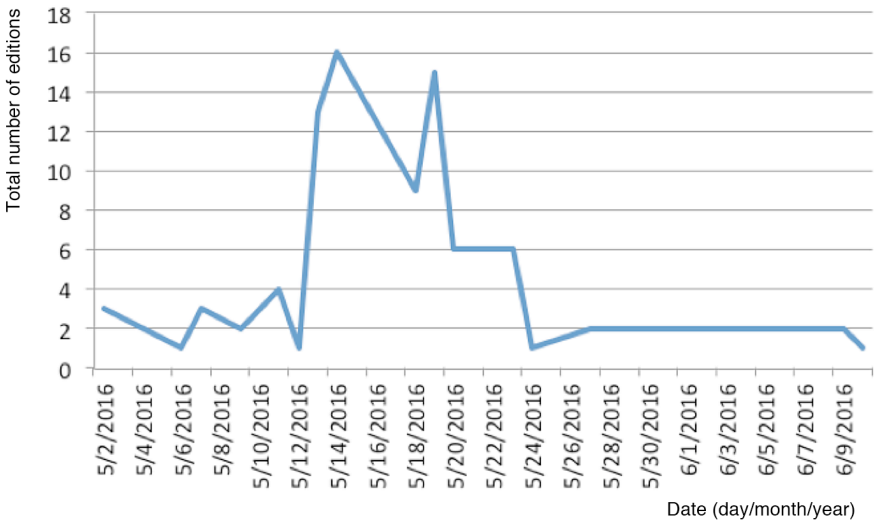


Figure 2. Histogram of editions on the pitch document

There was a first peak of edits (see Figure 2) at the dates when students should submit their pitch documents, and the number of edits did not immediately decrease, but kept at a regular (although lower) level until completing the edit of the Story Development Document (see next).

C. Story development document

There was an average of 5.84 edits (stdev 2.6) to the document per team, a total of 152 from 94 accesses (there could be several edits in an access). On average there were 2.03 edits (stdev 1.14) to the *introduction*, 2.26 (stdev 1.31) to the *core*, and 1.53 (stdev 0.81) to their *denouement*.

A total of 50 links were included in the pitches (54 counting repetitions of some contributions), making an average of 1.92 links per team (stdev 2.88). Links were usually added between the second and third changes. There were 30 links to *character* cards (55.5%), 12 to *character group* ones (22%), 10 to *place* cards (18.5%), and one link to an *event* and an *object* card. Most of the links were to own cards (41 links, 82%) and the remaining 9 were to seed cards. There were no links to other teams' cards. Most of the links to own cards went to *character* cards (73.1%). All links to seed cards were to *character group* cards.

Very few (9) comments were made: each team received an average of 0.34 comments (stdev 0.93). 6 of these comments were made on other teams' contributions, and 3 were comments on the own team's.

Finally, the resulting story document, confirmed by the observations made by the lecturers, show that participants did not take into account the other teams' contributions to put theirs in the timeline.

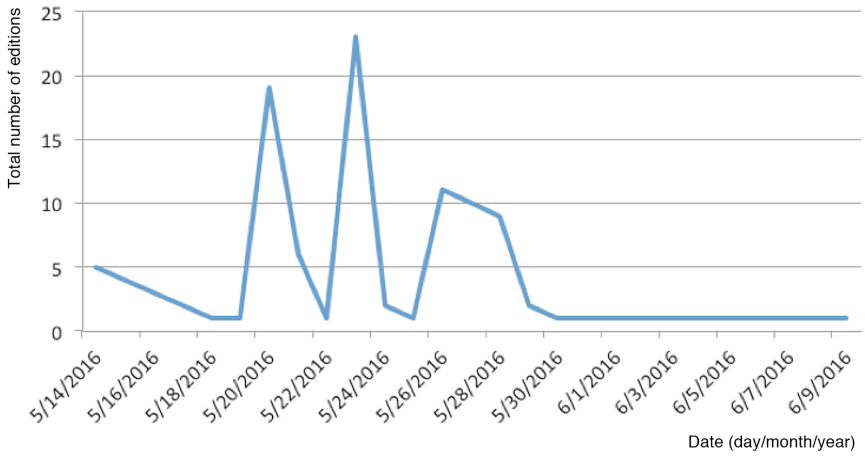


Figure 3. Histogram of editions on the story development document

The histogram of edits (Figure 3) shows three peaks, each corresponding to the date when students should submit their introduction, core and denouement.

D. Questionnaires

23 persons (approximately equivalent to half of the teams) answered the questionnaire, whose results we summarize next.

All teams read stories of other teams (they were asked to do so), and most of the teams (47.8%) read between 6 and 10 stories of other teams (see Table 1). Likewise, all teams read between 1 and 20 cards, with results more equally distributed, being predominant those who read between 1 and 5 cards (Table 2).

Stories read	Teams	Answers %
None	0	0%
1 to 5	7	30.40%
6 to 10	11	47.80%
10 to 15	4	17.40%
>15	1	4.30%

Table 1. Number of other teams' stories read

Cards read	Teams	Answers %
None	0	0%
1 to 5	9	39.10%
6 to 15	8	34.80%
16 to 20	6	26.10%
> 20	0	0%

Table 2. Number of element cards read

As shown by Table 3, the dominant use of the element cards was inspiration (21.8%), followed by using them as a formal reference to create their own cards, while some did not find it useful (9.37%).

Use	Teams	Answers%
Organization	2	6.25%
Curiosity	2	6.25%
Inspiration	7	21.875%
Differentiation	1	3.125%
Adapting elements	4	12.5%
Formal reference	3	9.375%
Not useful	3	9.375%

Table 3. Usage of the element cards

Most teams (39%) read the stories of other teams while they were creating their own contributions (Table 4). The order of picking and reading the stories was mostly chronological. However, the stories were presented with internal chronology but were not ordered relatively to each other, so it was possible that most subjects chose stories randomly (30%) and then read them chronologically (see Table 5). Most subjects decided to do a

quick reading of multiple stories instead of focusing on a detailed reading (Table 6).

Moment of reading	Teams	Answers%
Before creating	4	17.40%
While creating	9	39.10%
After creating	5	21.70%
During the whole process	5	21.70%

Table 4. Moments when stories were read

Reading order	Teams	Answers%
Random	7	30.40%
Chronologically	11	47.80%
First checking the cards	3	13%
Searching specific authors	1	4.30%

Table 5. Order chosen to read stories

Reading method	Teams	Answers%
Quick view to multiple	13	56.50%
One or more complete	2	8.70%
Mainly their element cards	4	17.40%
Other methods	4	17.40%

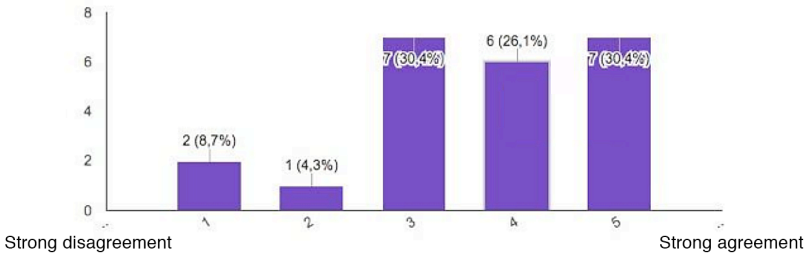
Table 6. Strategies to read stories

The majority (69.6%) of the teams indicated that the Pitch document was the most useful way to understand stories of other teams, as shown by Table 7.

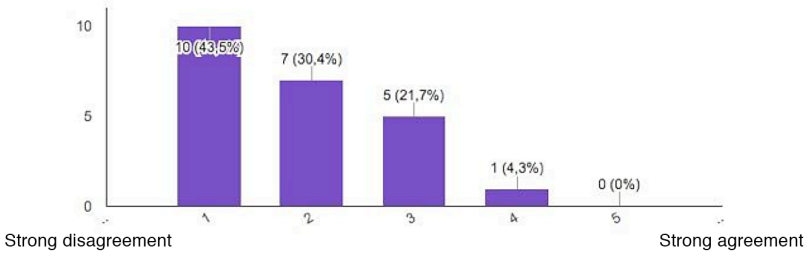
Preferred info. Element	Teams	Answers%
Element Cards	3	13%
Pitch Document	16	69.60%
Story development	4	17.40%

Table 7. Information elements regarded as most useful for understanding

I mainly based my story on the provided seed



I inspired myself on the other teams' stories



I mainly based my story on my own ideas

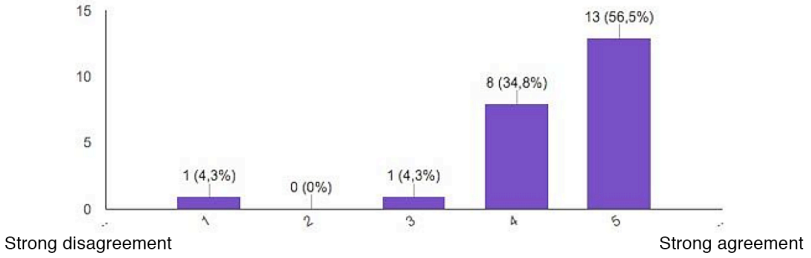


Figure 4. Answers to the Likert-scale questions about story inspiration

Regarding the questions about the elements that inspired the own story (Figure 4), medium, medium-strong, and strong agreement with using the seed as main inspiration received a similar number of answers, making up 87% of the total. Creating mainly based on the own ideas received 91% support, while inspiration by the stories created by other teams was rejected by 74%. Answers about the ordering of their stories concentrated

around being somewhat easy and neither very useful nor useless (Figure 5).

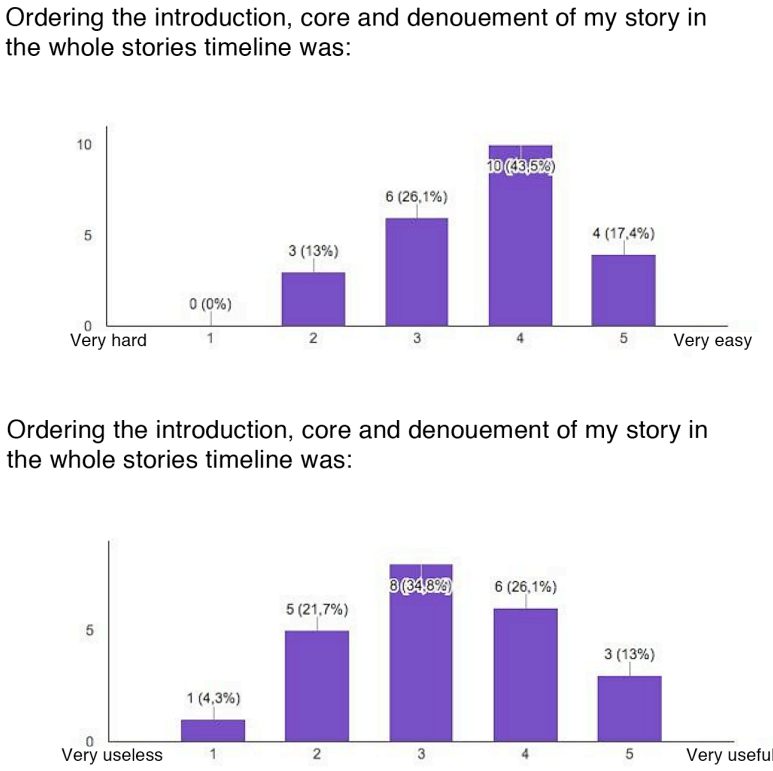
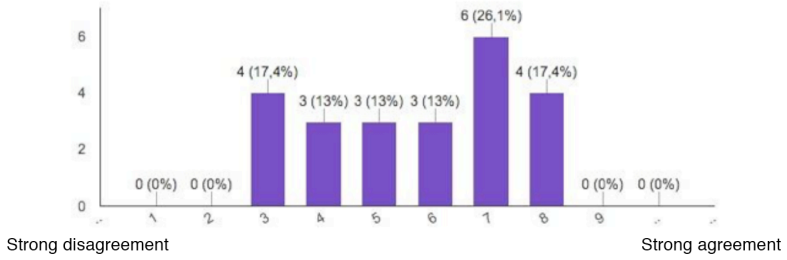


Figure 5. Answers to the Likert-scale questions about temporal ordering of the story

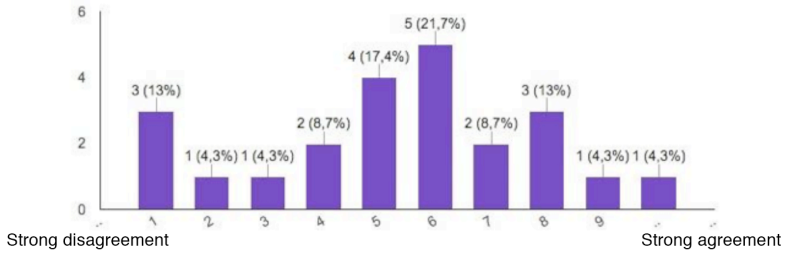
There was wide diversity as whether the whole of the stories formed a coherent set (see Figure 6), the average being 5.7 on a 10-point scale and answers ranging from 3 to 8. The agreement was somewhat greater with respect to the coherence regarding the other stories, the answers concentrating around a rating of 6/10 on coherence. This contrasts with the coherence of the seed being rated with 8/10 by 39% of the participants, and most other answers being around this rating, with a 7.9 average.

When asked about a detail of the story that was purposely left open in the seed, (the cause of the apocalypse), most teams gave their own invented explanation.

All the stories form a consistent set



My story is consistent with the stories created by other teams



My story is consistent with the provided seed

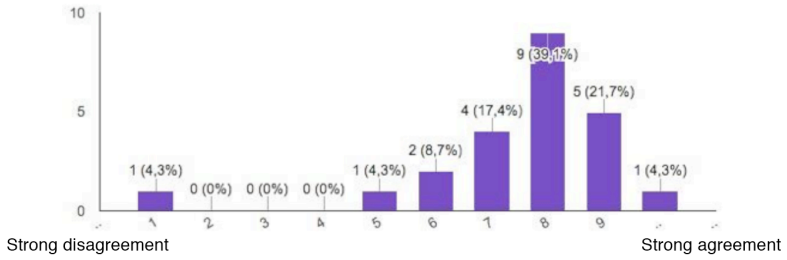


Figure 6. Answers to the Likert-scale questions about consistency

4.1.6.2. Discussion of the field study first analysis

Next we discuss the results analysis in terms of the *performance* of the participants (how they interacted with the informative space, through which interfaces and which use they gave to each interface) and the *output* they generated (the elements created, their nature, and the way they were structured). This will allow us to discuss the interaction model implicit in

our system in the next section, deepening on how performance and output are related to the different parameters of the designed system corresponding to the other four concepts of the analysis framework used.

As an overview, one can appreciate that teams create narratives with good levels of seed-related consistency, while relations with other team's contributions take place through occasional use of some other shared elements but mostly of common seed elements. As Magerko (2014) points out, content authoring is a typical bottleneck in generative narrative systems, and some systems just avoid this problem by restricting themselves to work with "protonarratives" devoid of grounded semantic content. Unlike this, our field study successfully drew on developments of the more semantically oriented multi-author systems as on-line communities of fiction creators, with their strong points and weaknesses. We will elaborate more about this when dealing with the "walled gardens" problem in the next section.

A. Elements influenced by the seed

In classical storytelling (Propp 1968; Greimas 1983), characters are regarded as the main elements that drive a story. This is confirmed in our study, as characters are the predominant type of elements created. If we examine the elements in detail, the seed seems to have influenced the nature of the characters created: it represented a couple of characters as band leaders with a nickname, and most of the user-created characters followed this pattern of having a nickname; some were leaders or belonged to their own bands. The seed elements seem to have influenced the kind of created elements as well: *character groups* (i.e. factions*)*, which are particular to the seed, were the second type of element most created, together with *places*.

Element cards were the information units that included more links, compared to both the *pitch* and the *story development* documents. Two thirds of the links connected to other cards of the same creators, and one third were connections to seed cards, 70.3% of those being *character group* cards. Thus, links were mainly used to establish the relationships among the own elements, usually characters, and secondarily, to establish those characters as belonging or related to the factions presented by the seed.

There were only three stories that took elements created by other teams, and only one link went to a *character group* card created by a different team. However, the content of some comments reflected the interest in using elements authored by others. Cards were the information elements that received more comments, and most of them (71.4%) were made on other team's cards, usually on *characters*. On the other hand, 88.8% of the comments on setting cards were made on *character group* cards, which along the number of links received reinforces the idea of *character groups* being the seed elements more influential and used by the participants. Perhaps there was only time to take advantage of the seed and not enough time for taking advantage from the other team's ideas.

B. The pitch document turned into the story development guide

Compared with the *pitch* and the *story development* documents, element cards were less modified after their creation in the initial days of the process. This indicates that they were used to establish an initial grounding expanding the seed: they contained the main elements, original or borrowed from the seed, that would be used to ground their story creation process, but the pitch document was the main tool to keep track of the story elements and changes. Indeed, 80.8% of the links included in the pitch document were to cards created by the same team. This indicates that the groups started to develop their stories playing mainly with their own elements, once the relations between their elements and the seed were established in the cards. Specifically, groups linked mainly to their own *character* cards and to *character group* cards of the seed, to provide the relations between their specific story elements (mainly characters) and the seed elements (usually factions).

One of the most unexpected results was the high number of edits the participants made to their pitch documents after the initial phase, despite the pitch was originally intended to serve only as a first draft of the idea. Groups kept editing this document as a way to keep track of the changes and additions during the story development. This is also supported by the number of comments that the pitch documents received from other teams, higher than those on the story development document. Further, the pitch was most useful to quickly explore the stories of the teams, confirmed by the answers of 69.6% of the participants in the questionnaire.

C. Story development documents providing detail and report externally

As expected, teams spent a considerable amount of time editing the story development document. Despite this, changes appeared concentrated in the dates corresponding to the scheduled submissions of the introduction, core and denouement of the story. The regular amount of contributions to the pitch document seems to indicate its use as a planning tool, while the story development document was the place to detail and extend the outcome of the creative process.

The number of links included in the pitch documents was a lot higher than in the story development ones. This points towards participants focusing on developing the specific plot of their story once their elements and relations with the seed were established. As we remarked earlier, most links in the pitch (82%) were to own cards (mostly *character* cards), and links to seed cards were to *character groups*.

The low number of comments to story development documents in comparison with those on other elements and the answers to the questionnaire reinforces the idea that teams were not interested on deeply exploring the full story developments of others, and they just used the pitch documents to do that in a quicker way. While teams did not comment on their own pitches (but worked extensively on them), they did it on their own story developments, confirming that those document were used to show 'final' results, and the comments were especially geared towards the lecturers.

D. Time and coherence

Answers to the questionnaire indicated a medium-high interest on getting inspiration from the seed. In fact, most groups described the use of the element cards (both seed and their own) as an inspiration focusing on strategy, rather than on content. Indeed participants were very negative when asked about developing their story using ideas from other teams, and conversely, they were very proud of having used their own ideas to develop the story. Analyzing the final stories produced, even those who used specific elements created by other teams just used them as isolated appearances, but did not take into account the events and developments that those characters, items or factions underwent in the stories of their

original creators. The questions about coherence also reveal that, while creators cared about making their stories coherent with the seed proposed, they did not care that much about the compatibility with the stories of other groups.

Participants found the task of ordering their contributions in relation to the seed moderately easy but not particularly useful. Analysis of the plot development documents reinforce the idea that specifying the chronology was not found especially relevant: most groups only gave a vague notion of the temporal situation of their stories with respect to the seed, or just did not care to do it, and they usually did not take into account the other teams' contributions to put theirs in order.

4.1.6.3. An information interaction model of three interaction levels

This subsection formalizes some interaction aspects to build shared narrative spaces, in order to understand and discuss better the results of our field study. From these results, three different types of information elements with different contexts of work and different interaction strategies (see Figure 7) seem to emerge in the collaborative creative process (despite some aspects of the collaboration have not been completely realized); we call them levels:

A. First level: Elements and relations

The first level of interaction is performed when the users explore the seed (the pre-created information elements contained on the system: story fragments and narrative elements of the fictional storyworld, which is commonly known in narratology as "narrative setting") and also the elements created by other authors, and then establish their own story elements as the main pieces to develop their story. This is performed in a relatively short period of time, before the story development phase, and once done, the amount of interaction with the already created elements is low, with users focusing on the next two levels of interaction.

Within this first level, our participants mostly created original characters and similar character-related elements that can be used heavily to drive the plot – in agreement with classical narratology (Propp, 1968; Greimas 1983), where characters are the main building blocks of narratives, while

the relation to the seed is commonly established by relating these original elements through links with more open and/or abstract elements of the seed, such as *character groups,* i.e. factions. While our participants did not create links to the elements of other groups' elements, teams used comments on the cards of other teams to list them as possible candidates to be incorporated into their own narrative (which they sometimes did, but quite infrequently). It seems that with the little time available, originality of the own creations was stressed. This raises the question of how to encourage and reinforce the users' exploration, creation and direct explicitation of relations with other authors' original content.

B. Second level: Story index as a planning tool

The teams used the pitch a lot more than we had intended, and it was regarded as a good means to plan and evolve each team's narrative and explore the narratives of other teams. Internally, the interaction went beyond establishing the main storylines of their narratives: teams also returned to it to modify it in order to keep track of the evolution of the story developed in the highly-detailed, less-manageable story development document. The pitch was also used as a way to connect the sketched plots with the detailed descriptions of its elements in the first level, serving as a "guide" or "bible" to the story development. Externally, teams used it to explore the activity of other creators, as it allowed them to understand easily and quickly the story and how it evolved, again without having to dive in the story development document.

C. Third level: Development document to expose finished narratives

This third level was used in practice to produce the "final" narrative. There were much less explicit references (links) to the element cards of the first level, since it seems that users relied on the pitch document to keep track of all this information. Within this level, the exploration and interaction with other teams was almost non-existent. This could be one of the reasons why contemplating the temporal frame of the own story development in relation to the others was deemed irrelevant by the participants. According to the design of the field study, pitch documents were just a list of entries, while the whole story development document was intended to have a more open structure, allowing for collaboration, rearrangement of contents and extensive use. Despite this, creators made a

far more extensive use of the pitch during the whole creative process, and exploration of other creators' ideas was highly undertaken on it. We can hypothesize that a summarized, index-based level to allow both exploration and planning and separated from the final development level is very good to encourage collaboration and sharing ideas, especially when the final development is expected to be deep and detailed.

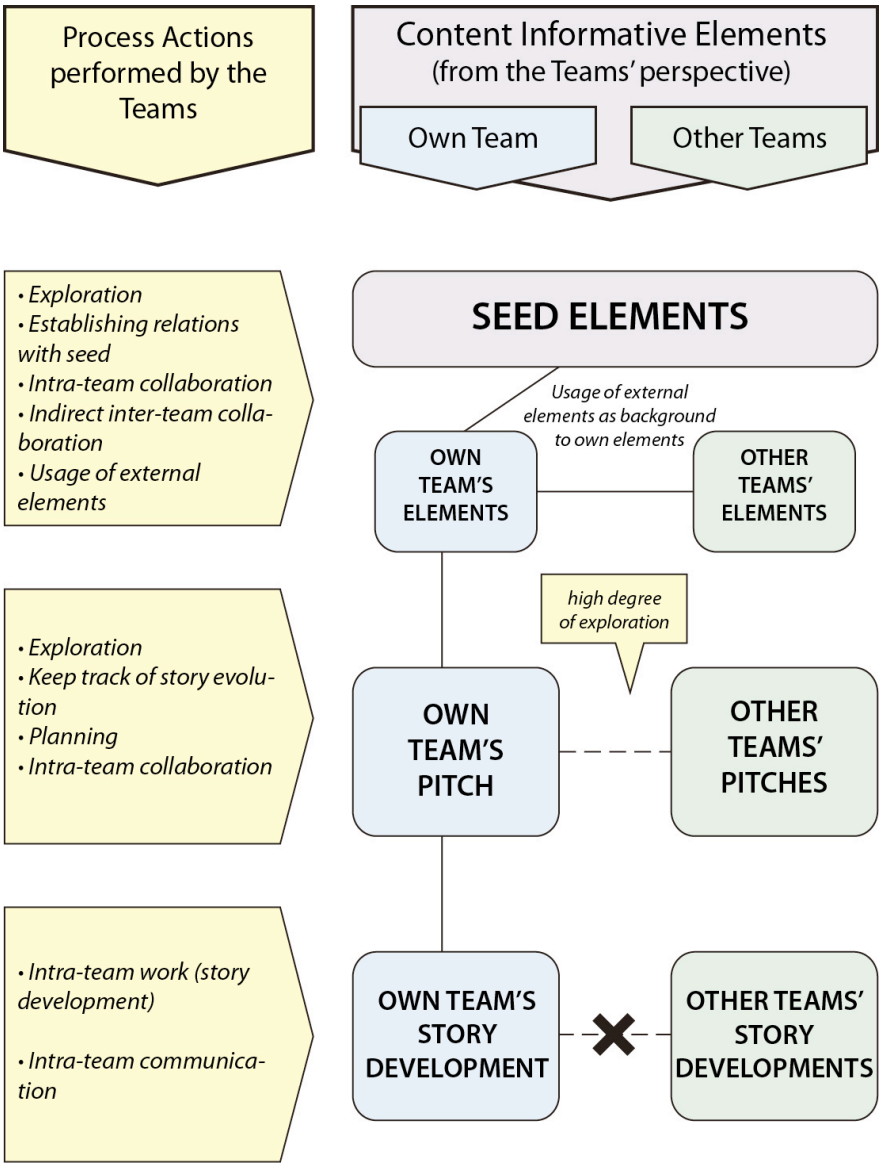


Figure 7. Information interaction model from the field study

4.1.7. Discussion

The goal of this paper is to understand better the interrelationship of interactive systems and resulting collaborative narratives. Subsection 7.1 is devoted to deepening this understanding through comparing and analyzing the results of our field study, previous significant collaborative narratives and previous experiences we had developed, through the detailed framework introduced in the paper. In subsection 7.2, we propose an improved generic model of human information interaction for shared narrative spaces.

4.1.7.1. Comparing models of different systems through the proposed analysis framework

We compare the field study with our previous research (Colás et al., 2013, 2015; Tapscott et al., 2016) and other large scale collaborative fiction studied (some of which inspired ours), such as *A Million Penguins* (Mason and Thomas, 2008) (the first novel created through a wiki), the Twitter-driven *Exquisite Corpse* (Likarish and Winet, 2012), and some creative online communities (the wiki-driven *SCP Foundation* we analyzed in parallel; or *Fanfiction.net*).

We also include some specific aspects of media of other types, such as locative narratives (Colás et al., 2016; Mashall et al., 2016) when dealing with the exploration of non-linear informative spaces, and classic hypertext fiction (Bernstein 2001; Pope 2006) regarding the use of the hypertext as a way to causally relate information units, to triangulate better. We divide this analysis in the first four concepts of the framework (*context*, *content*, *process* and *control*) which characterize the systems and interaction, dwelling on how they affect each other and especially how they impact on the last two concepts of the framework: the final *performance* of the participants and the produced *output*.

A. Context

Regarding *participants (1a)*, the compared shared narratives vary highly in the number of participants and the wide range of their participant's profiles. Some were small-scale lay oriented experiments (as *CrossTale;* or *Proppulsion*, Colás et al., 2015), while others contemplated the

participation of some expert profiles (as the examples of *A Million Penguins* and *Exquisite Corpse*). This also causes differences in terms of *team composition (1b),* but since most of the analyzed experiences are on-line systems or experiments imitating on-line interaction models, participants' team composition, their *distribution (1c)* and their *external communication (1d)* are not as relevant as their **process**-mediated counterparts (this is, the *team composition (3e), distribution (3f) and communication (3g)* allowed/enforced by the tool or system), which are discussed in the corresponding section. Despite this variety, differences observed on the creation and the collaboration performed do not seem to depend on the number of participants or their expertise in literary creation so much, but rather on the *goal of the task (1e)* and its *nature (1g)* regarding its complexity in terms of scale: some systems goal is to create small-scale stories (Colás et al., 2013), while others aim at greater amounts of complexity, from the creation of long-spanning novels (Mason and Thomas, 2008) to the creation of shared universes with lots of different stories taking place on them (as the *SCP Foundation*). This complexity also affects the **content** and **process**, as we discuss in the corresponding subsubsections.

Focusing on the direct influence of the **context** aspects in the **performance**, the mentioned complexity can result in the participants having difficulties to *explore (5a)* and *comprehend (5f)* the large (and complexly interrelated) amount of information. If this happens, people share a common narrative space but do not *collaborate (5d),* which affects the *creation performed (5b)* in what is known as the "walled garden" problem, as in the case of *A Million Penguins*: the created **output** is a *structure (6a)* of non-related, individual contributions isolated in the narrative space, which do not bear any *consistency (6f)* with each other. *A Million Penguins* also shows how sometimes contribution compatibility and participant's coexistence problems arise, especially for people *concerned with the consistency (5h)* of the resulting narrative space and the integrity of their own contributions.

Despite this, our field study results and the activities of the other large-scale communities mentioned reveal that this concern for consistency also varies when the *task goal (1e)* is presented in a different light. For example, fan-fiction communities (as *Fanfiction.net*) embrace this "separated versions" paradigm for creating multiple, non-related

derivative stories from an original pre-existing setting (i.e. there is usage of the original story *elements (6d)*, and sometimes usage of the original *plots* (6e), but there do not exist relations between different authors elements and plots). Or, when presenting the task as the construction of a shared storyworld, (as in our field study, in our previous experience (Tapscott et al., 2016), or in the case of *SCP*), participants are interested mainly in developing their own stories while respecting the common elements (presented in the seed or, sometimes, created by other participants), with very different consistency concerns compared with the experiences where all the participants try to construct one single, consistent story (Likarish and Winet, 2012; Colás et al., 2013). Those cases of *engagement (5g)* when creating partially-coherent storyworlds point towards the possibility of transforming the "walled garden" issue from a problem into a different way to encourage collaboration, through adequate information structures for the content and interaction mechanisms, as we explain next.

B. Content

As mentioned, the *task*-related aspects of the **context** influence on the nature of the system **content**: Small-scale stories (as *CrossTale*) tend to be centered on a small group of characters that do not demand complex information *elements (2a)* to be represented. Big storyworlds (as *SCP*) do not only need a larger amount of characters and other elements, but also a complex *information structure (2b)*. On the other hand, as discussed further in the next subsubsection, **content** and **process** are closely related, as the varying complexity and nature of contents can suit different kinds of interaction processes and vice-versa.

Structuring (2b) the story into nuclear *elements (2a)* and its relations has been shown to be a good way to synthesize and *comprehend (5f)* a complex narrative space (Tapscott et al., 2014). Comparing with other cases, *SCP* presents a detailed classification of narrative content and also different levels of canonicity, while *A Million Penguins* puts the emphasis on the development of the narrative without a clear division between elements and story content (although some individual authors made an effort to, for example, create hyperlinks to character-description pages). In our field study, this division was made clear since the beginning of the process, providing the participants with the space (an *interaction level*

(3a) containing the *informative elements (2a)* of the cards, folders, and documents) and the examples (the *seed (2c)*) to explore and include narrative elements as information pieces than could be hyperlinked to the plot content, although in a vague, non-direct way, especially when compared to *SCP*.

To sum it up, providing a system with clearly defined nuclear narrative *elements (2a)* of the story space (e.g. actors, places, or events), and the information element categories and *interaction mechanisms (3d)* (see next) to explore, create and/or relate them, makes it possible to transform the "walled gardens" problem into a new way of *collaboration (5d)*. This different model of **performance** supports the co-*creation (5b)* of the elements that populate the storyworld and their utilization by different participants in their own *plot developments (6e)*, which can present a flexible amount of *consistency (6f)* within the global **output**.

Finally, we have to take into account the nature of the *seed (2c),* the pre-existing content (if any) populating the system before the process is initiated. Our field study, like other experiences (Tapscott et al., 2016; *SCP Foundation*), reveals that the type of elements and their narrative qualities, such as the genre and tone, influence partially the *literary aspects (6c*) of the contributions that populate the narrative, since participants tend to imitate the genre resources or tropes. On the other side, a complex historical setting that demands a high previous knowledge, such as the pilot experience (Tapscott et al., 2016), may affect the *engagement (5g)* discouraging contributions. It would seem that the seeds that work better are those that provide a solid depiction of a general setting framing the story, its style and conventions, serving as a reference for the participants' contribution, but do not difficult the access to the narrative by over-populating the informative space with too intricate pre-established elements and relations.

C. Process

We pointed out that the vast majority of the experiences analyzed are remotely participated, making the *process-mediated participants distribution (3e)* and *collaboration (3h)* remote and asynchronous. But while some of them propose a totally indirect type of collaboration (with each isolated participant taking turns to add a new part to the narrative)

(Likarish and Winet, 2012; Colás et al., 2013), others, as our field study, stimulate direct collaboration through processes that allow feedback in the form of the iterative modification of contents.

Usually, the first type of processes, which work as an exquisite corpse, present the **content** as a linear *structure (2b),* but not always, as shown by *CrossTale*. What they do have in common is that they seem to suit better small-scale shared narrative spaces, concentrated around a narrative arc or a very small number of them. As we indicated earlier, this type of spaces are accompanied by some positive level of *concern about keeping the consistency (5h)* of the story developed. This is more or less easy to keep, especially in processes whose allowed *interactions (3d)* include the modification of the contributions previously introduced, since the last contributor can always become the leading voice at any point, either by adjusting his/her contribution to the existing content or by adjusting the previous content to his/her contribution.

The **performance** problems of participation, consistency, and the "walled garden" phenomenon (mentioned in the previous section) appear in the second kind of processes, which are more *collaboration (3h)* demanding, thus requiring *participant's organization (3e)*, *internal communication (3g)*, and an *interaction level (3a)* to plan the narrative development.

Most of the systems analyzed (as ours) do not *mediate team composition (3e) and communication (3g)* through the inclusion of any support for different roles or process-mediated organization mechanisms, relying only on the participants' ability to self-organize. Others do, as the systems based on wiki platforms, which support different roles including privilege-control mechanisms to track and undo changes. But the differences on the **performances** and **output** observed, for instance, in *SCP* versus *A Million Penguins*, indicate that the mere inclusion of those technological mechanisms does not guarantee collaboration in its stronger meaning.

This relates to both the previously analyzed participants' perception of the collaborative *task (1e),* and the capability of communication of the participants (*internal (3g)* or *external (1d)).* The results of our study showed a lower degree of direct, inter-team *collaboration (5d)*, but little impact of contribution-consistence issues and participant-coexistence issues. As we pointed out when examining the context aspects,

participants were not *concerned with maintaining high consistency (5h)* between contributions, but their contributions *related through the elements (6d*) of a consistent setting. Regarding the communication, our study was quite uncommon due to its high face-to-face *communication (1d)* component, when in the majority of cases the participant presence is remote and the communication is difficult, thus *process communication mechanisms (3g)* should be comparatively stronger.

One of the most relevant findings of our study is the emergence of a "planning interaction level" during the process **performance**. Other systems, e.g. *CrossTale* or *Proppulsion*, showed good results in comprehension resulting from specific interfaces or *interaction levels (3a)* displaying the "big picture" of the narrative space, i.e., the map of plots, elements and their relations, especially if they feature *visual metaphors (3b)* and *interactive devices to explore (3c)* this space. This kind of interfaces is very effective to *comprehend (5f)* the information, and also impacts positively on the output *consistency (6f)* through the *participants' collaboration (5d)* (Colás et al., 2013), since they support well the comprehension of the *element relations (6d)*. Hypertext has proved to be useful as a way to follow narrative developments as a series of relations, not without some known problems such as maintaining the causality of those links (Bernstein 2001; Pope 2006). Due the linear nature of classical storytelling, the ability of reducing complex story spaces via filtering and dividing the information into linear sub-plots (storylines) allows the participants to perform multiple character/plot-based explorations (Colás et al., 2013), and to easily understand the relations of one storyline with the rest of the narrative space (Colás et al., 2015, 2016),

In the case of the our field study, in order to understand more transparently the users' models themselves, this level was not present, thus it is remarkable that the participants used the Pitch Document as an intermediate "planning interaction level" in the three layer model: between the narrative elements and the plot. They kept updating the information on this document during the whole *creative experience (5b),* and kept using it to *explore (5a)* other contributors' stories. This "interaction level emerged through performance" is comparable to the organizational index and hub pages that participants use and develop in hypertext/wiki based interfaces, as in *SCP* or in *A Million Penguins*.

D. Control

The transversal analysis of the different experiences mentioned reveals that the **control** aspect is one of the most difficult to address when designing collaborative narrative systems.

Regarding the methods for *preserving consistency (4b)*, built-in mechanisms (as automatized restrictions) that try to enforce the consistency of the content are not well received, as they are regarded as intrusions to the creativity of the participants (Tapscott et al., 2013), impacting negatively on the *engagement (5g)*. As seen in the previous sections, given a "planning" *interaction level (3a)* and human controlled mechanisms, participants can self-organize and keep control of the plot structure and canonicity. Those mechanisms are preferred by the creators, but as we have described, the ability to *establish editorial roles (3e)* and to control the "planning context" does not guarantee *collaboration (5d)* and preservation of *consistency (6f)* per se, and this needs to be supported by adequate *information structures (2b),* and *exploration (3c)* and *communication (3g)* interaction mechanisms.

Cause-to-consequence temporal sequentiality and, to a lesser degree, the notion of physical space are key elements of the narrative genre (Chatman 1980), especially when associated to the individual positions and itineraries of such actors in such a framework, which has been the foundation of classical narratology studies (Propp 1968; Greimas 1983). Studying how to approach the organization of the story through a *time-and-space framework (4a)*, interactive *visual tools (3b)* as timelines seem too restrictive when used as highly precise informative structures. With the exceptions of informative spaces dealing with items such as precisely-dated real world events (as in Ankaji et al., 2013), narratives should put the emphasis on relative temporality (i.e. when an event occurred in relation to others): dealing with time in absolute terms (e.g. putting specific dates to all the events on the narrative) is regarded as too demanding, and often dismissed, as in our field study or in Tapscott et al. (2016). On the other hand, temporality is a powerful tool to *explore (3c)* a narrative space, as we have seen when describing useful visualization mechanisms dealing with the filtering and presentation of the informative space as sets of storylines (Colás et al., 2013, 2015). We could argue,

then, that it suits better the domain of the **process** than its use as a **control** mechanism of the content.

4.1.7.2. A proposal of a human information interaction model for collaborative storytelling systems

From the comparison of systems and their results with the framework proposed, we suggest a model for (effective) collaborative narrative systems. While the reviewed works from the literature deal with heterogeneous *ad-hoc* models (suited for the specific goals, information elements and interaction mechanisms of each of them), we propose a more general model extracted from the comparative analysis of all them, suited for informing the design of a wide range of collaborative storytelling systems.

This model, shown in Table 8, reflects three stages of the collaborative creative process of narratives: setting, planning and development. The description of each of these levels can be implemented as guidelines for the design of the system; for each level we present:

1. **The Process Actions** which should be designed at this interaction level, defined as the *process* activities it supports. Although this is a generic model, those actions are influenced by the *context* of the system, as we have seen in our comparative analysis, where different *goals and natures of the task* can alter the relevance and difficulty of those activities.
2. **The Content Informative Elements,** the type and nature of informative elements this level should use to represent and structure the *content*.
3. **The Process and Control Interaction Mechanisms**: which interaction mechanisms (in terms of interaction and interface design), and *control* mechanisms, this level should provide to the users to perform the *process* actions mentioned.

The first level corresponds to the shared narrative management. It deals with all the nuclear narrative elements (as characters, places, or other items) that compose the story background, allowing their exploration, categorization and the definition of relevant relations among them. The level should encourage the collaboration through facilitating the

participants to expand the existing shared narrative universe and to make use of elements created by other participants in their own stories.

The second layer is the planning level: making use of information visualization techniques and interaction mechanisms for filtering information and present it in understandable linear ways, this context should work as a map of plots unraveling in a flexible and sufficiently abstract time-and-space framework. This level is critical to empower creators with the ability to structure the narrative space, to define the different layers canonicity and their sub-plots, and to facilitate communication among authors. The planning context is the key to transform the "walled garden" problem (i.e. each author working in isolated and contradictory versions of the story) into a new opportunity for collaborating through sharing a common setting across multiple derivative stories.

Finally, the third level deals with the plot development. Depending on the desired nature of the narrative produced through the system, it can vary and deal with very diverse types of media and very different composing processes (writing, drawing, editing media, etc.). The design challenge posed by this interaction level in the context of the whole system is that it has to maintain the connection with the informative elements used during the composition process. In other words, it has to facilitate tracking the situation of the edited story units in the context of the narrative space in the planning level, and tracking the narrative elements taken from the shared narrative background. This would allow readers to explore the connections of the currently edited story unit (e.g. a scene) with the whole net of plots composing the informative space; and also the connections of its narrative elements with the rest of the elements of the narrative background, facilitating and increasing the opportunities of collaboration and story expansion.

LEVEL	Process Actions (Context-influenced)	Content Informative Elements	Process & Control Interaction Mechanisms
Setting	• Organization, classification and search of narrative elements. • Collaboration through elements re-appropriation.	• Nuclear narrative elements. • Definition of relations. • Categories for classification.	• Introduction and edition of nuclear narrative elements. • Categorization and interrelation of narrative elements. • Exploration and search of narrative elements.
Planning	• Visualization of the informative structure. • Participants' communication and organization.	• Story Unit Surrogates. • Plotlines. • Categories for collaboration/canonicity.	• Graphic visualization and exploration of the narrative space. • Organization and filtering of the narrative space using storylines (characters and plots), authorship, and levels of canonicity. • Communication mechanisms. • Flexible and abstract time and space framework. • Hyperlinking to the setting nuclear narrative elements.
Plot Development	• Plot content development. • Maintaining links to the upper levels.	• Story units. • Media.	• Introduction and edition of story units. • Contextualization of the story units in the organizational space. • Hyperlinking to higher categories: storylines and narrative elements.

Table 8. General HCI model for collaborative storytelling systems

4.1.8. Conclusions and Future Work

We have proposed a framework analysis for collaborative storytelling systems: the *context* in which the activity is performed (taking into account the nature of the activity itself), the definition of the *process* as a human practice mediated through interaction methods, the taxonomy and properties of the information *content*, and the mechanisms to *control* the narrative aspects; as well as the analysis of how these areas impact on the final participants' *performance* and the actual narrative *output*. This framework extends a previous conceptual backdrop (Magerko 2014) with the performance and output concepts, and incorporates precise parameters within each concept to make it a more precise evaluation tool, parameters based upon both the literature and our previous findings. As a result, it suits the comparative analysis and evaluation of a wide range of heterogeneous narrative systems.

We performed a field study on co-creation of shared narrative spaces. We used the framework to analyze and compare its results with those of other state-of-the-art experiences (including our various previous research studies). While most of the human-information interaction models proposed in the literature are suited for a specific system, our comparative analysis allowed us to formulate a general model for collaborative storytelling, suited for informing the design of a wide range of collaborative narrative systems.

This model is based on the main factors revealed by our comparative analysis: complexity of the task (and its associated information structures and interaction mechanisms) increases when the scale of the built narrative does (from building a small-scale story inside a narrative setting, to a full setting populated by multiple stories), but at the same time, building a storyworld offers lots of opportunities for massive authorial participation, a kind of collaboration which is difficult to perform with small linear stories with a limited amount of elements. Those more complex narrative structures are better addressed through a process that uses a three-layer model: a first layer for developing, organizing and maintaining the narrative background elements, putting emphasis on sharing narrative elements as a means of collaboration to develop a common storyworld. A second layer needs to present the story narrative space, using interactive methods to explore the multiple-plots structure

filtering the non-linear informative space into linear sub-developments or storylines in a flexible time-and-space framework, which can be used as well as for story planning. Although difficult, a more pleasant experience is obtained when the control mechanisms do not enforce spatial, temporal or plot-related consistency, but the users are provided with the necessary tools to communicate and control consistency and canonicity themselves. Finally, the editorial development task should be the last level of this model, underlining its relation with the upper levels of informative elements to avoid working on isolated story units.

These results, implemented as design guidelines, open a research line to develop, perform and maintain long-term collaborative narrative platforms that would allow us to experiment and evaluate this proposed model of interaction. In addition to that, there are some aspects of our analysis that we would like to explore more deeply, in order to refine the resulting interaction model and expand our design recommendations. First, we would like to address the relation between the *nature of the output* and the *goal and nature of the task*: although we evaluate *output* aspects of literary genre and interactive nature of the resulting narrative, we cannot expect these aspects to change significantly in systems specifically designed to produce a pre-defined, concrete type of output (despite varying the process and control mechanisms of the system). Also, we have analyzed works with different degrees of process-mediated team composition, distribution and communication, but we would like to deepen our understanding of how the external context conditions for these aspects affect the whole system, beyond the common case of free remote participation. Related to this, works as Luther's Pipeline (Luther et al., 2013) point at the relevance of the communication and distribution of leadership, roles and tasks in massively-participated collaborative systems, a kind of organization that is pre-determined or informally addressed in the majority of the analyzed processes. All these three concerns could be addressed by expanding our comparative study, analyzing more systems that appear as better examples of varied type of desired outputs, different contexts of use, and different self-organization mechanisms respectively.

On top of that, we would also like to refine the framework analysis, regarding some aspects observed during our study and comparative analysis: this framework has been predominantly tested on systems that

produce narratives working at *interpretative* (i.e. reading) and *functional* interactivity levels (i.e. exploring, using the terms defined by Salen and Zimmerman (2004)), but not for producing narratives that can be manipulated at *explicit* level by the final consumer (i.e. interactive narratives as games or choose-your-own-adventure hypertext fictions, as *Storytron* by Crawford, http://storytron.com). This would require a new level of complexity of the framework, since we should address two separated levels of interaction-related aspects of analysis: the interaction process of authoring, and the interaction aspects regarding the users of the produced narrative.

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5. CONCLUSIONS

This thesis dissertation has explored the field of collaborative storytelling, contributing to it from an HCI perspective. First, by changing the lens under which narrative co-creation systems are traditionally examined: going from the study of isolated, ad-hoc interfaces/tools/systems, to defining the concept of a shared narrative space, which is the basis of our subsequent contributions. In the first half of this work, we have approached the issues of multiple authoring as an opportunity for collaboration, using a character-based storyline paradigm grounded on classic narratology [12, 13] and adapting it for a multiple points-of-view approach [22, 33]. This way of structuring the information has proven satisfactory for both exploring and contributing to multi-character stories in the context of small shared narrative spaces [22, 33].

As a next step, we have proposed an analysis framework for narrative systems, grounded on both the literature [39] and the findings of our own research-through-design [25] process. It suits the comparative analysis of collaborative systems of very diverse nature in a standardized way, and covers fundamental HCI issues as the interaction design, the information design, the users and the context of usage. This framework has allowed us to gain insight of how systems can replicate a solution for the multiple authoring problematic in larger informative spaces, by shifting the consistency concern from the storylines themselves towards the elements of a common storyworld, keeping the need for intermediary interfaces for synthesizing the multiple-storylines informative structure and connecting it to the common narrative elements. Finally, thanks to this, we have laid out the bases of a general model to approach the design of a wide range of collaborative narrative systems [38].

In this chapter, we want to summarize and discuss briefly some aspects of these contributions in the context of our research questions. When examining those questions and the results of the research to address them, it is easy to see how each adds to the previous one: not only perception, exploration and contribution influence each to the next, but also it can work backwards: as shown in our first explorative work [22], analysis of the contributions can serve intuitively to understand how contributors perceived the shared narrative space. These interrelations led us to examine systems for as a complex ecosystem of interdependent HCI

factors, and finally to develop the comparative analysis framework for SNSs, whose results informed all our contributions discussed next.

5.1. Understanding Shared Narrative Spaces: Consistency and Unitarity

Users perceive and procreate the narrative space in a unitary and consistent way [22]. In smaller, more manageable systems [22, 33], consistency between all the story elements and scenes is the main conception that readers use to understand the narrative space, and also one of the main concerns when expanding the space by adding new scenes. But as the informative spaces grow, it also does its complexity [22, 44]. Larger shared narrative spaces (those intended to accommodate hundreds of contributions, and/or to approach vast narrative worlds [15] like on-line amateur-creator communities [3, 4, 43]) complexity can result in the participants having difficulties to explore and comprehend the volume of information and its internal relations. This can lead to participants coexistence problems [21] or the "walled garden" problem [20], where contributions do not bear any consistency with each other.

But, as we conclude in [38], some systems can turn this problem into a way for collaborating avoiding the need for absolute, detail-level knowledge and comprehension of the whole narrative information space: separation between the informative elements detailing the storyworld and the narrative developments allows for diverse cases of collaborative systems where authors develop different storylines or add new informative elements in the same space, regarding this space as unitary and shared, but with different levels of inter-elements consistency concern. For example distinguishing between canonical setting elements and other-authors developments (as in [38, 3]; see section 5.3) or developing more complex, multi-layered canonicity levels (see [19] presented in Annex 2). Our proposal in [33] of character storylines representing multiple points-of-view (more about it in the next section) can be seen as a first implementation of this paradigm.

It could be argued, then, that what creates the perception of a single shared narrative space is the sense of unitarity: the notion of all the different narrative developments taking place in the same storyworld [40],

(i.e, the -usually fictional- literary universe where the stories develop [45]). Readers always search for (and try to maintain) a level of consistency, since cause-to-effect temporality is a fundamental part of storytelling [23], but this consistency concern can be shifted to different levels of the information model, depending on the purpose of the system and the size and complexity of the narrative information space [38]: from storyline level (as in [33, 22]), to storyworld level (as in [44, 38, 3]). The nature of the key elements of these information structures will depend on the nature of the narrative, as we discuss in the next section.

5.2. Linearity, Exploration and Comprehension

One fundamental problem of non-linear narrative informative spaces is that, as we mentioned, temporality and cause-to-effect logic is inherent to narrative perception [23], added to the fact that, as humans subject to the physical laws of time, we experience reality linearly. In our first, explorative chapter [22] concerning the interaction with the informative space, the critical aspect revealed to be how to provide means to obtain meaningful information when exploring a complex net of causal-related scenes or story parts. Our research-through-design observations revealed how users mentally structure the informative space in terms of time (and place in a lesser degree), and navigate it following structured sequences of character and plot-related scenes. The use of the "storylines" mechanism was a first successful step towards this objective of providing meaningful "reading paths/orders". As next step, [33] shows how associating storylines with the character narrative programs [13] resulted in a quite natural way to comprehend the story, with readers characterizing them as having one protagonist accomplishing one goal. The reader-perceived "main characters" of the story were those with longer and more defined narrative programs in terms of classic semiotics.

From the results of those studies, comprehension seems to be achieved through the ability to identify key characters and scenes and to understand their relations with other storylines, rather than through an exhaustive processing of all the information in the narrative space. With those key events the reader's mind can establish connections and fill the gaps in the story. Field studies with alternative storyline-based interfaces [34] also confirmed how users jumped from one story to another by following an ordered single storyline as a backbone and exploring the crossing stories

as deviations, and how this exploration mode serves to maintain the perception of linearity and cause-to-effect.

Our proposal for structuring and exploring the informative space not only seems to avoid issues traditionally linked to hypertext fiction [17, 18], helping reading and comprehension of the narrative space, but showed that comprehension leads to contributions with a good level of consistency, in this case featuring largely the main characters [33]. It could seem that characters are always the nuclear element used to determine these main structures (storylines) in which the story is divided, explored, and procreated, as would dictate the classic narratology [12, 13], but when analyzing multiple systems it appears to be slightly more complex than that, depending on what element functions as a "character" in the storyworld considered: e.g. character factions on our last experiment in [38], or paranormal objects (called SCPs) in the SCP Foundation [43, 19]. This creates slightly different methods to explore and procreate the narrative space, focusing on these main elements at interface level (e.g. character storylines in CrossTale [22] and Proppulsion [33], groups of interest in SCP [43], fandoms in fantiction.net [3]) and sometimes, as we mentioned, allowing for different levels of consistency with the elements of the storyworld. The informative structure and interaction mechanisms destined to address these, conform what we define as the intermediate level of our three-layer model for the design of shared narrative systems, summarized next.

5.3. Participating on Shared Narrative Spaces: a first General Model for the Design of Shared Narrative Systems

In the last chapter of this work [38], the development of a framework suitable to compare analytically several ad-hoc models of a wide range of collaborative storytelling tools allowed us to study the main factors condensed in this chapter, and to propose a general information-interaction model intended for informing the design of shared narrative systems. We have already stated how the complexity of exploring, comprehending and contributing to narrative spaces increases when the scale of the system does, as it does its information structures and interaction mechanisms.

The model (described more extensively in [38]) works in three interaction layers. The top layer deals with developing, organizing and maintaining the setting elements, putting emphasis on sharing narrative elements as a means of collaboration to develop a common storyworld. As mentioned along this work, the 2.0 web paradigm and specially systems such as wikis are especially suited for this kind of information structure requirements [46]. Meanwhile, the bottom layer of our model is devoted to the editorial development task, containing the whole, detailed development of the narrative in its final media form (textual, multimedia, etc.). Thus, the top and bottom layers could work in a way analogous to the classic narratological concepts of story and discourse [23], with the in-between layer in charge of the management of their interplay.

Regarding this, our comparative analysis [38] pointed the need for providing a system not only with the abovementioned adequate nuclear informative elements of the story space (i.e. the "narrative setting" elements: its characters, events, places, etc., which belong to the domain of the first layer) which are used in the story development (third layer), but also the proper interfaces that allow to explore this space through suitable information structures that follow the multiple-developments paradigm (e.g. storylines, sub-stories, levels of canon) and make explicit the connection between those setting elements and the development. To sum it up, this second layer needs to present the structure of the story narrative space, using interactive methods to explore its multiple-plots architecture filtering the non-linear informative space into linearly consumable sub-developments, and connecting them meaningfully to the narrative setting. This paradigm makes possible the co-creation activity of the elements that populate the storyworld and their utilization by different participants in their own narrative developments with the desired level of consistency (from consistency at plot element to consistency at the narrative setting level).

Is interesting to remark that, at this level, implementing computational rules can help to raise consistency but can also undermine the user experience, being regarded as intrusions to the creativity [44]. Better perceived experiences are obtained without the enforcement of automatized control mechanisms over the content of the contributions, providing the users with the aforementioned adequate information

structures and mechanisms to explore the informative space, plan their developments, and keep control of the overall narrative structure.

5.4. Future work

We expect that our proposal of a model for designing shared narrative spaces can inform the design of a variety of prototypical and/or experimental systems and tools, acting as the basis of a line of research that implements and tests the suitability of the proposed process actions, information elements and interaction mechanisms in each of its levels, and how they have to be adapted to each specific usage context in a diverse range of use cases.

Focusing specifically on our theoretical framework of analysis, the last section of chapter 4 proposes two different lines of action in which we would like to expand and refine it, which we briefly summarise here (see [38]). On one hand, we would like to evaluate more deeply some aspects which were not fully covered by our comparative analysis: the possibly pre-defined relation between the nature of the task and the nature of the output, the role of the external mediation of the participant organisation, and how the notion of process leadership is handled. On top of that, another line of research would develop from addressing systems in which the resulting, collaboratively-produced narrative can be explicitly manipulated by an end-user profile (as is the case of video-games, visual novels, hypertext fiction and other interactive media), which would add a new level of complexity to our framework.

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ANNEX I: WRITING CONSISTENT STORIES BASED ON STRUCTURED MULTI-AUTHORED NARRATIVE SPACES

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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Keywords and phrases storytelling, collaborative, consistency, narrative space.

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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 though 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 condition their interaction with it. Fans often expand the narrative space of their favorite

Conference/workshop/symposium title on which this volume is based on.
Editors: Billy Editor, Bill Editors; pp. 1–16

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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.

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

Table 1 Multi-Authoring Narrative Supports Comparison

- 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).

4.2 Experiment I: 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.

4.3 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.

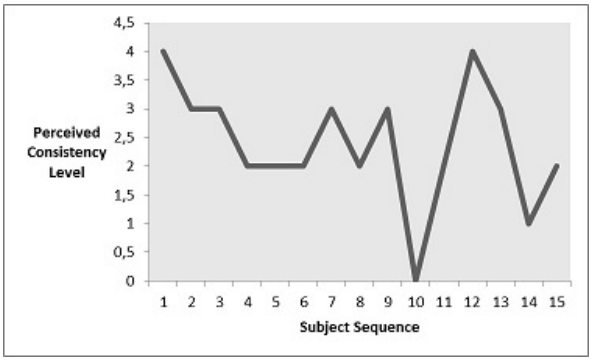

Figure 2 Story on a Wall reader-perceived consistency level

4.4 Experiment I: 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 principle 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.

4.5 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.

4.6 Experiment II: 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

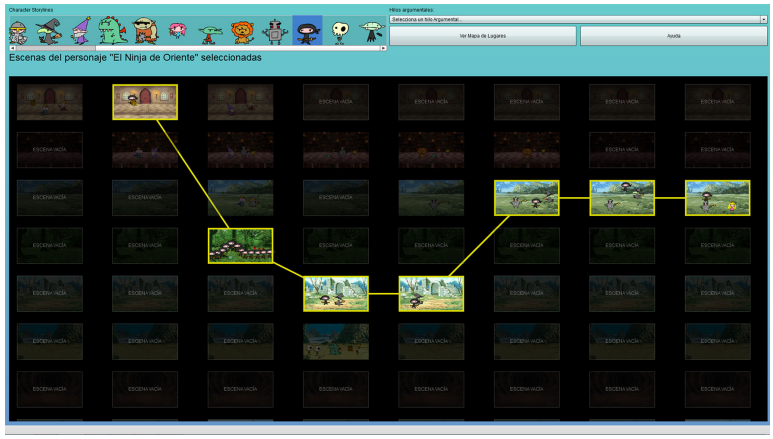

Figure 3 CrossTale Interface

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.

4.7 Experiment II: 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).

4.8 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

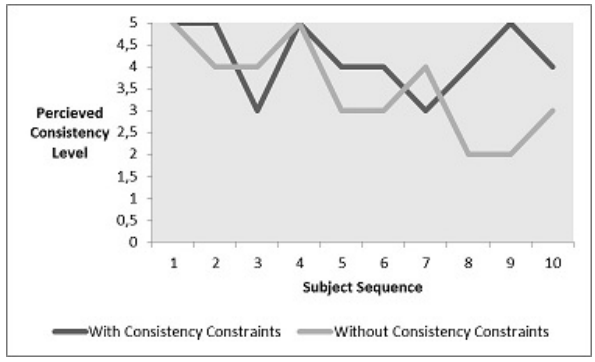

Figure 4 CrossTale reader-perceived consistency level with and without consistency constraints

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 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.

4.9 Experiment II: 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.

4.10 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.

4.11 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 it: 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.

4.12 Experiment III: 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 the semiotics and some of their 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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ANNEX II: LARGE-SCALE COLLABORATIVE STORY WORLDS: FORMALIZING CONTENT AND AUTHOR DYNAMICS

Large-Scale Collaborative Story Worlds: Formalizing Content and Author Dynamics*

Alan Tapscott[1], Joaquim Colás[1], Carlos León[2] and Josep Blat[1]

Abstract— **Shared collaborative narratives are an emerging media, in parallel with the so-called Web 2.0 and Web 3.0 and along with other forms of enriched user-generated content. Participative creative writing and the documentation of fictional story worlds represent two instances of this trend. Hybrid story world sites mix both goals into a single platform. In this article, we do an overview of some of the most successful ones, and study one of them in depth, with the specific goal of understanding their content structure and the author dynamics. Indeed, our analysis reveals the ways these sites allow large author communities to create their own stories and document the story world they contribute to in an intertwined loop of synergies between both activities. Reflecting the web general evolution, in these sites the author dynamics have changed over time, opening their editorial control progressively, delegating the plot overall control to general users and providing semantic networks to link contributions. We also show how hybrid sites resort to certain stylistic resources, such as unreliable narrators and mysterious backgrounds, which are very different from those introduced in encyclopedias. These resources imitate popular folklore and urban legends, and seek to avoid potential inconsistencies between authors while resulting into a more engaging read. We analyse more in detail a recent and successful site - the SCP Foundation (http://www.scp-wiki.net/) -. By examining the semantic tags of the pages and link distribution we conclude that most content is either an encyclopedic article, a tale, a link hub or a community discussion. We also discuss how characters roles are displaced from traditional characters to supernatural anomalies and group of interest, inclusive character factions. The SCP Foundation implements the legendary status of hybrid story worlds through a multi-level canon model that allows authors to be coherent with each other to the degree they wish to. To conclude our work we present a more formalised model (which we call Open Story World) of this type of content structure and dynamics found in hybrid story world sites. The model introduces metrics inspired by popular page relevance algorithms, meant to determine content and author plot integration and inter-author affinity through simple wiki page magnitudes. We conclude this study with a discussion of the implications of the model for author dynamics and their contributions.**

I. Introduction: Collaborative Creative Writing

Shared collaborative narratives are an emerging media, in parallel with the so-called web 2.0 and web 3.0 and along with other forms of enriched user-generated content. In this article, we aim to get a better understanding of how large author communities collaborate to write stories and document original story worlds in online sites created for that specific purpose. We use the term story world to describe the conceptual dimension of a story, containing the facts and plot elements (such as characters and locations) that constitute the emerging fictional reality established by the author(s). Yet, a story world can be created as an original entity, in a process that mixes creative writing and encyclopedic documentation. Moreso, if more than one author is using the same plot elements, the creation of the story world is a collaborative exercise. The term collaborative writing is often used to describe a project in which more than one person is involved in the joint creation of a written document. Coordinating collaborative writing generally benefits from a strategy, a methodology. From pairs of authors working closely to large crowds that communicate scarcely, there are many possible roles and configuration of participants. Amongst the participants, there is at least one who writes or formulates the actual words while other contributors might participate in the writing, conceptualization, edition and revision. The result of such collaboration might be superior or not, yet few authors feel the process is something natural or intuitive [72]. On the other hand, each genre has its own culture and style, sometimes even involving specific multi-author methodologies. Academic articles, for instance, are often signed by multiple authors, but narrative and similar forms of storytelling are rarely attributed to more than one author, despite going through extensive editorial and processes, Individual novels or tales signed by multiple authors are rare, often experimental occurrences: the creative role in narrative works is very often attributed to a single author. Fictional narrative relies on invented facts and stylistic resources, generally used more coherently through a single authorial voice. Indeed, anthologies are one of the few common collaborative narrative formats, compiling the work of multiple authors into a single publication. However, each chapter typically contains a tale by a single author, still maintaining the boundaries between authors and their creations. Tales contained in an anthology might or might not converge in plot or tone and very rarely occur in a common fictional reality with shared plot elements. Not all the instances of collaboration occur in a single document. The backbone of human culture is a collection of popular tales and folklore, that indirectly influences our perception of reality and also our every creation. In this sense, collaborative writing can be understood as a more general activity that occurs implicitly and is hardly distinguishable from cultural dynamics. Ancient mythology tales feature intertwined plot elements, often crossing characters and themes in a similar way than contemporary media and large fiction franchises.

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For instance, Greek mythology had a recurring cast of heroes and gods who behaved in a more or less consistent way, establishing a pantheon with recurring themes, characters and plots. Tales from classic Greek mythology were often anonymous but it is assumed that they were created in different moments of history by multiple authors. Roman mythology picked up the same plot elements and further developed the mythos, extending the mythos even further. Later examples include the Arthurian cycle legends, written by multiple authors from the 12th to the 15th century and the Cthulhu mythos, by H.P. Lovecraft and his circle of correspondents during the early 20th century. Despite the existence of collaborative writing in our culture, most studies on this subject are relatively recent and scarce. [35] uncover some of the earlier works, such as an early essay covering teams of husband and wife writing children books. A more recent and general work [47] compares ancient mythology to modern fan fiction. In a influential work on small group research [43], the author acknowledges the complexities inherent to a successful integration of results in the context of a collaborative study effort. He also insists on the lack of research concerning this problem, although scientific publications have been the subject of the majority of the studies on collaborative writing. Typically more concerned with the product than the process, these studies deal with specific aspects of the collaboration such as effects of author name ordering [80], [61], a comparison of different types of textual measurements commonly used in attribution studies [41] and analyses of the causes and effects of collaborative research and publication [64], [63], [57]. The subject of collaborative writing has also been explored in the learning field, with relevant publications such as the ones that compose the cooperative learning body of research [45], [68], [62]. More recently, there have been many studies that also explore collaborative writing from the perspective of learning, particularly studies involving students producing a jointly written text [72], student perception of wiki use for collaboration and writing [55], [78], or the usage of wikis as collaborative writing tools for students [42]. The wiki is used in most of these studies, however some works resort to other platforms, such as blogs [75] or Google Docs [73], [48].

Collaborative writing has also been used for the authors own amusement. Some recreational examples of multi-authoring stories include the surrealist tradition of the exquisite corpse in which authors take turns to extend an existing story. [26] provides a thorough analysis of the exquisite corpse as a technique and strategy. Despite its experimental nature, [49] provide a unique academic and artistic view on the exquisite corpse. Another example of a similar technique is the round-robin story, in which every author takes turns to write a chapter of the same story. This technique is not as popular as the exquisite corpse and is often used as a tool to teach how to read instead as a writing technique [36]. In these examples, the original author delegates the creative authority to other participating authors, and the driving motivation is not to produce valuable stories, but to amuse the authors. In this sense, multi-authoring can sometimes be meant for authors instead of readers. This does not imply that experimental, participative methodologies for collaborative writing cannot produce valuable stories. The internet and information technologies seem to follow a similar path, relying more on user participation and content creation. Collaborative writing -for education, creative writing and as a leisure activity- has developed over the last years as a large-scale activity. Most studies involve relatively small groups compared to the large-scale real communities engaging in this kind of activities, often involving hundreds or thousands of users reading and writing. Generally, these large-scale studies of collaborative writing are focused on Wikipedia, ignoring other collaborative exercises that deal with fictional knowledge such as derivative online encyclopedias (e.g. Wikia [6] or Wikidot [23]) or creative writing communities (e.g. FanFiction [7] or Protagonize [11]). Amongst the works that study these platforms, most explore fandom and fan culture [37], [65] or their literacy and language learning potential [29], [50]. Wikias have been featured in some works that explore their large-scale nature, such as studies of impact of membership overlap on the survival of online communities [79] or recurring subgraphs in co-author networks [28]. We found no literature focused on the collaborative construction of fictional realities or story worlds. The focus of this work are essentially unprecedented exercises of large-scale collaborative writing and the implicit story world building.

As we mentioned previously, there are many potential methodologies to write collaboratively and document types to produce. The latest developments in information technologies have made collaboration more accessible and viable for large amounts of remote users. This work seeks to study how authors collaborate in writing fiction together in the context of revolutionary information technologies, and more specifically, to understand how they coordinate and build fictional worlds together. Our main concerns are to determine collaboration dynamics, and which types of contributions are generated related to that collaboration. First, we do a brief overview of sites with either an active large-scale participating community or a singular approach to this scenario. We cover two distinct kinds of collaborative sites: those which promote creative writing, and those which document story worlds developed in popular media, followed by an analysis of the hybrid sites, which appeared later and mix both goals; indeed they are collaborative sites that promote creative writing and the documentation of the emerging original story world in parallel. Our analysis is focused on content types (its function and relationships) and author dynamics (collaboration nature and traits). Some of these sites have been less successful than others, and we analyze in detail the SCP Foundation which is hybrid and one of most successful ones, using more exhaustive web crawling to get more precise qualitative and quantitative results. From a more abstract view of these, we propose a model that helps in describing and analyzing original collaborative fictional story worlds, the Open Story World. Our proposed model includes formulas that inform of content and author plot integration

along with inter-author affinity.

II. Collaborative Stories and Story Worlds in the Web

This section presents an overview of different types of online sites for collaborative writing, starting with participative creative writing sites and collaborative fictional world encyclopedias. Then we focus more in detail on the hybrid collaborative narrative and story world sites, discussing the main ones, in terms of content types and author dynamics.

A. Participative Creative Writing Sites

The Internet and the rise of information technologies have brought about public and accessible information platforms, including some that encourage users to participate by contributing with fictional writings of their own. The cost of exchanging information and collaborating has decreased dramatically, allowing large crowds to contribute and share their creations. In this context, there has been a wide array of emerging opportunities for users to become authors of all sorts of fictional stories and share them with each other. Indeed, there have been many sites that promote collaborative fictional writing, implementing a wide array of rules and methodologies. We discuss some of the popular or singular ones along with the content they host(ed), readers capabilities and author dynamics.

WikiStory [] was one of the pioneering initiatives that allowed authors to collaborate online. It provided users with a wiki in which they could write their own stories. Contributions were public and any user could participate in the attached discussion section. Any author could opt to participate in the multi-authoring segment of the site, allowing any other user to edit or comment the story. The sites own guidelines suggested edits could be either story extensions or editorial revisions, but had no sort of editorial control besides the basic profanity restrictions to allow readers of all ages. Optionally, authors could protect their stories to avoid other authors modifications. Readers could also comment stories as long as they registered into the site. StoryMash [15] is another creative writing community meant for authors and readers. Authors can create new fiction stories or introduce a new chapter into an existing one. The focus on chapters is perhaps one of the most unique traits of this site. Chapter additions can go anywhere in the narrative sequence (preludes and interludes are allowed and encouraged). The web shares part of the advertisement revenues with the authors and holds writing contests with monetary prizes, enhancing the allure for amateurs and professionals. The sites community has a reputation - perhaps due to some professional authors charging readers - of being quite critic with the authors, however there are no restrictions for uploading contributions. Readers can rate stories and provide in-depth feedback, as well as purchasing the non amateur stories. Fabulate [5] was another similar site and community with a different premise. Authors submitted individual pages to extend an ongoing book. The sites guidelines were loose: pages had to contain up to 500 words and follow the previous page and make sense in the context of the book. Readers could also become reviewers by applying for the role. Reviewing readers could rate individual pages and post reviews for recent contributions. The staff then decided if a page was approved or rejected according to the reviews and scores. Addventures seem to be a recurring format for internet collaborative fiction writing. According to Wikipedia, an addventure is: ... a type of online interactive fiction that combines aspects of round-robin stories and Choose Your Own Adventure-style tales. Like a round-robin story, an addventure is a form of collaborative fiction in which many authors contribute to a story, each writing discrete segments. However, like a gamebook, the resulting narrative is non-linear, allowing authors to branch out in different directions after each segment of the story. The result is a continually growing work of hypertext fiction. One Million Monkeys Typing [] was a site dedicated to collaborative addventures. Authors could submit their story snippets for users to read, either by starting a new story or branching an existing one by allowing readers to alter the direction of the plot to follow their contribution, in a what-if? scenario of sorts. Readers could explore any story, interacting with the plot whenever a question was asked by choosing the direction of the events. Readers

Protagonize [] was another successful collaborative writing community that used the addventure format. The community originated in a site meant for addventures called Choose your own Schizophrenia, which evolved into Protagonize, a platform that supports all kinds of creative writing. One of the most salient features was the capability of the original author to establish the author guidance section. The author guidance section contained notes on the plot outline, setting, characters, narrative mode, intended length, and inspiration amongst other relevant aspects. This did not enforce subsequent authors to comply with it, but it did empower the original author with explicit informal authority over the content. Neither the original author, collaborating authors or readers could exercise editorial control of any sorts over the contributions. As usual, users could comment stories, rate them or even recommend them to other readers.

Overall, most sites present a decentralized informal editorial process, in which readers rate their favorite stories and explicitly comment them. The only users with real control over what is published are the staff, and generally only intervene to prevent profanity and unpleasant behavior. Authors and readers are free to contribute and criticize with little constraints. Another common trait observed was that most contributions were individual, rarely involving collaborations with other authors. Crossovers with shared plot themes or elements were rare, i.e., despite users were collaborating via reader rating and feedback, a collaborative story world is generally not established.

B. Fandom and Fictional Story Worlds

The irruption of the fandom phenomenon has brought new perspectives on creative writing and the documentation and creation of fictional story worlds. Fans use the internet and

digital encyclopedias -generally derivative wiki sites such as wikia [6] or wikidot [23]- to document their favorite media. As of May 2016, there are 30643 active wikia sites run by dedicated communities. The result is an explicit formulation of an existing story world, most often curated by users unrelated to its original authors. Some works have studied these fan-related phenomena, Narractivity [30], Documentary Simulacra [32] and wikis and participatory fandom [58]. The contents of these wiki sites describe the causal and temporal connection between actions to document story worlds, as in the concept of narrative space [59]. Collaboration on wiki platforms has also been the subject of many studies, as [54] perspectives on its value as a collaboration platform, [51] interpretation of the revision history as a collaboration network, [53] analysis of collaboration patterns and article quality, or [74] social dynamics. [40] analyzed the Lost TV series and their fan activity on the net, discussing the encyclopedic and creative dynamics while focusing on the spoilers revealing crucial information to the audience during the chapters original run. The authors elaborate on the communitys struggle to establish some sort of order to the chaotic contributions from fans. Overall, wikis have been often presented as a good example of collaboration, even to the point of being considered good democracy [54]. The collaborative documentation of a story world by a large-scale community has been made possible for the first time thanks to the tool itself -the wiki site-, and therefore users might not conceive performing it with a different one. The original purpose of a wiki site was not to document fictional knowledge from multiple authors -with its potential gaps in consistency and coherence- , i.e., its design might have room for improvement and other hypothetical tools might be suitable for the task. There are alternatives to wiki sites for large-scale collaborative documentation of story worlds. Traditional written encyclopedic documents have been used for this purpose as internal documents -such as a franchise bible- and merchandise -such as a sourcebook-.[1] and [2] are both commercial collaborative tools meant for structural creative video game story world development. Their design is partially focused on the specifics of the video game medium. These kind of tools are often created by the same company responsible for the final narrative content, meaning that their design might be less generalist and more ad hoc, seeking to a specific medium and a specific set of problems. Other similar commercial tools include editors designed to design non-linear branching narratives and interactions [20], [3] or more general purpose semantic diagrams [25] and digital information maps [21]. The general purpose of these tools allows designers to craft interactive stories, but they are not meant to document or extend story worlds and mostly avoid the collaborative dimension we are exploring in this paper. A skilled writer with the capability to abstract data might be able to document a story world with them, but they are neither accessible nor scalable for this specific use case. Fans, however, do more than document existing story worlds. Using participative creative writing sites, similar to the ones we have seen in the previous section, they also extend popular media with their own contributions. By intertwining their own stories with a well-established story world and its mythology, networks of original fan fiction coexist with the official material are created. Online information technologies provide momentum to these phenomena, exponentially augmenting their size, reach and impact. For instance, [7] or [12], gather hundreds of thousands of users around hundreds of franchises, presenting fan-developed stories that extend the story world of popular media. Most of these stories, however, do not take into account the contributions of their fellow fan authors and represent a one-off extension of the original story world, limiting their potential to enrich the original material or even to span new fictional parallel realities or story worlds. The fanfiction phenomenon has been extensively studied over the recent years. [76] provides a brief overview of the nature of online fanfiction communities, studying their general literacy practices within forums, chatting, role-playing and the discussions strands of the community. [38] discusses the main characteristics of fandom from the perspective of economics, highlighting how this phenomenon establishes an alternative culture that goes against the official one. This perspective reinforces that story worlds are used to collectively creating an alternative reality. The line between factual, hypothetical, speculative and original content was not a very clear one, especially when documenting fictional media that often resorted to mystery or intrigue tropes. Again, fan contributions are struggling to become more than a reflection of the original media. [69] presents a model that brackets the opposing potentialities of internet influence on offline society using large scale participatory fandom to center her discourse. She discusses fan clubs, online producer-consumer affiliations and real-world legal controversies in the context of fans attempting to participate in the media they revere.

C. Hybrid Collaborative Narratives and Story Worlds Sites

1) Hybrid sites and similar initiatives: The communities discussed in A and B, where creative writing and documentation of fictional story worlds were separated, inspired the creation of hybrid sites merging both at some point. This idea had some precedents, such as multiplayer games in which players build the world themselves (e.g. Multi User Dungeons -MUDs- or Second Life communities). It also seems somewhat similar to the novel scriptural world suggested by [32] in its analysis of the Harry Potter Wikia site. The crossroad they describe between fictional regime and documental regime seems to apply in these original collaborative story worlds. In creative writing, the overwhelming success of wiki-like platforms for collaborative tasks encouraged communities to develop their story worlds and fiction jointly in a common wiki site. The result is a collaborative site with a repository of tales that take place in a shared story world and also an encyclopedic collection of articles that describe the very same story world defined by the tales. The hyperlinking capabilities of the web allow inter-page links that readers and authors use to navigate in an integrated experience. From the authors perspective, this represents an opportunity to contribute in fundamentally different ways.

S/he can write a new story and upload it to the site, or alternatively, an encyclopedic entry, describing an element that fits the theme of the site but not elaborating much into its role or history. This also means that authors can write stories that feature the existing encyclopedic elements or also write encyclopedic entries for the elements introduced by existing stories. In creative writing, these use cases are innovative and made possible thanks to the hybrid nature of these sites. The wiki also provides the default mechanisms for author and reader interaction, including discussion, versioning, reviewing and rating. The hybrid sites we discuss next include large author communities and substantial content both narrative and encyclopedic. There are several reasons for an extended discussion of these sites: they combine both writing and documentation, and they have been successful in involving large communities and generating extensive content. One of the sites (The SCP Foundation) seems especially successful in terms of the number of authors/readers and the content created and/or documented. Thus, we undertake its detailed analysis in the next section. We discuss first several of them, which have been successful as well, but to a lesser degree, to provide a background for this analysis and avoid it to be too unilateral.

2) Overview of the sites: The following tables reflect a descriptive overview with some measures of participation and content of the different sites (as of May 2016).

The Holders Series [16] contains a collaborative collection of supernatural Holders. Every Holder is an entity (physical or metaphorical) and its entry describes a methodology to acquire it. The steps often involve creepy or unsettling actions written with an urban legend vibe. The site also has a section for creative fiction that involves the Holders mentioned in the collection. Galaxiki [8] is presented to readers as a fictional map of the galaxy, allowing to read and author the description of specific solar systems, planets or stars. The site also has a section for stories of any sort that take place in the galaxy. Its business model encourages users to purchase existing solar systems with real money, whose content can be only modified by the buyer. The Orions Arm Universe Project [17] describes itself as a hard science fiction collective world building effort. It contains the Encyclopaedia Galactica, a large collection of articles that describe with detail the fictional universe. Users may submit new science fiction articles that either rely on real science publications or are grounded on a plausible chain of events in the future. The site promotes many forms of art, such as renders, music or writings, and often hosts contests and publishes magazines and anthologies to disseminate the art produced. Some of these publications are not free. The SCP Foundation [14] is a fictional organization to secure, contain and protect humanity from all sorts of supernatural anomalies (the SCPs themselves). Each SCP entry, created by a participating user, follows a structured template and uses scientific terms to describe the supernatural object or occurrence. Pictures and complimentary reports are commonly included in each SCP. There is also an extensive collection of fiction linked to the documented SCPs and the Foundation. The Wanderers Library [18] is a spin-off site originated from the SCP Foundation based on the same fictional material, which holds all sorts of fantastic manuscripts instead of documenting supernatural occurrences. As its sister site, it also contains stories that involve the documented manuscripts. These two sites exist in the same shared story world, with some elements (such as certain groups of interest) featuring in both. The sites summarized were created between 2000 or after 2010, and we could not find similar sites that started before or later. While their golden age might have passed, these sites that are still active and receive new contributions. Only the oldest sites (The Holders Series and The Orions Arm Universe) use their own engines, while the most recent ones implement an existing collaborative engine. Their functionality is very similar to regular Wikis, allowing users to create their own pages.

3) Content analysis: There are two main trends regarding plot and tone of the contents, sci-fi and urban legends/paranormal phenomena. Both are multi-author friendly. Sci-fi and space exploration are very favorable for authors who wish to carve their own region and story without conflicting with others. Urban legends borrow from oral tradition and ancient storytelling dealing with fictional facts that could occur in our daily lives. As stated by Tolkien [77], fantasy that does not diverge much from reality is friendlier to most readers. Furthermore, urban legends rarely cross or reference each other, granting more freedom to authors to contribute without taking the other existing contributions into consideration to prevent contradictions or incoherences. In general, these sites seek to portrait themselves as extensions of our own reality, although through very different means. The usage of these purposely vague background might reduce the need for all stories of a common story world to be coherent with each other. A shared story world with stories that tie to each other perfectly might be at odds with having many authors with strong creative visions free to contribute in the way they see fit. One of the most distinguishing traits of legends is their implicit unreliability. Even if the narrator does not make it explicit, the audience acknowledges that they might or might not have happened [33]. This legendary trait is used to avoid the problem of coherence in large-scale collaborative story worlds. While it is far from a new perspective, it is innovative when applied to a digital encyclopedia. It is debatable if it merely represents a way to avoid the problem (incoherences are still present and might hamper the readers experience) but nevertheless it is a functional and successful solution. Also, the usage of in-universe strategic omissions and unreliable narrators reinforce this strategy, suppressing the need for precise information and rigor with stylistic resources that even increase the engagement of the text. Despite being hosted in wikis (essentially web 3.0 software [39]), these sites go beyond regular electronic collaborative encyclopedias usually used to document knowledge or fictional knowledge, providing a framework for the organic growth of fictional cultures or mythologies in a process that is reminiscent of our own

cultural development.

Semantic tags only make an appearance in the SCP Foundation and the Wanderers Library. These mechanism, often seen in modern sites, allow content to link each other following specific subjects or themes. Besides allowing to clearly distinguish the encyclopedic from the narrative content, these non-exclusive tags allow users to navigate through specific author content, similar SCPs, or even content related to specific groups of interested or canons. Authors can not create new tags, however, if they follow the guidelines, they might introduce new groups of interest or canons, effectively altering the topology in ways the other sites cant replicate. We go more in depth to explain this aspect of the Foundation later. Overall, we see a trend here to imitate the semantic web 3.0 by adding other metadata to the user contributions. Our analysis of encyclopedic content revealed that the majority of the sites have a section that focuses on one type of encyclopedic element . While there might be other element types featured, most of the content is of the same kind. Only the Orions Arm doesnt feature a standardized encyclopedic content, meaning that the site encyclopedia is of general purpose. The Holders Series encyclopedia is about Holders, Galaxiki focused on galaxies, the SCP Foundation is meant to collect SCP reports and the Wanderers Library is a manuscript library. This central element is based on a standard template with some required fields to be filled as the author sees fit and is useful to provide some order and writing guidelines while enhancing consistency and coherence. This implies that the encyclopedic segment of the sites might not be an actual encyclopedia (with entries describing relevant objects, characters locations), despite using an encyclopedic platform and format. The serialized nature seems to favor author participation, providing a basic guideline for new encyclopedic entries. The Orions Arm encyclopedic section is the only that follows a classical encyclopedia formula. Regarding narrative content, there seems to be more encyclopedic content than tales (with the exception of Galaxiki, although our analysis couldn't cover all solar systems, so this might not be conclusive). Overall, the encyclopedic original purpose of a Wiki site seems to drive authors to contribute with non-narrative information. There is, however, a strong link between tales and encyclopedic content. Our informal observations suggest most tales feature some element from the encyclopedic content, but many encyclopedic pages are not featured in any tale. Most references are explicit hyperlinks, however implicit references without a hyperlink are not unheard of (for instance, SCPs from the SCP Foundation often refer to each other by codename rather than hyperlink). Only the SCP Foundation and the Wanderers Library offer authors the capability to connect content through custom hub pages. Generally, hub pages provide a list of links to content with a common author or canon while providing additional context (in-universe information and/or from the real authors viewpoint). Ultimately, custom hubs allow authors to go beyond mere contributions to provide new ways for readers to navigate the site and the story world. These semantic interpretations of the content are in line with modern creations closer to the web 3.0 paradigm.

4) Editorial control, feedback mechanisms, interaction: In terms of editorial control, all of the sites have some sort of guidelines on the kind of content expected from contributors, which are used to determine which contributions are accepted. Galaxiki is by far the less strict when it comes to content, allowing anyone to post new content and only enforcing minimal standards (a profanity filter not related with the science fiction theme). Only the Holders Series has a non-participative editorial process in which the site staff has the last word on whether a new contribution should be erased, while the rest of the sites have a public process in which all users can participate. The Orions Arm Universe requires new submissions to be posted in the message board to allow other users to post their reviews, although the staff finally decides. The sites writing guidelines remark the need for any submission to be backed by the laws of science, citing rigorous publications if needed. This is a deliberate attempt to keep the Orions Arm Universe in the genre of hard science fiction instead of fantasy or space opera. The SCP Foundation and the Wanderers Library require new contributions to be publicly posted on the board, but the ultimate decision is (democratically) determined by users scores. There is a trend to move content authority and responsibility from the site staff to the participating users. Only the Orions Arm Universe lacks feedback mechanisms allowing readers to rate and comment specific pages, but drafts must appear on the message board for other users to criticize. The more modern sites allow users to say their opinion, assuming that this usually means more user activity and involvement and perhaps more user attachment to the contributions. Indeed, Galaxiki system was rewritten in 2010 to include feedback. The message boards to support interaction are always present. More evolved systems are those of Galaxiki, that introduce a public blog that allows users to upload their own news and chats provided by the SCP Foundation and the Wanderers Library, which support as well running recurrent contests to promote new submissions (the Orions Arm Universe, too). More community interaction options are thus available in more recent sites. Formal support for collaborative authoring of individual pages is only supported by the more modern sites, the SCP Foundation and the Wanderers Library. These sites include a tag for these contributions, clearly highlighting their different nature. They also provide access to the whole page history through a version control system to keep track of changes so that multi-authoring is more stable and secure.

5) Activity: Table III presents quantitative data on the sites as of May 2017, based on semrush.com and similarweb.com

The activity data weve gathered suggest the SCP Foundation has the most user activity in terms of visits, average visit duration, average pages visited per user and links received from other sites. The previous analysis suggested that the SCP Foundation and the Wanderers Library were the most open and participative sites, yet the latest seems to be underperforming compared to her sister site. Also, the Orions Arm Universe displays a high activity despite not implementing many of the mechanics found in modern

participative communities.

6) Summary and discussion: While we have no data from our own sources to corroborate that the presented activity measurements are reliable, we suspect the snowball effect -found in many online communities- and other factors unrelated to the interaction design and author dynamics might be very influential in the sites overall success. Perhaps the SCP Foundation relation to the extremely popular internet board 4chan (the backlink measurements could reinforce this hypothesis), as well as the potential splintering of the community when the Wanderers Library was created could explain some of these results. The analysed hybrid sites were created over the last decade, perhaps highlighting a trend from that specific time period. Unlike some of the creative writing sites we saw in the previous overview, they still exist and remain active. Our analysis of these hybrid sites has showed how they have evolved over time to progressively allow users to actively participate in the editorial process and its discussion (following the web 2.0 trend in storytelling [27]) and to add structure, semantic navigation and other meta-data (following the web 3.0 to introduce semantic web content, specifically contextually relevant and easily interpretable content [70]). We anticipate a tendency for this sites to imitate or integrate with popular social content platforms such as Thumblr [19] or reddit [13] in the immediate future. It remains to be seen if other popular, participative activities or platforms could be integrated to introduce other innovations beneficial to the creation of a collaborative story world. For instance using social network friend circles to explicitly associate author circles or blending the concept of news aggregation or trending topic with narratives arcs.

Overall, These sites represent examples of how author communities can create original story worlds collaboratively while being successful, overcoming all possible difficulties. Their hybrid nature might be reflecting our own culture deeply grounded in documented knowledge and myths. A microculture of sorts that reflects our own. Weve also seen how in terms of author dynamics, generally speaking, openness and participation in terms of editorial process, contribution and data structuring, seems to be the predominant trend. Perhaps with a closer look into one of these sites we might learn more about the content contributions in terms of function and relation to each other.

In the next section we conduct a more thorough analysis of one of them (the SCP Foundation).

III. The SCP Foundation

From the figures of Table III, the SCP Foundation attracts more visits, which are also longer than other sites; also as seen in section the previous section, it holds more content, both encyclopedic and tales. It seems worth studying it in more detail, in terms of content and author dynamics and their relations. The quantitative and qualitative measures of the site content through crawl analysis leads to a better picture of how the large-scale collaboration and hybrid nature of the site influence its content. While some of the analysis shows traits similar to other sites, there are differential (novel) aspects specific of the collaborative creative writing (and reading): we discuss the specific function that story canons and groups of interest have with respect to creativity and consistency; and how hub pages guide the readership. These aspects probably explain the popularity of the site, which conceals its structural complexity behind attractive and simple mechanisms to appeal new and veteran users alike. We discuss as well the apparent contradiction of the small role played by characters.

A. Overview of the site

The SCP Foundation is a wiki with a large community dedicated to creating and curating reports and stories that take place inside a common fictional story world. Authors contribute, discuss, peer review, rank and edit pages, in a public and participatory process. The staff try to keep a minimum order in the message board and the profanity level low while enforcing the basic rules. The SCP Foundation sites own description provides a detailed history of its inception. The site started after some users from the paranormal board of the 4chan community [24] began posting reports of fictional paranormal anomalies in a standardized way, including pseudo-scientific descriptions along with creepy and eerie (sometimes manipulated) real pictures. These reports were named Special Containment Procedures (SCPs). The community eventually moved to its own site. We lack clear evidence to establish if they ever considered a non-wiki platform. The site added a new background section that developed the idea of a government-backed organization devoted to the scientific study of paranormal objects and entities, the SCP Foundation. SCP stands for secure, contain and protect, the mission statement of a fictional shady organization dedicated to the location, study and containment of paranormal anomalies. Over time and thanks to ongoing contributions, the content of the SCP Foundation slowly grew involving loosely related set of fictional mythos that included multiple relevant organizations and recurring anomalies. The community eventually began to push the boundaries to not only create new SCP reports, but also to write tales involving the anomalies. Instead of setting up another site for the tales, they were included in the same wiki site, using the hyperlinking capabilities to knit the content together following references and allusions.

B. Content analysis

The SCP Foundation site is a complex intertwined network of information with distinct purposes inside a common fictional story world, supporting more kinds of contributions than a typical wiki site. Its reference material is self-contained, meaning that instead of documenting external knowledge or media, the source material is the encyclopedia itself. In this section we explain the main content segments along with their purpose.

1) Content function: The SCP Foundation writers guide establishes this general classification for the sites content:

- SCP Series
- Tales

- Canons
- Groups of interest

The SCP Series reports document the anomalies that represent the focus of the SCP Foundation story world. SCP reports are always labeled with a serialized common denominator (SCP-xxxx) and follow a standard template. The SCP report (or just SCP) itself must be written using objective language, mimicking a scientific publication or research notes. The standard template includes the object classification (based on how dangerous it is), the necessary containment procedures and a general description. Additional media is often included, generally in the form of a picture of the anomaly but sometimes including audio or even video. The description is intentionally vague, providing intriguing aspects of the object without revealing their fundamental nature, origin or logic. Such omissions include avoiding the subject, citing poor experimental conditions or black tape found covering critical information. Authors also often include secondary articles such as interviews with people who have interacted with the anomaly, complementary reports on incidents involving the anomaly or detailed notes on fictional experiments.

Tales are stories that involve the SCP Series in some capacity. These pages contain fiction that uses classic narrative tropes more akin to the kind of content found in a novel or a short story anthology. Some contributions are more eclectic, including songs and poems, but most belong to the narrative genre. The Foundation tales feature and reference SCPs from the SCP Series or other Foundation Tales, enhancing the reader's immersion in the global story world and encouraging its exploration of other content. Most tales are contributions that reference (directly or indirectly) SCP reports, although a subset of them can be considered extensions of the narrative content. These extensions, instead of being a free narration with some connection to the Foundation anomalies, complement specific SCP reports with experiments, explorations, incidents, interviews or general supplements.

Canons are content subsets of the SCP story world created by author groups to reinforce the consistency and coherence of their content. The SCP Foundation allows contradictions and incoherences, mainly through canons. The sites guidelines explicitly states this:

"The idea that there is no canon is a bit silly at times. It's not that we don't have any. It's that we have a multitude which touch, cross, and dip into each other. It's up to you, as the reader, to decide what you believe and what you embrace as the heart of the universe. That doesn't mean, though, that authors lack intent or design, and collaboration is the heart of innovation."

Contributions introduced into a SCP canon present a reinforced sense of consistency dealing with recurring plot elements (mostly SCP anomalies) and an enhanced coherence. Internal canon contradictions are possible but rare -they defeat the purpose of canons-. While most SCPs and tales rarely reference each other (directly or indirectly), canons often feature closely related narratives, with overarching plots involving common anomalies, characters and locations. Canons might include a wide array of contribution types, including SCP reports, tales and other miscellaneous ones, for instance a hub page (or more) meant to explain their premise, content along with reading aids such as timelines or relevant characters lists. Also, canons often feature contributions from multiple authors.

Groups of Interest or GoIs, are another content subset featuring fictional character groups or factions relevant to the SCP Foundation itself. They are similar to Canons in the sense that they often feature multiple authors and include multiple types of content like SCP reports, tales and hub pages. The main difference with a canon is that instead of attempting to create a smaller reality with reinforced coherence and consistence, GoIs tie content together with a common plot element -the group of interest itself-. Canons and GoIs work in distinct dimensions, meaning that Canons might feature one or more GoIs and vice versa.

2) Content tags: Weve used the SCP Foundation page tags to identify these content groups. At the time of this analysis, the SCP Foundation site has 2915 pages tagged as SCP reports, 1972 tagged as tales, 327 tagged as belonging to a specific canon and 898 as belonging to a specific GoI. Some canons (7 out of the existing 23) do not tag their pages, and therefore our count is not completely reliable regarding the amount of pages in canon subsets. Despite the fact that tags are not exclusive by definition, there is no overlap between SCP reports and tales, but there might be between the rest of categories. We can establish the basic distribution seen in Fig 2.

Table IV enumerates the most common tags for pages that are not tagged as SCP reports or Tales.

Supplements and experiments are pages meant to complement the regular SCP series, therefore they fulfill a similar role. Author, hub and goi-format are pages meant to serve as structural hubs or index of sorts, connecting pages and presenting reading guidance to users. For instance, goi2014 is a tag for one of the recurring writing contests run by the community, according to our data the most popular one. The workbench is meant for drafts to be rated and evaluated by the community.

The previous data suggests that some contributions serve a distinct function in the context of a collaborative fictional story world. Some of the content (tagged as SCP series, experiments or supplements) documents the story world, functioning as encyclopedic content. Next, some of the content (tagged as tales) tells a story functioning as narrative content. Also, some of the content (tagged as hub, author or goi-format) attempts to provide order and guide the reader, functioning as a hub index. Part of the site, the community comment and discussion pages, provide community interaction but were not parsed and counted. This is because votes and user comments are attached to pages that are already serving another purpose, making the parsing and comparison troublesome. From all the previous observations, we summarize the following classification:

- Encyclopedic content: Content meant to document the story world with fictional information. (includes either

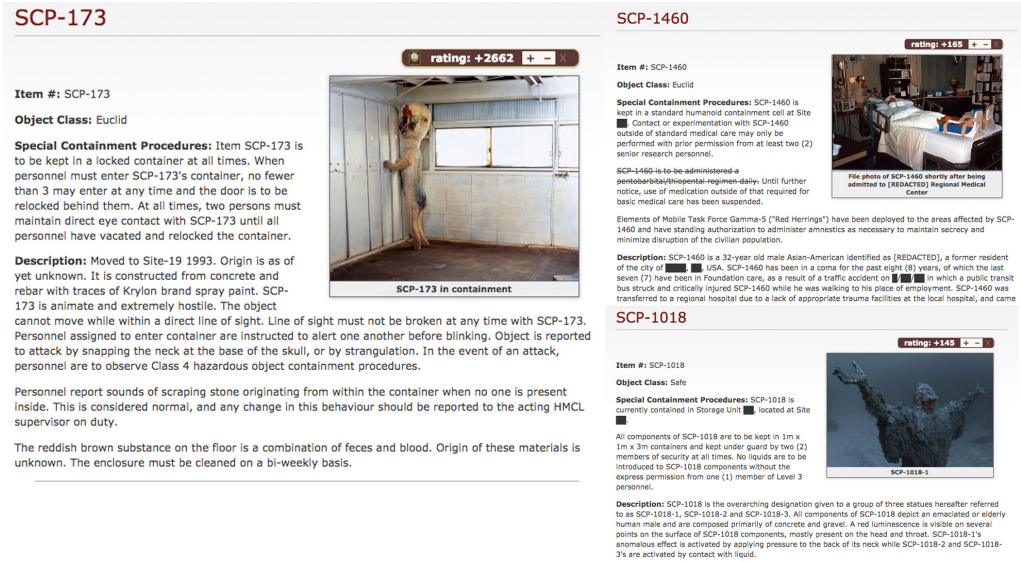

Fig. 1. Sample SCP Series reports.

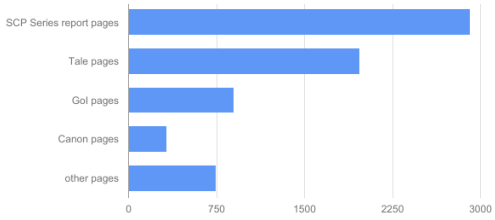

Fig. 2. SCP Foundation content tag distribution

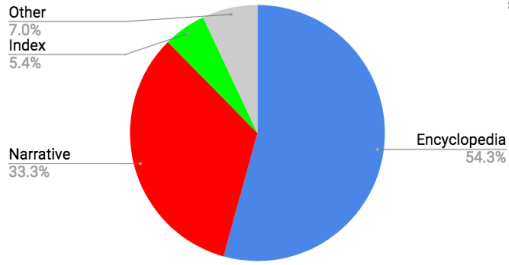

Fig. 3. SCP Foundation content by function.

tag SCP, supplement and experiment).

- Narrative content: Stories that take place inside the fictional story world (includes tale tag).
- index hub content: Navigation guidance for the story world content (includes hub tag).
- Community: Content meant for the discussion and criticism of the story world.
- Other content: Content that doesnt fit in any of the previous categories.

Fig 3 presents a graph for the SCP Foundation content according to its function (community feedback and discussion content is not included).

Table V shows the tag distribution amongst the overall and main designated content sets by function. The encyclopedic and narrative content represents the majority of the site contributions.

Content links: Weve used web parsing and the previous content by function designation to analyse the SCP Foundations content link distribution. First we analysed the site contributions, following our previous functional categorization, to determine what content had the most incoming or outgoing links. The analysis was constrained to source and target pages from inside the SCP Foundation. Encyclopedic content receives the most links by a wide margin and index content has the most outgoing links, also by a wide margin. We also counted mentions to specific SCP series as additional outgoing links. This explains the high count detected in the index pages, often dedicated to explaining the role of the mentioned anomalies.

In order to determine how each segment is connected to the other ones we then break down the outgoing links.

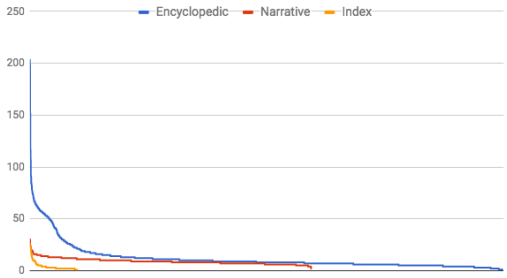

Fig. 4. SCP Foundation page incoming links

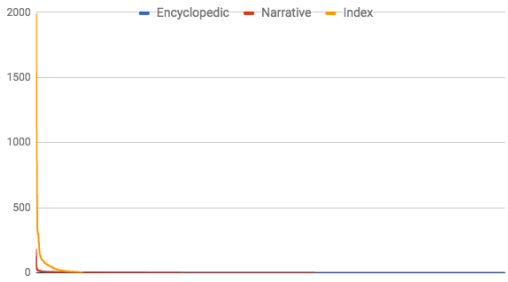

Fig. 5. SCP Foundation page outgoing links

According to our results, links from the index to the encyclopedic content are the most common ones, followed by links from index to narrative and index content respectively.

3) Content canon: Story canons are an important part of any large fiction franchise, transmedia or multimodal narrative. They determine the level of reliability or how official are the different story contributions to a common story world. The main authors contributions are generally considered canonic, and subsequent contributions to the story world will be coherent with them. Fan contributions are generally not official, and therefore, the main authors of the story world will ignore them. The SCP Foundation introduces a canon model that works on multiple levels and is both loose and strict simultaneously. All contributions

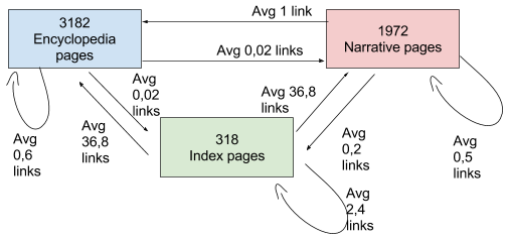

Fig. 6. SCP Foundation incoming and outgoing link averages

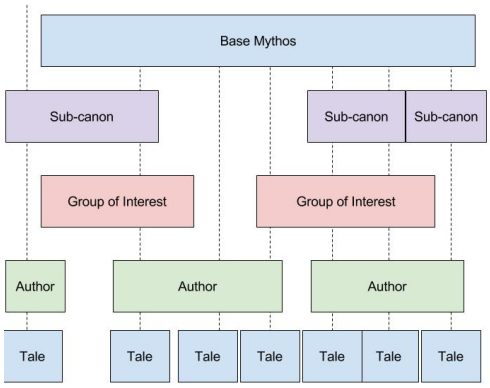

Fig. 7. SCP Foundation canon model

belong to the top general level of the SCP Foundation background canon, acknowledging its existence and basic tenets. However, contributions might be interconnected with other contributions by the through the common author, group of interest or subcanon tags. This model might not be very intuitive for readers but allows authors to participate with a flexible measure of consistency and coherence with the rest of the story world. The purpose of having multiple levels of canonicity is to allow a flexible unintrusive collaboration model for authors.

- SCP Background: a shady organization meant to secure, contain and protect us from paranormal anomalies (any contribution).
- Sub-canon: story world subset involving a specific theme or concept (content with the *canon* tag).
- Group of interest: fictional organizations with an specific interest in the SCP Foundation or its documented anomalies (content with the *goi* tag).
- Author: contributions from a common author (content by a common author.

All levels have a certain overlap, meaning a tale might belong simultaneously to the SCP background canon level, and an authors level, a specific interest groups level and an explicit sub-canon level. An author might contribute with a single contribution following the SCP background and ignoring or even contradict every group of interest and canon. Any contribution will belong to the base canon level and an authors level, yet its relationship with specific sub-canons and GoIs is flexible.

C. Activity

Our analysis revealed that the SCP Foundation has a relatively high amount of active contributors. Specifically 22 (Apr-May 2016), 31 (Mar-Apr 2016), 29 (Feb-Mar 2016), and 14 (Gen-Feb 2016). We consider a contributor active if she has contributed more than 4 times over the last month. For the top 1000 wikia sites ranked by article amount, the

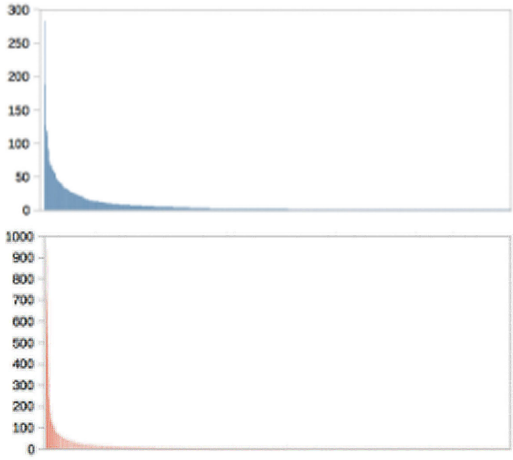

Fig. 8. Created and contributed pages per SCP author

average amount of active contributors (following our same criteria) is 5,7 [9]. Logged user activity data (seen in Table VII and Table VI) also revealed that most of the content is created by a minority. Authors create an average of 2,17 pages with a standard deviation of 10,47 and a variance of 109,76. Regarding contributions authors contribute to an average of 12,83 pages with a standard deviation of 89,62 and a variance of 8032,72. The most prolific author created 283 pages, and the most active editor contributed to 1972 pages.

Our measures of the SCP Foundation author activity also revealed some interesting correlations that highlight the importance of social activity, such a mid-high correlation between page rating and discussion amount (0.7), a low-mid correlation between page discussion post amount and contributor amount (0.4) and a medium correlation between revision amount and contributor amount (0.6). Additional mid-high correlations include that pages that link more SCP reports have more ongoing revisions (0.5 correlation coefficient) and that pages that mention more SCP reports in their text without hyperlinking them also receive more revisions (0.7 correlation coefficient).

D. Summary and discussion

The main implication we derive from the results is that the sites content is divided among exclusive encyclopedic, narrative, hub and community segments. The results agree with our function analysis; hub pages have the most outgoing links (they provide content guidance) and encyclopedic content has the most incoming links (it is used as reference material by other contributions). Groups of interest are public, inclusive character factions for authors to populate with their own original characters, establishing links between assorted content by distinct authors that features such factions. We observe how they successfully replace the role of characters in a story world encyclopedia and provide a collaboration opportunity that avoids the problem of author territoriality. Story canons are a singular feature that allows authors to establish their own content segment to collaborate with other authors with a reinforced consistency and coherence. This phenomenon produces a multi-level canonicity model that allows for a wide range of author contributions, including those who wish to ignore most of the existing content and those who attempt to remain coherent with a large amount of contributions.

The site emerged organically from the interaction of users on a paranormal message board. Apparently the urban legend theme (typically introducing an unsettling story set in a familiar context) might have been appropriate for the transition into an integrated story world due to the simple and familiar context and premise. The fictional SCP anomalies supposedly happen in our contemporary reality, not a distant, original invented world. Also, the usage of serialized standard templates (the SCP reports) seems to have promoted a certain consistency in terms of creative direction and reader expectations. In every SCP Series report, the authors present an original, intriguing and engaging read instead of simply presenting knowledge from an existing source to raise the interest of potential readers. This kind of content blurs the line between story and encyclopedia as it tries to document interesting and mysterious fictional knowledge in a structured, technical way.

The results helped us in understanding better the sites overall topology and link distribution, and reinforcing our content categorization according to its function. Since index pages have the most outgoing links and SCP Series reports have the most incoming links.

1) Multi-level canonicity: The term canon was used beyond its biblical origins (sacred texts accepted as genuine) to distinguish Sir Arthur Conan Doyles original Sherlock Holmes stories from pastiches created by other authors. According to [34], a canon is ...a selection of texts that represent the supposed essence or highest quality examples of their forms or phenomenon. Typically, in modern transmedia narratives, a history is considered to be canonic if the original author acknowledges its existence in his creations -often because it was also written by him-. This is often seen for instance in tv shows. Every season, its plot direction firmly controlled by the main writer and showrunner, drives the narrative forward, by often, there are other releases that expand the story in different directions. These secondary narratives, often written by other authors for other media, might be canonic (for instance a prequel to the main story) and will impact the next episode or season from the tv show. Alternatively, the production might be non-canonic (a sidestory) and will be ignored by future releases. Typically, these tales have vague connections to the main narrative, allowing the main author to ignore them without explicitly labeling as canonic or non-canonic. In a scenario where many authors use elements from a shared story world, with no clear author hierarchy, canonicity determines the level of accordance between all the interweaving stories. A strict

canon model encourages all authors to produce coherent and consistent stories with each other, while a loose or nonexistent canon model overlooks plot incoherencies by allowing authors to contradict each other. According to Butler et al the true power of wikis lies in the fact that they are a platform that provides affordances which allow for a wide variety of rich, multifaceted organizational structures [31].

The SCP Foundation canon model makes collaboration an explicit multi-dimensional activity that makes possible for multiple authors to build a story world together, being consistent and coherent only up to the degree they prefer to without alienating much the readers. This model allows great flexibility when contributing to the SCP Foundation, it requires very little knowledge for newcomers but can establish sub-story worlds with complex inter-relationships of stories and narratives elements. The more layers the story belongs to, the more consistency constraints the author will find. Another strength of this model is that theres room for incoherences and contradictions. From the readers perspective, this model provides a mean to navigate the SCP Foundation content by specific themes, groups and continuities. The tags found at the bottom of the page inform of what canon layers the page belongs to. The SCP Foundations canon model seems to be an instance of a complex multifaceted structure that takes advantage of the wiki software.

Sub-canons and groups of interest reduce the time investment required to participate in an ongoing story world such as the SCP Foundation, providing freedom for creative authors while remaining consistent to some degree. In essence, the SCP Foundation delegates to the authors the responsibility or the power to enforce or ignore plot continuity through their interaction of the multiple canon model layers. While we might not go as far as to herald a new web paradigm, we believe this is certainly revolutionary for collaborative creative works. Participatory fandom often deals with the need for a canon model due to the implicit need to distinguish original story elements from the ones they create. For instance, the Lostpedia (the Lost TV series encyclopedia) at one point considered introducing a model based on the catholic one, featuring canonical, noncanonical, deuterocanonical, apocrypha and ex cathdr contributions [58]. The Lostpedia ultimately established a model that featured canon (original authors of the show), fanon (facts established by fans based on their inventions), theory (facts product of pure speculation) and parody. Canons are not necessarily expected by all users, the need for canons in literature has been questioned [67]. Canons have also been defined as slippery things [66] or as a moment of the life of a story within a community [71] Ultimately, the Foundations canon can not implement a model based on a religious one (it lacks a deity or prophet with authority to establish facts) or based on fandom (it lacks original authors and fans).

It also seems to reflect the conclusions from [58], in the authors own words "I want to conclude by highlighting the potential of the wiki architecture to overcome and blur boundaries and hierarchies between fiction and truth, canon and fanon." In our opinion, the multi-layer canon model along blurs lines between realities and hierarchies, proposing an innovative perspective on fictional story world building that introduces middle ground for consistency and coherence, maintaining the fundamental illusion of one single reality in the story world to its users while allowing many partial ones.

2) Where are the characters?: As shown in Table V the SCP Foundation site has an extensive list of non-hierarchical tags for pages, however there is no tag for designating characters. Characters are a fundamental part of any story. Despite the presence of characters in tales, they are not fully featured with their own tag in the fictional encyclopedic content of the SCP Foundation. We found surprising that a site with hundreds of tales featuring characters does not use its encyclopedic capabilities to explicitly document such characters. This is especially rare when compared to existing fictional wiki sites such as wiki of Ice and Fire [22] (a fan-created encyclopedia from George RR Martins book series) where out of the more than 7000 articles half of them are character profiles or the One Piece Wikia [10] (documenting the japanese cartoons and their Story World) where out of the 4450 articles more than 1100 are character profiles. Many anomalies reported on the SCP Series have human traits. *humanoid*, *sentient*, *alive* and *sapient* are some of the most common tags used in the SCP reports. The fantastic nature of the reported anomalies blur the line between object and character, meaning SCPs can in fact play a character role in tales or SCP reports. Despite this being explicitly discouraged in the sites writing guidelines, the extensive use of human properties in the SCP description might point towards the natural tendency of humans to focus narratives around human characters. Tales that feature SCPs with humanoid qualities often see those SCPs playing character roles with agency and an impact on the story. This is a bit misleading, mainly because the tags would be assumed to refer to humanoid characters by a casual reader, and instead they refer to alien, strange anomalies or entities. Given that the site emerged from SCP reports contributed into a paranormal message board, it is reasonable that most of the tags revolve around them. We would like to analyse more original shared story worlds in depth to see if this focus on one kind of element is a recurring tendency, or if it only represents an anomaly product of our reduced sampling.

Group of interest have a large role in the SCP Foundation and their tags (e.g. *goi2014*, *dr-wondertainment*, *marshall-carter-and-dark*) are used very frequently in the tale segment. Groups of interest can also perform with agency and fulfill the role of characters, driving the story forwards while interacting with each other. Another interesting trait of these character groups, is that their control is not relegated to any author or group of authors. The actions of the group are constituted by the actions of its members, and generally, the creators of each character determine their actions. We believe the structural focus on groups of interest instead of characters is an intentional attempt to make a more approachable and inclusive story world for potential new contributors. The switch from individual protagonist to pro-

tagonist character groups should also help in switching the protagonism from one author to many. Despite the absence of character encyclopedic content pages, we believe this has reinforced the collaborative authoring dynamics of the site. Author territoriality is a problem in a collaborative writing scenario as seen in an analysis of wiki collaboration for a fictional story world [44]. The same work discusses how characters are amongst the pages that gather more author collaboration and discussion. By replacing characters with inclusive organizations, the story world becomes more accessible and less territorial. This might help authors in creating stories in the story world that feel significant by making their original characters relevant, avoiding the need to use existing characters other authors might feel more attached to or protective about. The general implication for story worlds is that participative plot element groups are good to promote inter-author collaboration, bypassing their creative differences and democratizing the story control.

3) Author activity: Author activity data suggests a similar pattern to the 90% rule or 90-1-9 principle that states only 1% of the visitors to a website create content, 9% sporadically participate in the related discussions and 90% just observe. This is also related to the participation inequality coined by Nielsen [60]. Most content is created and maintained by a minority of contributors, who already are a minority amongst the visitors. This phenomenon is in line with [52] that explicitly claims that "Wikipedia articles are often maintained by a dominant few". Encyclopedic content (the SCP report pages) represents the majoritary content segment of the site. Index hub pages have a higher amount of contributors and revisions per page, they are less discussed, tagged or rated than the encyclopedic content pages. Index hub pages have a very high editing activity mainly due to the need to update them every time new content is introduced. Despite being a site meant to provide engaging fiction authors are more active in the fictional encyclopedic part of the site than the rest of it. This might be related to the users preconception of what a wiki site is used for. Another way to interpret this phenomenon is that creating SCPs is a similar exercise to other collage or pastiche creative activities that can be performed in social fan art sites such as DeviantArt [4] or FanFiction [7]. The main similarities are that theres a part of reference material (the original intellectual property or inspiring media) a part of social interaction (usually in the shape of a social network) and some creative process involved. It is a common practice in fan sites for authors to introduce their own ideas (such as a new character description or drawing) that other users might use or link in their own contributions. These popular fan collaborations have some similarities to the writing paradigm found in the SCP Foundation; an authors original ideas might directly or indirectly influence other authors subsequent creations. The main difference is that theres no external intellectual properties explicitly referenced in the SCP Foundation; authors and readers are their own fans. Once again we suspect this creative process is something new that hints towards new authoring dynamics and has emerged thanks to the latest information technologies.

According to our measurements (Fig 4, Fig 5 and Fig 6 showing page connectivity), the SCP reports found on the fictional encyclopedic segment are consistently cited by tale pages and other SCPs. Traditionally wikis have always been used for citation and referencing, but given the creative nature of the SCPs, referencing might be considered as an innovative instance of co-authoring. An author often cites her own SCPs when creating new tale or SCP pages, however that it is not always the case, some of the references are made by distinct authors. SCP Report pages are use used as reference material, receiving more links than pages from other segments. Our data also reveals that pages that link more SCP reports have more ongoing revisions (0.5 correlation coefficient). Pages that mention more SCP reports in their text without hyperlinking them also receive more revisions 0.7 correlation coefficient). This seems to follow a similar pattern than the one described by [46], that reinterpreted Wikipedia as a social network, claiming that social dynamics (including the page connectivity) are more important than direct collaborative aspects (such as the amount of contributors or page ranking, two magnitudes that weve failed to correlate to any relevant measures). This phenomenon also somewhat implies a collaboration trend in which authors link material rather than co-author it, collaborating indirectly. The tendency to cite a small set of old, well-established encyclopedic elements is reminiscent of how some disciplines structure knowledge (for instance biblical scholars favoring antiquity or author over other concerns such as internal consistency or coherence). Other works have highlighted how most participation seems to be focused on a few authors in wikis [51] and online communities [60]. Despite being an original fictional world, authors prefer referencing old encyclopedic content than newer or more narrative content. This is somewhat reminiscent of the principle of seniority, in which the oldest surviving knowledge is granted the most reliability. We found interesting that despite the modern nature of wiki platforms, with their hyperlinking capabilities, social affordances and semantic data, the Foundation presents such tendency.

Due to the distinct nature of the message board, the threads were not included in our quantitative analysis. The Message board or forum is generally used for discussions relevant to the site, its content and policies. The discussion of specific content and its rating is done in the comments sections of each contribution. This includes the democratic editorial process of each contribution. Any subsequent attempt to perform an in-depth analysis of a site should include this data to elucidate the editorial process and dynamics.

IV. A model proposal: The Open Story World

In this section we try to integrate into a model all the previous insight derived from observing hybrid story world sites. We propose a model that integrates the observed content types and author dynamics, the Open Story World. The OSW seeks to formalize large-scale collaborative sites meant for building story worlds while describing how these

explicit collaborative story worlds are structured. We use our previous observations as foundation for the OSW stipulation. It aims to provide a certain measure of general plot integration to its content and participants, based of the recurrent use of specific elements and user activity. We base our measure of plot integration in the hypothesis that author activity, and content function and connectivity imply plot integration, their influence in the overall plot direction of the story world. It also introduces inclusive collaboration dimensions, an indirect collaboration pattern specifically designed for large-scale collaborative story worlds that structures information around specific themes. Last, we discuss the resulting flexible hierarchical canon content distribution, the canon pyramid.

A. *Contributions by function*

Contributions to the OSW should fall into one of the following categories:

- Encyclopedic contributions
- Narrative contributions
- Index contributions
- Community contributions

These content segment follow the same guidelines than the ones we used in the SCP Foundation content analysis. Authors contribute with content that falls into one of the categories. These categories establish a synergetic loop that describes the collaborative creative process. Creating new content for the fictional story world, narrating tales, structuring content or interacting with fellow authors. New fictional encyclopedic content produces tales, and new tales produce new encyclopedic content. Index hubs provide structure to both collections and keep the site accessible to readers. Community contributions helps authors in staying close to the story worlds continuity, reinforcing consistency and coherence. The encyclopedic content should generally document the same sort of relevant arbitrary object (such as locations, weapons, reports or manuscripts), easy to use and reference. The standardized nature of the template provides an intuitive entry point for new authors. Also, having some sort of template guidelines helps in focusing the discussion of whether the content is appropriate or not for the OSW, facilitating agreement between authors. Despite being primarily informative, encyclopedic content is also an implicit form of fiction itself, since it describes fictional items. It might also resort to tropes such as unreliable narrators, intentional omissions and episodic arc structures to engage the reader without abandoning the illusion of rigor. Information gaps and omissions in the encyclopedic content provides opportunities for tales and more encyclopedic content. The main difference with traditional, non-fictional encyclopedic content is that it describes imaginary elements in a not very rigorous manner. Centering the encyclopedic content on characters is not forbidden, but is not recommended. Instead, the objects of the documentation could be capable of acting with a certain agency, with the capability to drive the narrative forward. Content that falls into the tales category includes any form story or narrative that exists in the same fictional reality that the rest of the OSW. Generally, it will involve contributions from the encyclopedic content segment. The featured plot elements serve as linchpins for collaborations to emerge, and also as entry points for readers, not familiar with the story or the author but interested in the elements shared with the OSW. Index hubs serve as a mechanism that links tales and fictional encyclopedic content amongst each other, providing entry points and contextual information to potential readers and assisting with the non-linear structure of the site. They help authors in organizing the content of the OSW and provide a congruent mechanic for readers to explore it. Typical examples of index hubs include chronologies of tales, author pages, tag pages or thematic pages. The authoring of a index hub is a unique opportunity to frame a subset of the OSW in a specific way, providing a specific configuration to readers to influence their exploration for a specific purpose. The nonlinear nature of the OSW contributions provides a great deal of flexibility to the content of index hubs. Community content exists with for the purpose of user interaction. The editorial process requires some sort of mechanic for communication. Also, to promote author participation, community content also introduces participation opportunities such as thematic cycles and contests. Community content also must resort to the best information technologies to blend into the content itself, providing appropriate context to keep the discussion focused.

B. *Contribution and author plot integration*

With many authors contributing in diverging directions, the main question still stands: What contributions are the most integrated into the story world plot, influencing its consistency and coherence rules? Based on our previous observations we aim to determine what contributions are the ones that drive the overall themes, plot decisions and aesthetics of the OSW.

The following formula provides a measure of the plot integration:

Individual OSW contribution plot integration = outgoing links + incoming links * 2 + discussion amount * discussion participant amount + number of edits * number of editors + reader score.

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C. Collaboration dimensions

Collaboration dimensions represent a public, participative subsegment of the OSW with a common plot element that links all of its contributions together with an enhanced consistency and coherence. OSW Contributions might not belong to a single story or plotline, they coexist in a shared fictional reality that is weaved by the juxtaposition of all of them. As in the real world, readers expect certain coherence and consistency to suspend disbelief. As [29] states, this rich depiction of a fictional reality allows readers ”to experiment with hypothetical changes in his imagination. So he can imagine what would have happened had circumstances been

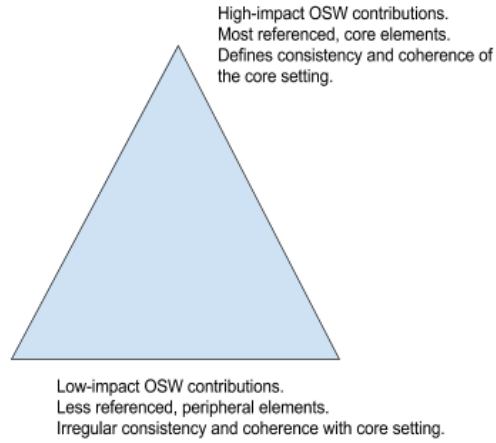

Fig. 9. OSW canon pyramid

different in the storyworld. In our previous observations, this coexistence in a collaboration dimension is made explicit through a semantic tag. This explicit tags not only inform of the link between contributions, but also provide navigation mechanisms between them, often through an intermediate hub page. The dimension can represent many things, including in-universe factors, such as a common organization, location or timeframe or other community motivations such as author circles with common interests. An implicit advantage of using public collaboration dimensions is that they promote author collaboration, direct and indirect. Structuring the information in the site is paramount to achieving good results, as [46] points out , giving visibility to pages is fundamental to achieve a good collaborative dynamic and results. Following the same measurements we used before, we might determine the plot integration of a collaboration dimension by summing the integration of its contributions.

OSW collaboration dimension plot integration = sum(dimension contribution integration)

A discrete measure of author collaboration can also be obtained through a similar formula that takes into account direct and indirect collaboration.

OSW author1 affinity (author2) = sum (co-edited contributions * 10) + sum(co-commented contributions) + sum(collaboration dimension coincidences)

D. Canon pyramid

Contributions from the OSW can be categorized into a hierarchy according their plot integration. If the content distribution is to follow the data analysed in the SCP Foundation, in which most contributions are rarely referenced and a few subset receive many explicit mentions, the result should be exponentially distributed in a pyramid of sorts.

In the high level, contributions receive the most references, comments and edits and constitute the core backbone of the

OSWs background. These contributions state the main rules to achieve coherent and consistent contributions with the overall background. Also, readers might base their expectations around these contributions. On the other hand, low level contributions receive the less scores, edits, comments and references. While still being technically part of the OSWs background, they have little influence on authors and their contributions or in readers and their general perception. This does not mean their consistency or coherence with the core OSW mythos is necessarily low, but they are more likely to deviate from the overall fictional reality established by the site. This same analysis could be used to determine the general influence on the OSW of specific author circles or collaboration dimensions.

V. Discussion

The internet has been used consistently by online communities to engage in innovative creative activities. Weve seen how some communities have mixed well established site types to create a new type meant to built original fictional story worlds and write stories that place in that same story world. The result is a hybrid site with a unique scope and goal. In these sites, the amount of participants with an active role in the original fictional story world (who either write, edit, comment or vote) is unprecedented in the history of creative collaborative writing. Despite the inherent complexities associated to building a story world with so many authors, with coexisting authorial visions and conflicting narratives, the usage of a participative wiki-like site seems to make this possible. Making sense of such large collection can be very challenging, just like in the case of any "big data" scenario [56]. This is applicable for authors and readers, and even for we the researchers. The formal structuring of a collaborative site, moreso a wiki site, is a great opportunity for the study of user information interaction, with many implications for multiple fields such as social activity, knowledge and culture. Our contribution has been focused on fictional story worlds and their consistency and coherence, yet there are many potential directions for other studies and their potential generalisations at large for our society.

We observed a tendency in encyclopedic contributions of the SCP Foundation to omit critical information, contradicting the purpose of a traditional encyclopedia trading informational completeness for engaging reads. In terms of consistency and coherence, this ad hoc strategy might have solved one of the main challenges for establishing a collaborative story world, yet as previously stated, this strategy might not work for a hard science fiction section like the Orions Arm Universe. Our preliminary observations of the Orions Arm Universe suggested that real science was used to establish the main rules, while contributions had to take into account previous entries, exponentially increasing the contribution cost for new, uninformed authors. While this approach might work, we lack the empirical data to check if it is realistically scalable. Overall, the idea that an information space requires vagueness and contradictions frontally conflicts with the general belief that optimal information systems are complete and logically stable. This characteristic trait of the SCP Foundation might be an obstacle in formalizing its contents coherence and consistency in a potential model. The OSW avoids this problematic by simply basing its measurements in content referencing, content connectivity and author activity. Therefore, the OSW provides a measure of plot integration based on magnitudes we hypothesize to be conceptually related to consistency and coherence.

The classification and organization introduced by the OSW model is a first step towards in formalizing collaborative story worlds and their consistency and coherence. Our study was limited by the nature of the medium (a wiki site) and our resources, therefore lacking reader data that could help us in ensuring the integration measure reflects not only author or contributor criteria, but also reader. These measurable magnitudes allow us to apply formulas (based on the previous categorization of contents) to determine each contribution and each authors overall plot integration in the story world contained in the OSW. The resulting distribution for contribution plot integration was exponential, pointing towards a very reduced and influential core contribution set. This result is reminiscent most of our current online information spaces and also other traditional and modern story worlds, such as a specific seriess wikia or the ancient mythology from a specific culture.

VI. Conclusions

The evolution of participative creative writing sites and story world collaborative documentation has produced an innovative hybrid site. The SCP Foundation structure reflects the essential nature of a hybrid encyclopedic and narrative site while extending this stipulation with additional index and community content segments. The SCP Foundation introduces participative collaboration dimensions (groups of interest and sub-canons), meant for a guided exploration of its contents and flexible consistency and coherence to promote author participation. The resulting canon model is implemented with page tags. Characters, typically central in a story world, have delegated its protagonism to the central entity of the SCP Foundation (SCP anomalies) and participative collaboration dimensions (groups of interest). We introduced a model that structures collaborative story worlds, introducing content functions and dynamic collaboration dimensions along with a flexible canon model. The model also provides a measure of consistency and coherence through its formulas for contribution, author and collaboration dimension plot integration. A formula for inter-author affinity is also provided.

VII. Future Work

The SCP Foundation has been analyzed in depth. The obvious direction to generalize our claims is to perform a similarly rich analysis of other hybrid sites, such as The Holders Series[16], Galaxiki[8], The Wanderers Library[18] and the Orions Arm Universe[17]. Our proposed model for an Open Story World could greatly benefit from the results. The sites studied in this work are relatively modern,

but we suspect collaboration has taken new forms over the last years. Newer communities such as thumblr [19], reddit [13] or similar social media might represent the latest incarnation of collaborative story worlds. Subsequent efforts in this direction should take into serious consideration newer online trends and compare the content and dynamics with the ones we have analyzed. The study is lacking important data; detailed visitor metrics. Although our analysis was centered on the authoring dynamics, the visitor amounts and frequency could enrich our perspectives and improve many of our findings. Obtaining such data might necessarily involve the community of the observed site, but could justify the effort with improved results. We still suspect there are group dynamics to be revealed, specifically the existence of active author circles and hierarchies. Despite our readings failing to support our theory, A clustering process using inter-author affinity might help in isolating these hypothetical collectives and their activity.

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TABLE I

HYBRID SITE DESCRIPTIVE STATISTICS I

	Creation year	Theme	Wiki engine	Editorial control	Reader feedback	Community interaction
The Holder's Series	2007	Urban legends, cursed artifacts	Custom built	Automatic acceptance, site staff approval	Rating system	Message board
Galaxiki	2007	Sci-fi universe	CorneliOS	Automatic acceptance, profanity check	Comment and rating systems	Message board, blog
The Orion's Arm Universe	2000	Sci-fi universe	Custom built	Public election, science and logic focus	None	Message board, contests
The SCP Foundation	2008	Reports on paranormal anomalies	WikiDot	Public election, minimum rating	Comment and rating systems	Message board, contests, chat
The Wanderer's Library	2010	Collection of supernatural documents	WikiDot	Public election, minimum rating	Comment and rating systems	Message board, contests, chat

TABLE II

HYBRID SITE DESCRIPTIVE STATISTICS II

	Version control system	Multi-user contributions	Encyclopedic content	Specialized encyclopedic content	Narrative content	Dynamic hubs	Semantic tags
The Holder's Series	No	Not supported	660 holders	Yes	∼200 stories	No	No
Galaxiki	No	Not supported	47 solar systems	Yes	∼77 stories	No	No
The Orion's Arm Universe	No	Not supported	∼1000 assorted articles	No	Commercial books and magazines	No	No
The SCP Foundation	Yes	Supported	2900 anomalies reported	Yes	1927 tales	Yes	Yes
The Wanderer's Library	Yes	Supported	307 collected documents	Yes	24 archive tales	Yes	Yes

TABLE III

HYBRID SITE ACTIVITY

	The Holder's Series	Galaxiki	The Orion's Arm Universe	The SCP Foundation	The Wanderer's Library
Monthly visits	29300	18200	38500	2800000	18900
Avg visit duration	6:46	0:06	6:10	11:25	0:28
Avg pages per visit	7.17	1.16	5.65	11.34	1.5
Backlinks	801	550	1000	1100000	3200

TABLE IV

MISC PAGE TAG INCIDENCE

Tag Name	Page Amount	Overall Percentage of Others
supplement	266	25%
author	229	21,60%
hub	87	8,20%
experiment	68	6,40%
goi-format	62	5,80%
goi2014	51	4,80%
workbench	38	3,10%

TABLE V

SCP OVERALL, ENCYCLOPEDIC AND TALE TAG INCIDENCE

	Overall			Encyclopedic			Narrative	
Tag	%	Amount	Tag	%	Amount	Tag	%	Amount
scp	49%	2900	scp	100%	2900	tale	100%	1972
tale	33,30%	1972	euclid	45%	1159	nyc2013	4%	79
euclid	22%	1323	safe	40%	738	hub	4%	78
safe	20%	1159	humanoid	26%	704	goi2014	3,70%	73
humanoid	12%	738	sentient	24%	581	marshall-carter-and-dark	3,20%	63
sentient	12%	704	alive	20%	566	featured	3,10%	62
alive	1%	581	sapient	20%	503	broken-god	2,70%	53
sapient	1%	566	mind-affecting	17%	355	collaboration	2,60%	52
mind-affecting	0,90%	503	keter	12%	297	dr-wondertainment	2,60%	52
keter	0,60%	355	cognitionhazard	10%	290	global-occult-coalition	2,50%	50

TABLE VI

AVERAGE SCP AUTHOR ACTIVITY

	Overall Pages	Encyclopedia	Narrative	Index
Avg Page Contributing Author Amount	5,75	6,7	4,64	17,4
Avg Page Revision Amount	18,54	16,62	12,1	85,83
Avg Page Discussion Amount	31,8	41,45	18,7	18,35
Avg Page Tag Amount	4,38	777	1,9	1,26
Avg Page Rating	84,34	109,05	50,2	29,89

TABLE VII

SCP PAGE AUTHOR AMOUNTS AND AVERAGES

	Overall Pages	Encyclopedia	Narrative	Index
Page Amount	5975	3182	1972	318
Participating Author Amount	2670	2100	963	766
Avg Created per Author	2,17	1,16	0,71	0,14
Avg Contributed per Author	12,83	7,26	3,43	1,12