# Storytelling in Collaborative Augmented Reality Environments

Norbert Braun
Interactive Graphics Systems
Department of Computer Science
Technische Universität Darmstadt
Fraunhoferstraße 5
64283 Darmstadt, Germany
Norbert.Braun@zgdv.de

## ABSTRACT

We describe the several possibilities of using storytelling in an Augmented Reality Environment to support the collaborative experience of the users in those environments. We start with the motivation of a lack of storytelling and experience in Collaborative Virtual Environments. As an implication of the need for such experiences, we give a general definition of Interactive Storytelling and offer some insights on the difference between Interactive Stories and Games. We introduce our approach to Interactive Storytelling as a combination of Audience Participatory Theatre and a morphological approach to storytelling in Augmented Reality Environments. An overview of the technical development of the approach is followed by a project description, using the stated approach to verify the useful application of the approach in regard to collaborative user experiences.

## Keywords

Augmented Reality, Interactive Storytelling and Narration, Collaborative Virtual Environments, Rich User Experiences

## 1. INTRODUCTION

Augmented Reality (AR) Environments, as well as Augmented Reality applications, seem to be the next big wave in the Computer Graphics applications market. Just as Virtual Reality (VR) applications in the years before, there seems to be a great deal of hype about the possibility of ubiquitous computing in the way that virtual reality and physical space merge together to form a common information space, offering all the advances of virtuality and physicality together in one environment. But one problem with Virtual Reality spaces seems to remain the same in Augmented Reality spaces - no one (except the online game users) likes to use them - neither collaborative work in Augmented Reality places nor collaborative enjoyment (except game play) are common to users all over the world. The main problem of wide-spread usage of Augmented Reality systems is certainly found in the limited availability of Augmented Reality Equipment - from AR Viewers to AR interaction possibilities, to simple problems like the limited amount of AR-usable graphic models and animations. But - the same arguments were true for VR environments just a few years ago. If you look now at the possibilities for VR in the family living room, you find that everything needed is already there - from hardware equipment like fast rendering processors, large screens, well equipped computers to the software needed like viewers, graphic systems (Open GL), etc... Still, the VR revolution has not started yet in the traditional sector like information systems, collaborative work systems, etc. There is only one successful market - the market for massive multiplayer online games like *Ultima Online* (first-person shooter like *Counter Strike*) or *Everquest* (role playing game). Why do people use such 'useless', in terms of time-consuming, personally non-profitable systems? The answer is found in the personal pleasure and fun experienced by the users, as well as in the use of the content and the collaboration with other users. How can we transfer this experience of use to commercial collaborative information systems like Collaborative Virtual Environments (CVEs) at work or for education, etc.? The answer can be



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likewise found in the experience of the user while using an AR or VR CVE: Give the user a suspenseful, immersive experience and she will use your system.

The following paragraph will discuss the way of generating experiences in AR and VR CVEs using Interactive Storytelling in comparison to Game Play. We will introduce our approach to Computer Supported Collaborative Interactive Storytelling in Augmented Reality Environments in paragraph 3. Paragraph 4 is used to discuss our approach in an example project (Geist); finally, we give a conclusion of our work and a notion of our future plans in paragraph 5.

## 2. EXPERIENCES CATALYZED BY INTERACTIVE STORYTELLING

Influenced by researchers of the Massachusetts Institute of Technology (MIT), the term Narrative Intelligence was created; see Murray [Mur98]. This research community developed the human-computer interaction from a story-oriented view. They try to obtain believable behavior for so-called (visual) agents.

Bates [Bat92], as well as Mateas and Stern [Mat00], tried to generate believable agents using the principle of emergent narrative. As stated by Aylett [Ayl99], the principles of emergent narrative may generate a believable actor with (also believable) conversational interaction possibilities - however, the behavior of the agents is rather simple: they are not able to tell or play an interesting, thrilling story[1]. Crawford [Cra01] also describes the fact that a dramatic story is nearly impossible to author with agent-based narrative systems.

The *story* is a concept used by several research communities in several different ways, just as every person has their own definition of a story when asked on the street. Therefore it is essential to define what we mean when we use the term *story* in regard to Interactive Storytelling.

We follow the definition of Laurel, [Lau93]:

A story offers a context. Within the context, it offers activities and plots played by characters/actors. The narration and experience of the story create a manipulation of space and time that causes certain cognitive processes within the mind of the reader/audience.

We concentrate our definition of the structure of a story to an approach of Goethe. We define a story as a Novella:

The Novella is of the category Epic[2], but with an internal dramatic structure: It shows events that are interpreted as turning points within the life of a protagonist; this causes actions that rise to a climax. Therefore, the Novella offers the dramatic structure of exposition, a climax or turning point, a decline and an end (see Figure 1), see Braak [Bra69, p.550].

The narration of a story also needs to be defined, as we think that the narration of a story should have drama aspects. We refer to Staiger's definition of the form category of *Dramatic* (German: Formkategorie des Dramatischen); see Braak, [Bra69, p.117]. He used the term Drama to describe *the playing of characters*, therefore, as a mimetic presentation. Braak says, that the key to the Dramatic is dialogue, if the dialogue raises suspense; see Weber, [Web98, p.117]. The actions within a Drama are aspiring to a peak level, therefore, a Drama is directional. Suspense emerges when the audience awaits the peak level.

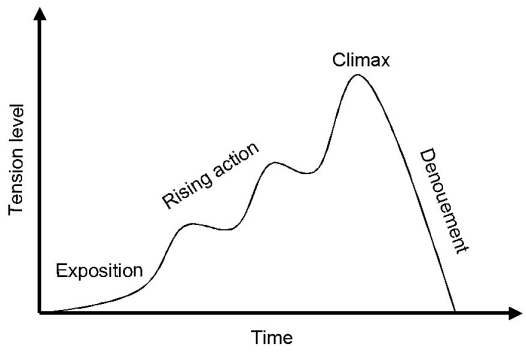


**Figure 1: Classic structure of a drama as it is founded by Aristotle**

With the definition of story and narration in mind, we define *Interactive Storytelling* as the interactive mimetic presentation of a Novella.

How do the definitions of story and narration relate to the audience of a story? Traditionally, storytelling has not focused on the single users as an audience. There are examples, like the book, focusing on a one person audience, but generally the traditional narration of a story is done in front of a broader audience, e.g. in a theatre. But how does the audience in a theatre or a movie collaborate in regard to interactive manipulation of the story? Traditional theatre or movie presentations do not enhance the interactive

[1] These agents are not used to the drama of their play - what is thrilling to the user, what pushes him to interact.

[2] For the German language area, Goethe ([Goe48]) defines three categories (German: Gattungen): Lyric, Epic and Dramatic.

altering of the story or its narration at all.

When looking at Game Play it is obvious that most games are a collaborative group experience: Teams or individual persons are playing against each other or together to achieve the game's goal, in general to win the game. They often play different roles in the game, but they all get their personal experience in the thrill and suspense of winning or losing the game.

Compared to storytelling, the collaborative experience in regard to role-playing within a game is totally different from the collaborative experience in stories. This is due to the fact that stories achieve their suspense out of actions, rising to a climax, not out of the possibility to win or lose the story. How, then, can a suspenseful narration be provided for every member of an interactive audience? The answer is found in the theory of Audience Participatory Theatre (APT), e.g. interactive theatre or improvisational theatre. The Theatrical Freestyle[3] form of APT includes the audience as interactive parts of the story presentation and gives every member of the audience a personal experience in regard to ongoing actions that rise to a climax; therefore APT offers the traditional advantages found in a Novella and Drama.

As found in Wirth, [Wir94, p.53], narrative in APT is based on four general principles:

- Roles: The definition of characters, their relationships, their objectives and their environments.
- Pegs: A story element within the narrative, somewhat like a smallest piece[4] of a story.
- Links: Tying an unrelated story element into the existing narrative.
- Reincorporation: The technique of linking an element brought up earlier in the story to the current situation.

In regard to these techniques, each user is not left alone playing his character, but is carefully, in regard to the ongoing actions and his own experience, integrated into the overall narration by the engine executing the narration of the story.

The play of the user has to be supported by the improvisational system; Users have to be contacted to accept a role within the story; they have to be back leaded to play without their notice to be forced to play. Everything the users do is to be incorporated into the story's plot. Of course the system should prevent anachronisms as well as every other circumstance that could stop the flow of the story.

For sure, each member of the audience is still having his own, subjective view of the story, but is lead by the narration to a personal rise in action to a personal climax, with a regard for the objective storyline[5] and the interactions of every other participant of the story.

The general story modeling, the story's structure as demanded by Wirth, see [Wir94, p.53], is found by using the semiotic model of stories founded by Propp, see [Propp68].

Propp defines a story as a set of morphological functions, dependent of the dramatic characters within those functions. He writes that [Pro68, p.21] *Function is understood as an act of a character, defined from the point of view of its significance for the course of the action*:

- *Functions of characters serve as stable, constant elements in a tale, independent of how and by whom they are fulfilled. They constitute the fundamental components of a tale.*
- *The number of functions known to the fairy tale is limited.*

Propp showed the possibility of generating new stories by combining functions in regard to a limited number of combination-rules.

As the work of Propp is based on the actions of characters in regard to the story as a whole, it can be adapted to the character based approach of APT to give users a unique and interactive experience of story.

Propp's research focused on Russian fairy tales; he discriminated several roles[6], enhancing several functions within a narrative and forming so-called spheres of action [Pro68, p.79]:

- Villain: Fights or struggles with the hero.

[3] There are several forms of APT: Environmental Theatre, Playback Theatre, Theatre of the Oppressed and Theatrical Freestyle.

[4] The original text of Wirth was written in 1957. Nowadays the definition of smallest pieces of a story does not seem to be adequate - in this context one better uses the theory of functional elements of a story as described by Propp [Pro68, p.21]

[5] The objective storyline, see [Phi02], is interpreted as the objective actions that happen within a story as seen from a view outside of the story.

[6] The so called dramatis personae, the roles within a story, are listed as follows: Hero, villain, donor, magic helper, false hero, princess, victim.

- Donor (provider): Gives the magical agent or helper to the hero.
- Helper/Magical Agent: Helps the hero to solve his task.
- Princess (luck): This is the princess (the object auguring luck) and her father (the one related in some way to the luck).
- Dispatcher: Dispatches the tasks.
- Hero: Solves the task and gets the gratification (e.g. luck).

In regard to the spheres of action, every audience member can be provided with a narrative experience; maybe, one experience is not the same as the other, but all experiences are suspenseful and story-driven. Every story participant will be guided to the (predefined) climax and to the conclusion of the story. Every role has a great degree of freedom, as the techniques of APT are adapted to the input of the users to relate them to the story and the play of the other users.

This directive approach is in contrast to role-playing in games, where characters' play is not automatically adapted to the overall story, but rises in the style of emergent narrative; see [Mcb02]. Within role-playing games, the narration is somewhat implicit, emerging into a direction that can not be predicted. It needs a so-called (human) Gamesmaster to redirect the stories and the actions of the many virtual characters and players to one overall experience for the players.

## 3. APPROACH TO STORYTELLING IN CVE

The architecture of the Computer Supported Collaborative Interactive Storytelling (CSCIS) system is separated in several layers. The story is interactively narrated via scenes and characters playing within these scenes - some of them physical (the interactive audience), some of them virtual.

As the story model is based on a morphological approach; combined with improvisational features, the story engine controls the suspense of the users at several abstract, 'storytelling' levels. The rendering is done by mapping the symbolic information to graphical and acoustical output systems; the input of the users is processed by several specialized user input interpreter modules that translate the various modal input of the user to symbolic information.

***Story Engine***: The content structuring and, therefore, narrative layer is implemented by using a Prolog interpreter as the basis of our story engine development. It is made of two separate units - the semiotic function module as well as the improvisation module.

The semiotic functions are processed in relation to:

- author constraints like limitations of time, gender, environment (stages, ways to pass, etc.)
- the functions already played out
- the remaining functions in regard to user roles and scenes 'implementing' the functions
- the remaining functions in regard to the possible reach of the story's defined end within the time constraints
- Possible nested storylines, as well as user pegs (as notified by the scene engine), to be reincorporated into scenes

From the functions currently possible, one is selected and mapped to one of the possible scenes. The mapping is done in regard to:

- the roles and actions defined within the scene
- the possibility to reincorporate pegs formerly notified by the Scene Engine

The selected scene is passed to the Scene Engine.

***Scene Engine***: The Scene Engine distributes the story content to the several actors in the story. It is notified about pegs by the User Input module and links it to the actual scene. Pegs are announced to the Story Engine for reincorporation.

***Actor Engine***: The media-related content presentation is done by using an actor engine, which is using a virtual character and synchronized speech to present media; see Iurgel et al. [Iur02, pp.115-125]. It uses an Expert System shell to provide emotional and social status, as well as conversational behavior (see Braun, [Bra02]) of the avatar.

***User Input***: The media-related input evaluation is done using Java to interpret the commands of the user in relation to the content that is given by the Actor Engine. User input is reviewed for pegs, which are then announced to the Scene Engine.

***Rendering***: The rendering is done by using exchangeable, purpose-related renderers. For AR purposes, the rendering is separated into the animation of the ghost behaviors, the modeling of historical buildings, and the rendering of this data into the AR scene.

Figure 2 shows the architecture of the system in regard to the several modules and layers used. Every

layer is parted in several AI sub-modules to improve the possible evolution of the systems abilities, as we wanted to design a reusable software system with the possibility to replace modules in regard to project specifications and scientific research ideas. This way, it is possible to strengthen or weaken a sub-module (e.g. the Story Engine (as the global story coordinator) or the virtual actors (as the local story coordinators)) and, therefore, to have several possibilities of interactive storytelling.

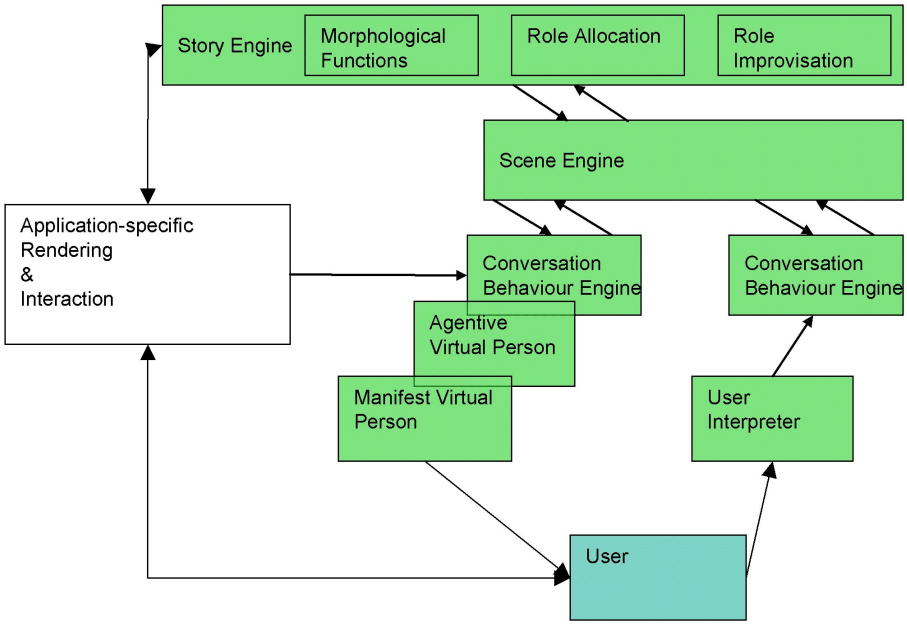


**Figure 2: Architecture of the CSCIS System**

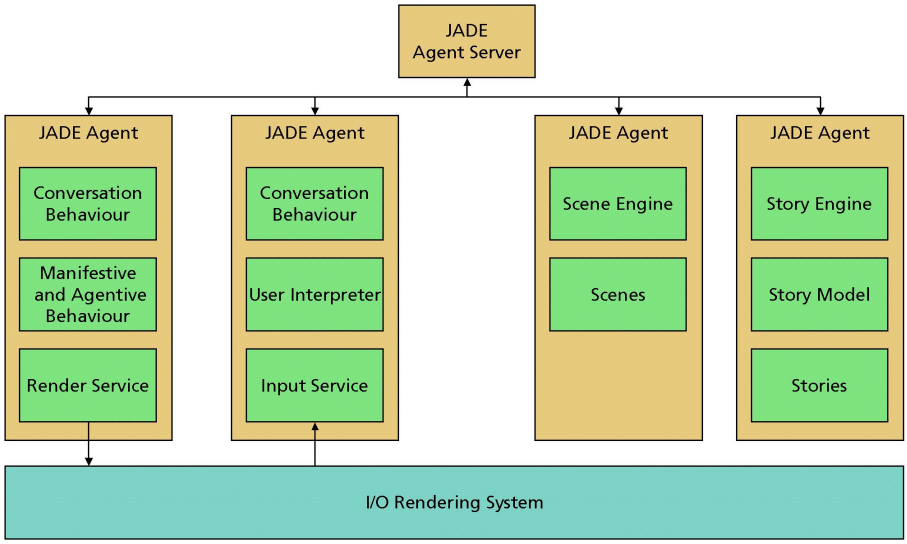


**Figure 3: Development of the CSCIS System**

Figure 3 provides a sketch of the implementation of the system. We used several AI-related software packages to develop the story engine (done with Prolog), as well as the conversational behavior, agentive and manifest modules of the several agents, with this agents playing roles (virtual characters) in the AR story environment (done with Jess, the Java Expert System Shell [Fri01]). Communication between the several modules is done using the JADE Agent Platform [Bel01].

The authoring process of Interactive Stories is supported in regard to the definition of scenes for the AR environment and the relation of scenes to the morphological story model (functions and roles), as well as to improvisational features; see Schneider [Sch02].

**Figure 4: Stage *the fountain* at the castle of Heidelberg, showing the Heidelberg river-god.**

## 4. PROJECT GEIST

To verify the usefulness of the approach to user experiences using storytelling in Collaborative Augmented Reality Environments, let us discuss the project *Geist* [Gei02]. Geist, (English translation: ghost or spirit) is a metaphor for the spirit of history.

This German Federal Ministry of Education and Research (BMBF) funded project, a cooperation between three German research institutes, -- the Computer Graphics Center (ZGDV e.V.), the Fraunhofer Institut of Computer Graphics (Fh IGD) and the European Media Lab (EML) -- explicitly shows the correlation of humanlike communication/interaction, story structures and the user's enjoyment of the application in Augmented Reality. The project basically serves as an education platform for historic data. The prototype gives insights into the Thirty Years' War as it happened in Heidelberg, Germany.

It provides information on this time period, including:

- cultural and social circumstances of life
- data of known historic figures
- data on political and ecclesiastical changes.
- models of architecture and places as they were formerly (buildings in their historical condition, potentially artifacts from a past age that do not exist in the current time)
- characters, clothes, etc.

As the system is developed as an Augmented Reality Environment, the Geist story takes place in the castle of Heidelberg; see Figure 6.

The users (users in the prototype evaluation are a group of kids age 13 to 15) are experiencing a story collaboratively together, playing a role in the story. The story is structurally predefined in plots and story roles that are adapted to the interactions of the users, e.g. local appearance of the users on different stages (see Figure 4), time flow, interactions with virtual characters (see Figure 5) and artefacts.

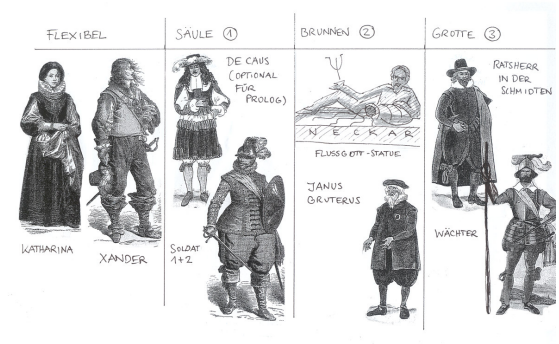


**Figure 5: Sketch of several virtual characters (ghosts).**

A typical AR story could be the following:

At the beginning of their afternoon at the castle, the users are equipped with AR equipment like an AR viewer and interaction properties (e.g. a magic wand for gesture recognition). The users are warned to be on guard, as the castle is a haunted place in Heidelberg where curious things can happen. Then, the users go to the castel. Soon the first ghost appears, calling attention to itself via a magical whisper (given via audio equipment). The users use their magic glasses to look for the ghost and soon find the ghost. The ghost is able to talk to them and understands input via the magic wand and simple wording; see Figure 7. Each user is inconspicuously delegated a role within the story. It involves the users in a dramatic story of war and love, introducing several other characters and forcing the users to interact with ghosts and the environment to see rising action, each having its roots in the history of the Thirty Years' War (as the founding of the story, so called back story). These roots are concerning the ghosts until today, this as the motivations of the ongoing actions between users and ghosts. The user is exploring the castle, as well as the history of Heidelberg, while interacting with the ghosts. While the story is progressing, it adapts to the input of the various users, as well as to their (human) demands of hunger or thirst, or taking rest room breaks. When the story is finished, the users pass their equipment back to the distributor. (We plan to offer the users a choice of souvenirs, both in electronic and physical form.)

Within this scenario, the user is experiencing the castle of Heidelberg as it was in former times, is learning about historical characters, as well as the everyday lives of people, and is examining the results of political and clerical changes in Germany. They are able to see the castle from a different view and relate the history of the city to the current time.

**Figure 6: The castle of Heidelberg, used as the Geist story space.**

**Figure 7: A user of the Geist Story, using AR equipment to watch a ghost (Katharina) in the story environment.**

The typical problems of AR environments are also addressed and incorporated into the story, e.g. like the audience getting hungry or thirsty, or requiring the possibility to rest for a few minutes (as the audience is walking on their own feet, covering some distances (e.g. between the park and the castle's courtyard) in reality. The story should not last longer than 2 hours as the evaluation of the environment is done with students from 13 - 15, just having an afternoon to experience the story.

The story itself was developed by a heterogenous team of storywriters and designers, using a storyworld creation tool; see [Sch02], [Hab02].

## 5. CONCLUSION AND FUTURE WORK

We describe an approach to enrich user experiences in Collaborative Augmented Reality Environments, to overcome the general problem of user abstinence in CVEs. Starting with traditional storytelling and its relations to general Game Play, we define story and narration from an interactive viewpoint. We show how an approach based on Audience Participatory Theatre and story morphology can produce a user experience based on a collaborative, coherent story narration.

The approach is then verified by discussing the project Geist [Gei02] (English: ghost or spirit, a metaphor for the spirit of history). So far, the project features the following points: The story is predefined via story semiotics (morphological functions), as well as through scenes and dramatic roles with improvisational capabilities. The single scenes are indicated with their influence on the story as a whole. The users are experiencing the story collaboratively and take part in the story as a dramatic character. Several other dramatic roles in the story are played by virtual characters, visible to the user via AR technique. The users are within the story location; they use the Computer Supported Collaborative Storytelling equipment to immerse themselves in the virtual story. The story is automatically adapted to the current role-play of the users; this guarantees a programmable, predictable amount of suspense and mental immersion in the story.

Future work in this area will focus on improving of the improvisational features of the system, in regard to natural language understanding and sentence generation. As these problems are generally investigated in Artificial Intelligence (AI) research, we will strengthen our AI modules. As a step to better AI within the actors, we will use the AIML-based Alice chat robots, see Bush [Bus01], to generate the sentences for incorporating user pegs into the story.

Currently, there are no gaming aspects incorporated in the story, as the story has an edutainment background. We are evaluating the idea of introducing a treasure hunt, with story points to win, to feature a game aspect.

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