Interactive Digital Storytelling: Towards a Hybrid Conceptual Approach

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ABSTRACT
In this contribution, "Interactive Digital Storytelling" is viewed as a hybrid form of game design and cinematic storytelling for the understanding and creation of future learning and entertainment applications. The result of several practical experiments in the design of interactive agents for storytelling, a formal design model is presented that provides a conceptual bridge between both traditional linear narrative techniques, as well as emergent conversations with virtual characters. This model describes several levels of apparent semi-autonomy in an agent-based artefact and agency experienced by participants, which draw - in the broadest sense - from Aristotle's elements of structure in drama. In summary, thinking models for several design levels of interactive narrative are pictured from a creator's point of view.

Keywords
interactive storytelling, digital storytelling, storytelling agents, story simulation

INTRODUCTION

Influencing disciplines
"Interactive Digital Storytelling" is a new topic of interest for a growing number of people from a huge diversity of disciplines and origins of expertise. As to the context of the work presented in this paper, there have been four approach directions, which have been most influential:

1. Generative computer graphics, animated storytelling for film production
2. Human-computer interaction (HCI)
3. Computer game design
4. Artificial intelligence

First, people from the film production segment of special effects and computer animation began to automate the movements of virtual characters by defining their abilities as a rule-based, "intelligent" behaviour, and to think about populated virtual worlds. Second, there was an attempt within the disciplines of Human-Computer Interaction (HCI) to view "storytelling" as a means to make computer applications more understandable and more compelling to the user by integrating narrative elements and seeing the computer as a stage. A major contribution to this point of view was provided by Brenda Laurel's book *Computers as Theatre* [10]. By combining

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aspects of both disciplines within the community of computer graphics and interactive systems, a concept of "interactive storytelling" was constructed that basically viewed human-computer interactions as an entertaining conversation between agents. In [10], Laurel draws a parallel between the principles of drama from Aristotle's *Poetics* and principles of HCI, and presents the Aristotelian definition of an agent as: *An agent is one who initiates and performs actions.* In her conclusion, computer-based agency is present in all human-computer activities, regardless of whether the representation of agents on the stage has human-like (anthropomorphic) features.

Third, within the computer games community, an application of these thoughts can be found in the provocative view of game designer Chris Crawford, who approaches computer games as an interactive artefact. According to Crawford and Stern [6, 20], an artwork is "really interactive" only if it not merely "talks" to the audience, but also "listens" and then "thinks" over suitable reactions. Members of the audience shall experience "agency" while perceiving the artwork as active participants. Janet Murray has defined this notion of agency in her book *Hamlet on the Holodeck* [15] as: *Agency is the satisfying power to take meaningful action and see the results of our decisions and choices.* Whereas this prerequisite puts "the user" at the centre of any told story, "Interactive Storytelling" - while first considered an oxymoron – nevertheless posed a real challenge for new computing concepts formalizing dramatic structure.

The dilemma with stories, unlike the more repetitive games, is that in order to be dramatic, their structure must have an immensely higher degree of complexity. In a novel or movie, this structure is tuned and laid out once in a linear order by human authors. To add interactivity to a story following the approaches mentioned above, these authors have to be represented by computer agents that can "think" about the changes in the unfolding of a story during the runtime of the agent-like artefact.

Hence, Artificial Intelligence techniques have been ultimately employed to generate suitable plot developments in reaction to participants' free actions. Seminal research in this field was conducted in the early nineties; for a number of references, see the OZ project Web site [4]. The result is an emergent behaviour of intelligent agents controlled by a drama manager. Within the last four years, there has been an increasing interest in building story engines with similar goals for automated narration in reaction to user input, or for planning actions of autonomous characters on a virtual stage. References can be found in the proceedings of new conference series on that topic [21, 22]. In order to interact with believable representations of virtual characters through multimodal techniques, the research field of "Embodied Conversational Agents" also provides major contributions to the relevant state-of-the-art technology. As an example, see the work of Cassell et. al. [5].

Motivation

The approaches mentioned above have largely been tackled by computer scientists. As their successes show, they sometimes have a strong interest in narrative, in the humanities or in cognitive science and, in rare cases, even have a second degree in philosophy or the arts. "Conventional" storytellers, who want to enter this field, are currently offered the advice that they would first have to learn to program [20]. If that alone were not enough, it seems that one would have to study the principles of Natural Language Processing on a very deep level to create interactive verbal conversations. Following this advice, there have indeed been a number of artists coming up with interactive narrative installations [12]. For the time being, their resulting

artworks are completed as a bundle of content with an engine. There is rarely a way to divide one from another, or to access authoring interfaces for one's own creations. These current trends toward building virtual agents point more towards a vision of creating full-fledged virtual humans with autonomous behaviour for end users, than towards solving authoring problems for creators of interactive storytelling artefacts.

In the humanistic research context of Interactive Narrative, the philosophical debate from the hypertext era about authors' rights to exist, and about the co-producing property of users in a collective authoring process, is resuming [16]. In a slightly modified form, its assumptions continue to be contended in the recent academic debate between "ludologists" and "narratologists" [7], which is mainly carried out in weblogs, as for example in *Grand Text Auto* [8]. In the following paragraphs, the term "authoring" is not used in reference to a specific attitude in this debate, but rather as a technical necessity to produce interactive storytelling artefacts within the technical boundary conditions. As the practical examples in the next section show, the context for envisioning entities of interactive storytelling is, for the most part, created by an instrumental view in that it is considered for educational purposes.

This paper is not about the difference between stories and games. The motivation is based on the potential of both to offer structures for learning and entertainment. Instead of trying to draw a distinct line between them, conceptual models have to be defined for the creating authors, who are responsible for fleshing out a suitable design within a variety of forms. Design elements include aspects of drama and filmmaking, dialogue design, as well as game design and game tuning. The actual challenge in designing learning applications with autonomous agents is the necessity that authors have to take on responsibility concerning the intended outcome and effect. In fact, they have to balance the bias between a pre-structured storyline (and possibly a timeline), which they may have strictly defined, and the agency that users shall experience through the design of the author. However, there is no one-dimensional borderline between the two extremes. In the following sections, a model is presented with several levels, which shall help to form a more differentiated picture.

EXAMPLE PROJECTS

The conceptual work is based upon practical experiments within several research projects on edutainment, which employ conversations with virtual characters to convey information and to entertain. A similar integration of simulation and plot was used in the project *Façade* by Mateas and Stern [13], which is acknowledged to be the first working example of interactive storytelling with both dramatic storytelling and user agency. By building several prototypes, different approaches were explored to combine plot-based interactive storytelling with character-based emergent conversations. Visual impressions of the example projects *art-E-fact*, *Scenejo* and *Geist* are shown in Figures 1 and 2.

In all examples, several virtual animated characters converse digitally with each other and with one or more users, who either type text with the keyboard, or apply choices, for example, with special hardware interfaces (compare Figure 2). The virtual agents are represented by 3D animations, as well as by a text-to-speech engine rendering their voices in real time. At the heart of the processing of the natural language conversation, open-source chatbot technology is used [1] and adapted to the particular needs of each application. Chatbot conversations in general are modelled by a so-called knowledge base, which primarily contains a huge amount of text

patterns that a user can potentially express, along with associated lines for the bot to answer. In up-to-date commercial applications of chatbots as company representatives on Web sites, there is no modelling of dialogues in the sense of a scripted screenplay or a goal-driven conversation – a digital answering machine is all there is, with a minimal ability to store a short-term dialogue history, as well as several user properties and topics to talk about. The result is an emerging dialogue that is almost impossible to anticipate as an author.

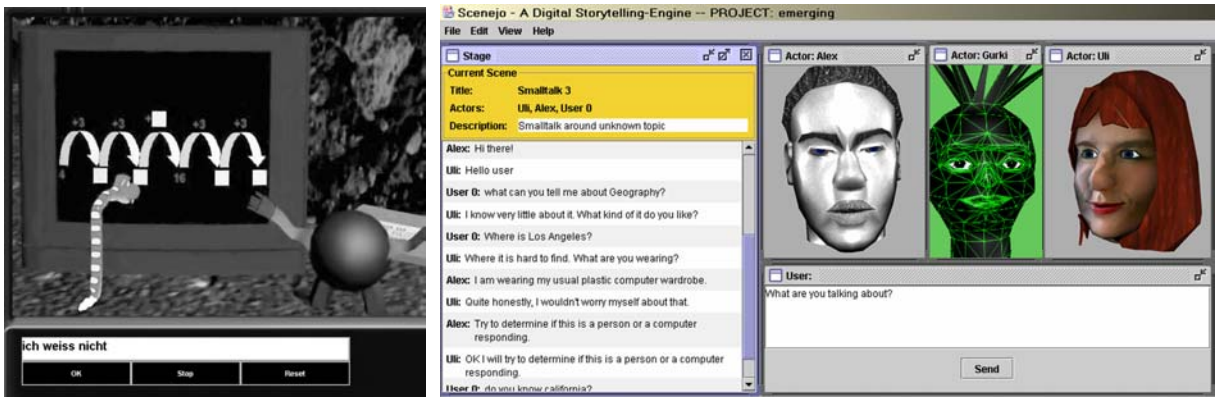

Figure 1: Example screens from applications with text interaction. Left: *art-E-fact* – Two fantasy characters are challenging children with math questions. Right: *Scenejo* – Emerging small talk between three virtual agents and one user.

For interactive storytelling to be used in teaching and learning, the anticipation of possible conversations is necessary to a certain degree. The envisioned learning scenarios with text interaction shall allow the training of verbal dialogues and the simulation of conversational behaviour. In employing aspects of stories, factual information can be conveyed by the authored spoken text of virtual agents and different opinions can be rendered by mapping them on several agents in a dispute. By using gaming aspects, playful verbal interactions allow users to test their own decisions and opinions; they participate through active construction of a dialogue. The overall goal is a middle ground between predefined narrative presentations and emergent conversations.

Figure 2: Special interfaces to interact with a story. Left: *Geist* – in the Mobile-AR scenario, interaction occurs through finding ghosts by walking in real locations. Right: *art-E-fact* – pointing gestures specify regions in a painting to discuss.

Authors need to control this semi-autonomous behaviour of interacting agents. As a means to define the flow of a conversation, authoring interfaces with graph structures of "dialogue acts" proved to be a prevalent approach. Dialogue acts refer to the idea of speech act theory, and support the definition of semantic and non-verbal statements. The nodes of the graph contain scripted content as contiguous actions of the virtual agents and transition edges describe possible user options or environmental conditions. The result initially has a branching structure, which then needs the addition of more complex rules within detailed nodes of the graph in order to achieve interactive experiences. Graph structures as a transition network of states can be used to model interactive experiences on several levels of detail, from the low-level utterances of single words up to scenes or sections of a timed narrative. Figure 3 shows examples of transition networks from the projects *art-E-fact* [19] and *Scenejo* [14].

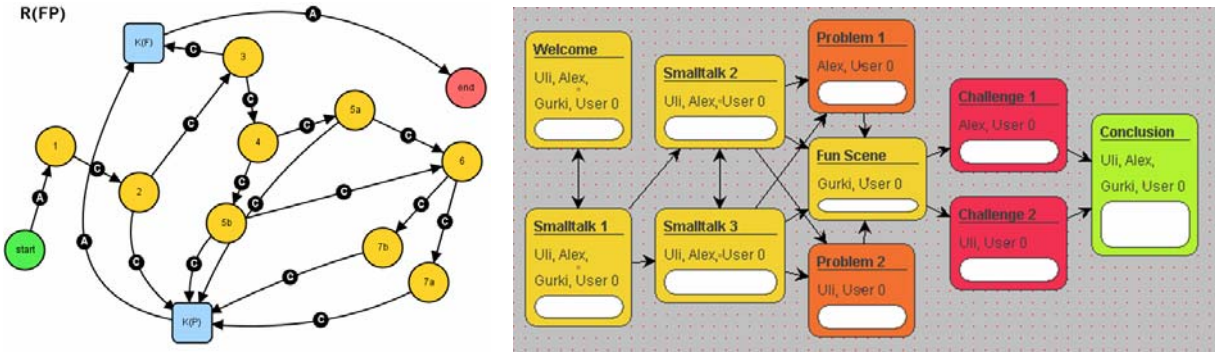

Figure 3: Transition network structures for conversations on several levels of detail. Left: Dialogue moves in *art-E-fact*. Right: Scenes in *Scenejo*.

The resulting conversations within the two mentioned projects differed in their direction of approaching the middle ground between guided interactions and emerging conversations. In *art-E-fact*, easy story creation with predictable user interactions was supported by the authoring tool, which let authors work with the graph structure from the start. Story writers are able to transfer a certain degree of factual knowledge through dialogue, using the hierarchical and modular control approach. However, the affordance of the graph tool resulted in first creations that tended to be rather linear and determined, providing long-winded experiences with little user agency. Together with designed interaction tools beyond the keyboard, the "vocabulary" of the users – and, therefore, their "choices" – was limited to pointing gestures. More complex and free conversations can indeed be offered with the tool, but are difficult to handle by coding rules.

By contrast, in the *Scenejo* project, AIML pattern matching [1] is used from the start to provide free conversational interaction with users and between virtual agents. On a very basic level, AIML can be used to model dialogue acts; it can also be used for scripting a determined two-way dialogue between virtual characters only by using appropriate keywords, but with the chance to let users intervene. In an interaction scenario with text input, little text-based games and simulations with high user agency are possible. As a next step in authoring, a story graph (see Figure 3, right) allows writers to line up conversational scenes and their parameters, including rules for transitions between scenes. Scenejo is an experimental improvisation stage, in that it

provides a playful test environment for emergent conversations between chatbots, which are hard to anticipate.

Conclusions on the practical experiments

The experiments using different forms of interaction and dialogue modelling, as well as several application contexts, resulted in the following conclusion: The definition of "Interactive Storytelling" as a narrative representation that "allows the audience to influence the story" is not sufficient to explain the nature of that specific concept. There are different ways for interaction to influence the story, different levels of content at which the influence can take place, and different distributions of agency between authors, digital agents and users. They shape mutations of possible artefacts, which all deserve to be justifiably named "Interactive Storytelling" – defining different genres with their respective conceptual models.

Storytelling is an art form that depends on talent and the will to shape and fine-tune the telling of events in order to achieve a certain experience. This notion is independent from the question of whether one strives for professional or casual storytelling: Humans are the storytellers, not "the computer". It is especially important to give talented authors from the traditional storytelling domain, as well as educators and instructors, the ability to access more complex stages of interactivity, beyond the definition of a determined story graph. However, for authors who decide to include experiences of user agency, it is necessary to anticipate the emerging situation to a certain extent. This can only be learned by experience during phases of play-testing. As an entry point to interactive storytelling, a graph structure with some variations can be the first access, working further from linear determinism to behavioural emergence resulting from rules and simulation models. It is also noticeable that "linear" storytellers have difficulty in explaining their wishes for a suitable authoring tool, because the complexity of the whole task is too high.

Simulation models and rules have to be technically defined on several levels of detail, as the whole experience of a theatrical play on a stage is formed by several elements of qualitative structure (for example, see Laurel's adaptation of dramatic principles to human-computer interaction [10]). Authors need to determine the technical quality on each level, either by scripting or by defining parametric values for a simulation, which set the boundaries for user interaction. In the following section, this is reflected in a conceptual model that allows the whole design task to be broken down into levels that can be thought about more easily. It can also be used for classifying a variety of forms.

CONCEPTUAL MODELS FOR STORYTELLING AND AGENCY

Linear storytelling

In Figure 4, a traditional modus operandi for the creation of computer-animated films is sketched at four abstract levels. In fact, the decision for a certain number of distinguishable levels may vary slightly from project to project. As shown later, each of the four levels were found to be suitable for the addition of interaction to form a classification.

This division into levels finds parallels in several theoretical and pragmatic contexts. At first, it reflects the design steps of a computer-animated story. On the top level of highest story abstraction, the overall dramatic outline is sketched. For example, there may be a story model of a *hero's journey* [3], including a dramatic configuration of characters, a situation that provides

dramatic conflict, and an overall narrative arc that maps the story onto a time span. A timed arc can be divided into narrative functional elements, such as 3 acts, the 12 situations of Campbell's *hero's journey*, or a model similar to that defined by Propp for folktales [17], depending on the genre. Further, authors break down the story into scenes, which are handled at the next level. Each scene has to end with a result that drives the story to the next point in the dramatic arc, and is defined by a scene script. Within one scene, dialogues and interactions between actors are designed, and lead to concrete stage directions. If being produced for an animated film, these directions are strictly mapped onto virtual actors by skilled animators, who define the exact way the virtual actors move and behave. The scenes and directions are ordered in time according to the planned course of narration, not to a chronological course of factual plot events.

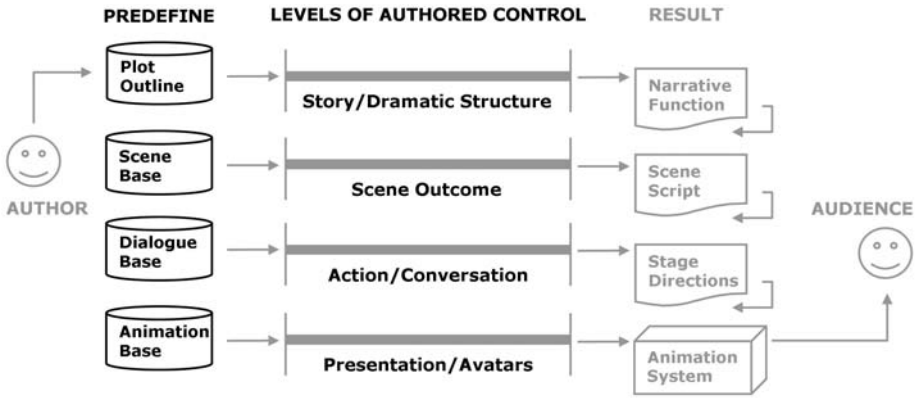

Figure 4: The definition of a linear animated story at four abstract design levels.

This division into levels also has some theoretical equivalence to the Aristotelian six qualitative elements of structure in drama, which have been discussed by Laurel [10] for their application to human-computer activity. From the highest level down to the lowest, these elements are: *Action*, *character*, *thought*, *language*, *pattern* and *enactment*. There are causal relations between the levels, which can also be applied to the sketched production model of animation. Upper levels provide *formal causes* for lower levels, represented by directions from a productive point of view. Lower levels provide *material causes* for the upper levels, in that their experienced properties shape the next higher level – and finally the whole artefact – in the eyes of the audience.

Interactive storytelling

As mentioned above, when storytelling gets interactive, the audience can "influence the storytelling". In fact, in games, as well as in constructivist scenarios for learning through a gaming simulation, users need to experience agency within a dramatic entity, and their roles change from being "members of the audience" to "participants". However, what exactly constitutes a "storytelling" that can be influenced by users? Since several levels have been identified, providing intermediate representations as directions to the next lower level, these are the stages at which users also affect the outcome.

In Figure 5, the animation model (compare Figure 4) has been extrapolated according to the need to introduce user agency individually at each level. Opposite the author, a participant is modelled

who now may contribute to the result of each level. In the terms of Aristotle, these user interactions may build the *material cause* for the next higher level because they shape the material that the upper level is made of. This is the reason why the participant in Figure 5 is depicted as starting to interact at the lowest level.

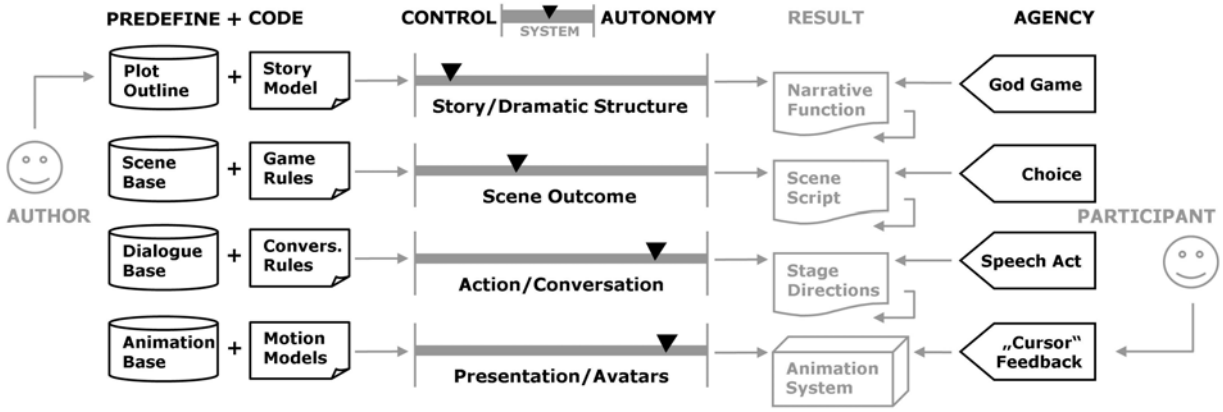

Figure 5: Four levels of semi-autonomy including agency

If authors intend to let users collaborate in the definition of the resulting artefact, the first implication for them is that it is not enough to just predefine databases of descriptions at each level, as was the case in the linear model. Instead, additionally, they have to code rules and simulation models, which control an autonomous and adaptive behaviour of virtual agents at each level in reaction to the participants. Next, it is possible to think of gradations of granted agency versus authored determination. Within Figure 5, this is indicated by the sliders between control and autonomy (of character agents) at each level.

The levels shall serve as conceptual stages for authoring rather than elements of software architecture. However, indeed there is a further correlation of the model to levels of software architectural structures, which can be found within a number of existing game and story engine systems. An analogue description of similar levels as software components has been provided in [18]. There, the sketched interactive storytelling software consists of a story engine, a scene engine, several character engines / conversation engines (one for each occurrence of a character), and avatar animation engines. The technical view is of course an important issue to be considered, as the design model has to have a technical correlation in the software in order to work. Here, the term "engine" could also be another word for "agent", underlining the fact that at each level, a separate software agent can make autonomous decisions while adapting to user input on behalf of the absent authors.

Semi-autonomy occurs on the edges between factual information being predefined by authors, and rules for each level. The more rules there are on one level, the more complex the perceived behaviour of a virtual agent can be, and, as a consequence, the more subjective user agency can be experienced by potentially affecting the respective level. For example: In the *Geist* project mentioned above (see Figure 2, left), user interaction occurs by walking through the historic site of the Heidelberg castle. The goal is to track down virtual ghosts, who tell stories about their past, resulting in an edutainment application on history for tourists. The interaction is technically

solved by a complex tracking system that provides information about the location and the line of vision of users. In effect, tourists cannot alter the storyline; at the most, they can change the order of scenes slightly, depending on the route they choose. All the same, this is interactive storytelling with semi-autonomous agents. The constellation of the "autonomy-sliders" on the levels in the model is configured in such a way that user agency is experienced at the lowest level, but not on the higher levels. Users are recognized and addressed personally through the adaptive behaviour of the animated agent, and their route history is accounted for, while at the end of the day, a predetermined story is presented.

It is imaginable that participants only experience agency on the lowest level, as a feeling of presence in a scenario. In this case, everything is predefined, but avatars would still react to the visitor with nonverbal cues and recognize her, comparable to a virtual cursor that shows a live status. At the conversation level, participants can, for example, have agency in an entertaining and informative chatbot dialogue with the characters. They may not even be able to affect anything in the story logic, but may participate at the dialogue level with speech acts. Agency at the scene level would result in real choices about the outcome of a scene. For example, the story of the game would have to change according to a user's actions. On the top level, players would influence the whole story of the application, if the "agency slider" were at 100% at the extreme right. For example, a simulation such as *The Sims* (Electronic Arts) can be put into this classification, since players are the ones who eventually create stories with the toy.

For factual knowledge transfer in a didactic lesson situation, the highest level could stay predefined, while the lower levels allow for conversational interaction, however constrained. If authors only provide a rule base with little pre-scripted structuring, they achieve a conceptual model more like an exploration or gaming experience, depending completely on the action of the player. While arranging the bias at each level to various slider positions, several abstract genres of Interactive Digital Storytelling can be represented in the model, which helps to specify exactly what kind of user experience an application shall provide. It is a conceptual model that can be used to classify story-related games, and it particularly supports authors coming from linear media, who are just getting into interactive storytelling.

CONCLUSIONS FOR A CLASSIFICATION OF INTERACTIVE STORYTELLING

The presented model can be used for classification of a variety of interactive entertainment and learning media, but not for all. In particular, a classification of "computer games" can only be done partially, and is restricted to certain genres – implying that the artefact shows some narrative structure, or at least a time structure with perceivable consequences of actions in a certain order. The underlying metaphor of "having a conversation" with a computer-based artefact as an agent is central to the approach taken here.

In Figure 5, the term "god game" is used. According to the mentioned discussion about authorship [16], it refers to simulation games, which put the player in the position of defining what is going to happen while playing with a designed model. In that sense, playful actions can lead to a narrative created by the participants. Following the fundamental categories of games specified by Roger Caillois [2] - competition (*agon*), chance (*alea*), simulation (*mimicry*) and vertigo (*ilinx*) - the *mimicry* aspect is the predominant value to look at. It can occur either as unstructured play (*paidia*), as well as in the highly structured category of *ludus*, in which Caillois also includes *theatre spectacles*. For Craig Lindley in [11], the competitive aspect of games is

crucial for a description of a *gameplay gestalt*. Using the terms of Lindley, the conceptual model presented here does not explain a tension between narrative and gameplay, but rather focuses on the *narrative gestalt* on a *performance level* while discussing an axis between narrative and a model as a representation of a *fabrication*.

Playing with a simulation can support the fabrication of thought, when the simulation model is used as a medium for communication with oneself. It can also be seen as a virtual sparring partner for training and learning, stressing again the aspect of agency of the medium, and "open-ended-ness". Interactive storytelling, when seen as an agent-based conversation, has a huge potential to be successfully applied to learning applications. In the *gaming landscape* described by Jan Klabbers [9], the actual learning effect in gaming simulations occurs due to a subsequent "debriefing" phase, which provides reflections on one's own decisions and actions by observing the game phase "postmortem" from a critical distance. Thinking in narrative time structures, this is actually the phase where individual user experiences can be transferred into their own linear stories after the interaction has taken place. Putting actions into a story structure also means applying structures of identified causes and effects. During the open-ended interaction time with a simulation, hypotheses are tested while forming "what-if" stories, which are based upon known stories of causes and effects.

While these structures are present within a game genre, interactive storytelling takes place. For example, role-playing games have narrative aspects, while a fabricated world is conjointly constructed within a possibility range defined by an underlying model. Depending on the state of the upper level axis of dramatic structure, there can be a variety of shapes based on the degree of game master presence. Within and beyond existing game genres, interactive storytelling as an agent-based conversation can take several shapes, which can be explained through metaphors of real situations. Examples are the metaphor of a lecture with allowed questions, a guided tour, a moderated meeting, an unmoderated regulars table, a conversational test situation, a conversational training situation, or a conversational doll house (such as MMORPG).

As potential authors with a variety of expertise have been recently approaching the new field of interactive storytelling, which also involves artificial intelligence and the construction of autonomous agents, the multi-level model presented in this paper shall support accessibility, particularly for those professionals coming from linear storytelling and education. The model provides a view of the overall possibility space that allows these newcomers to start thinking about it from a linear narrative perspective and to add interactivity partially and successively.

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