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IRIS

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Abstract

In spite of a wide variety of Interactive Storytelling (IS) systems available nowadays, there is no standard design framework to support the creators of IS systems. Since the goals of IS systems deviate from the goals of traditional interactive systems, design guidelines applicable to standard interactive systems are only partly applicable to the domain of IS. Whereas traditional interactive systems aim at efficiency, effectiveness, transparency and user satisfaction, IS systems rather focus on the user's experience. The experience people interacting with IS systems also differs from the experience of people playing games. Gamers usually have to accomplish a concrete goal, e.g. to defeat an enemy, while users of IS systems engage in open-ended role play.

Consequently, there is a need for a specific design framework for IS systems. Such a framework may inform the design of IS systems and help evaluate and revise existing IS systems. The framework should support designers along the whole design process: it should provide support during concept development, during low-fidelity and high-fidelity prototyping as well as during evaluation.

Important to notice, the evaluation criteria used for interactive systems should be adjusted as well to the specific domain of interactive storytelling. Existing evaluation approaches fail to capture the rich interpretive process peculiar to IS experiences: people tend to understand the story from diverse points of view, not looking for a solely possible solution. (Mehta, Dow, Mateas, & MacIntyre, 2007) emphasize that "studies typically separate subjective assessment from objective evaluation, thus preventing subjective assessment from feeding back to the technical approach".

This work aims at collecting design guidelines for IS systems and summarizing them in the form of a design framework. In the first chapter, we discuss a variety of factors from interactive systems in general and digital games in particular we consider as relevant to IS system design. In the second chapter we extract interaction guidelines for each of these factors by analyzing design strategies used in four prominent IS systems – one of them developed within IRIS. Based on this analysis, we derive a set of concrete recommendations for IS design. Chapter 3 presents the framework of design guidelines – the result of our work. The work is wrapped up by a conclusion and an outlook on future perspectives.

1. Design Factors for IS Systems based on Literature Research

Interface design guidelines for task-based systems usually do not consider the specific characteristics of IS systems. Unlike task-based systems, IS systems aim at providing interpretational freedom to the users, enhancing their perception of the story, inspiring their curiosity and encouraging their spirit of exploration. Therefore, interaction design guidelines set up for task-based systems should be reconsidered, and adjusted to IS systems. Below, we provide a survey based on literature research that aims at identifying factors that should be attended when creating IS systems.

1.1 Dimensions of Digital Storytelling

A first effort to characterize and compare existing IS systems was carried out by (Schäfer, 2004) who introduced the following classification criteria:

1. **Conceptual structure**. A story usually follows a conceptual structure that may be characterized by the degree of consistency of the material the story is built upon, the degree of story coherence and the degree of the continuity of the story plot. The conceptual structure affects the cognitive effort needed to understand the story flow.
2. **Spatiality and Virtuality.** Digital stories may be characterized by their degree of spatiality and virtuality. Spatiality relates to the effects that spatial distance of objects, space presentation, and navigation produce on the story. Virtuality relates to the degree of involvement of the virtual environment in story development.
3. **Degree of collaboration.** As a further classification criterion, the author proposes the degree of collaboration which affects how people experience a story.
4. **Degree of control.** This dimension refers to the level of control users have on the story flow.
5. **Immersion and suspension of disbelief.** This dimension defines how the story appeals to the user.

The main objective of the work by Schäfer was to come up with dimensions to describe digital storytelling systems. Interaction devices and modalities have only been handled as a side issue.

A more recent approach to characterize interactive story telling was presented by (Rowe, McQuiggan, & Lester, 2007) who introduce the notion of **narrative presence**. They start from the classical notion of presence which basically describes “the feeling of being there” and refine it to describe the experience of users being confronted with an IS system. They introduce three kinds of factor that may help to predict the user’s sense of presence in an IS system:

1. **Narrative-centric factors** include the consistency of setting, plot and characters, plot coherence and dramatic structure.
2. **User-centric factors** include the users’ emotional state, motivation, confidence in their abilities to perform and sense of control.
3. **Interpersonal factors** include the level to which a story appeals to an audience, the level of imagination required from the human user to follow the story, the degree of believability of the characters, the degree to which users are able to create empathetic relationships with the story characters and degree of user involvement.

1.2 Design Guidelines for Interactive Storytelling

The approaches described above provide a reasonable starting point to come up with a design framework for IS. However, they leave open how the factors identified may inform interaction design.

In the following, we provide an interdisciplinary literature review with the objective to identify criteria to be taken into account to design interaction for IS. To this end, we borrow ideas and findings from digital gaming applications, learning applications, and interactive installations, since the user experience in these domains has much in common with the experience in IS systems.

We start the survey with the more general design aspects known to be relevant to the design of interactive systems.

1.2.1 Assure Basic Usability

System usability should be considered a basic requirement for any interactive system in general, and for IS experiences in particular. The particular characteristics and related needs and performance requirements of the target population (including not just popular examples such as the young and the elderly) must remain central concerns to avoid flaws in interaction that could easily frustrate the users and lead to the loss of trust in the system. For any sensing capabilities (including the more recent cases of gesture recognition or emotion recognition) the qualities of the recognizers (including the complexity of the sensed features) and their levels of sustainable robust performance need to be carefully evaluated and considered. On the one hand, technology which does not meet the users' expectations may be a serious threat to user experience. On the other hand, advanced technology may inspire users to play around with novel gadgets instead of driving the story forward and thus distract from the intended user experience (see IRIS deliverable D7.1). As a consequence, a careful study of the users' attitude towards technology is required. For example, an immersive AR environment tends to raise higher user expectations about characters in comparison to a desktop-based version: Users expected the characters to be emotionally deeper and more conversational, see (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007).

In the area of usability engineering, a number of packages with design guidelines have been proposed, see, for example, (Shneiderman & Plaisant, 2004). While many of these standard design guidelines still apply, some of them need to be revisited for IS in order to take into account the specifics of user experiences with IS systems. For example, to inspire a player's curiosity, a high degree of variation and unpredictability might be desirable in an IS whereas in a traditional user interface design such features should be avoided.

1.2.2 Engagement

Various factors impact user engagement or involvement in the narrative scenario. By engagement we mean an excited and enjoyable state of mind in which attention is willingly given and held (Chapman & Selvarajah, 1999). In the following, we elaborate on the aspects of bodily interaction, fantasy and curiosity, rewards, and social presence.

a. Increase Engagement by Active User Involvement

In order to increase engagement, users should be actively involved in a scenario. In a multi-user IS environment, this process may be facilitated by assigning clear roles to users. A study by (Leichtenstern & André, 2009) revealed that a setting where each user was assigned a role via an interaction device with a dedicated function helps organize interactions within a group, balances the level of interactivity and avoids dominant users. This setting promoted collaboration among users in a better way than a setting where just one interaction device

was given to the whole group or a setting where each group member was equipped with an identical device. Based on these findings, they assigned roles in ORIENT, an IS system that teaches cultural empathy.

b. Increase Engagement by Bodily and Emotional Involvement

According to (Lindley, Le Couteur, & Berthouze, 2008) and (Bianchi-Berthouze, Kim, & Patel, 2007) there is empirical evidence that interaction devices that encourage natural movements help contribute to higher user engagement. (Newman, 2002) found that movements, such as reeling, swerving, and ducking increase engagement, even when they are not registered by the game. Interestingly, bodily activity not only increases the players' engagement, but also modifies the way people get engaged. In a study conducted by (Bianchi-Berthouze, Kim, & Patel, 2007), the players were given a guitar gadget to control the game. The players quickly entered the role of musician suggested by the game. Beyond the basic control of the game, they started to perform task-related motions that were not required by the game, but were appropriate to the musician role. Gaming thus was not only a challenge; it was the experience itself that rewarded the players.

A similar effect was reported during an evaluation of the IS system Façade (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007). The users of an immersive augmented reality version were seen to behave more artistically compared to the users of the desktop-based version. They intentionally used their bodies in dramatic ways suitable to the scenario. Moreover, the bodily interaction has led to a stronger emotional involvement of the participants who reported that they had the feeling they were experiencing the situation in real life.

The work by (Lent & Swartout, 2007) emphasizes the need to involve users emotionally in games order to achieve a higher level of engagement.

c. Increase Engagement by Awaking Fantasy and Curiosity

Unrealistic and unusual concepts have proven to be able to increase engagement of users, since they can awake their curiosity and fantasy (Malone, 1980). Malone distinguishes between two types of fantasies: intrinsic and extrinsic. In the case of extrinsic fantasy, a problem, e.g. solving a mathematical equation, may be simply overlaid with a game, for example, winning a sport competition. Whether or not gamers make progress towards the goal of the fantasy depends on their abilities to solve the posed problem, but not on events in the fantasy. In the case of intrinsic fantasy, a problem, e.g. learning cultural empathy, is presented as a component of the fantasy world, e.g. interacting with synthetic cultures in a 3D world. Here, there is a close connection between the application of skills and the fantasy world. Malone states that intrinsic fantasies are generally more interesting and more instructional than extrinsic fantasies.

A related fun factor discussed in the literature is curiosity, see (Lazzaro, 2004) and (Malone, 1980). According to Malone, games can evoke the curiosity by putting users in the environment with "optimal level of information complexity". The environment should be neither too complicated, nor too simple with respect to user's existing knowledge. Moreover, it should be novel and surprising, but not totally incomprehensible.

(Druin, 1998) points out that in particular children enjoy the use of interaction technologies which support their curiosity. Based on this work, the developers of the IS system ORIENT (Aylett, Vannini, André, Paiva, Enz, & Hall, 2009) made use of dance pads, Wiimotes and mobile phones.

d. Increasing Engagement by Stimulation with Intermediate Achievements

Intermediate rewards stimulate users to proceed exploring the interactive experience. A study on computer games conducted by (Nacke & Lindley, 2008) indicates that users appreciate rewards after execution of successful actions. The concept of rewards also relates to surprises and unusual situations introduced into the game. They raise the spirit of the players

and evoke curiosity.

e. Increasing Engagement by Appropriate Level of Complexity

In order to engage users, interaction with an IS should neither be too simplistic or too complex. In first case, users might get bored while frustration might arise in the second case. In a study which compared a traditional desktop-based version with an Augmented Reality version of the IS system Façade, (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007) found constant presence on the scene requires permanent attention from the user which may negatively affect IS experience, with users feeling obliged to react to scene changes and respond immediately to perceived cues of virtual characters. In their case, users preferred to take their time for replies and rethinking their input. The traditional keyboard-mouse environment satisfied these user needs in a better manner than the Augmented Reality version.

f. Increasing Engagement by Believable Character Performance

To increase the user's sense of presence, the characters driving forward a story need to be compelling. While for decades research has concentrated on geometric body modelling and the development of animation and rendering techniques for virtual characters, other qualities have now come in focus as well, including the provision of conversational skills as well as the simulation of believable behaviour including affect and peculiarities induced by individual personality traits (André & Pelachaud, 2010). A study by (Mehta, Dow, Mateas, & MacIntyre, 2007) has shown that user tend to forgive conversational breaks in a story as long as the character succeed in providing a compelling performance.

g. Increasing Engagement by Social Presence

Social interactions play an important role in interactive experiences. Various factors impact people's engagement and enjoyment related to social interaction. (Bryce & Rutter, 2003) and (Carr, Schott, Burn, & Buckingham, 2004) argue that it is the social interaction and participation that, to a large extent, explain enjoyment in digital games. Digital gaming brings many opportunities for social interaction. This concerns not only the active participation in the game, but also a passive observation of and communication with the active players, see (Carr, Schott, Burn, & Buckingham, 2004), (Lazzaro, 2004) and (Jansz & Martens, 2005).

Co-location by itself does not, however, guarantee behavioural engagement in multiplayer settings (deKort, Ijsselsteijn, & Gajadhar, 2007). Important characteristics of setting affording engagement include mechanisms, such as mutual eye contact, natural reciprocal interaction, avoidance cues and mirroring, and other emotionally relevant communication signals. Therefore, although physical proximity does allow for more intense and multi-sensory awareness and interactions than most mediated technologies presently do, in co-located settings we can also experience varying degrees of awareness, involvement, and engagement, i.e., social presence.

1.2.3 Immersion

The phenomenon of immersion was deeply studied in the context of computer games. Immersion roughly relates to the degree of involvement in a game (Brown & Cairns, 2004). A qualitative study conducted by Brown and Cairns analyzed players' feelings towards their favorite game and led them to propose three gradual and successive levels of player immersion: engagement, engrossment, and total immersion also known as presence.

- **Engagement.** In order to enter this level of immersion the players need to invest time, attention, and effort. The players, however, may not be willing to do so if they do not like the style of the game of if they do not manage to handle the game controls after some

time. That is the time, attention, and effort invested in a game should be rewarded with success.

- **Engrossment** is the second level of immersion. In this phase, the gamers invest a significant amount of emotional energy into the game. They are less aware of their surroundings than in the previous phase. This phase of immersion can be supported by audio-visual material, interesting tasks and plot.

- **Total immersion.** Total immersion is described by Brown and Cairns as a cut-off from reality. In this phase, gamers feel empathy with characters in a game and their situation. They immerse into the game so deeply that the game becomes "all that matter". The authors claim that totally immersive experiences are usually provided by first person perspective games as well as role playing games where the gamer impersonates a character. Taking on a first person perspective, a player can completely identify with the character.

Another classification is provided by (Ermi & Mäyrä, 2005) who subdivided immersion into three distinct forms: sensory, challenge-based, and imaginative immersion. The notion of sensory immersion relates to the audiovisual execution of games. This dimension of immersion is easily recognizable as it can be intensified through intensifying its components, such as creating more compelling graphics or playing on a much larger screen or with a surround speaker system. Imaginative immersion comes close to the definition of immersion used by (Brown & Cairns, 2004), describing absorption in the narrative of a game or identification with a character, which is understood to be synonymous with feelings of empathy and atmosphere.

The approaches above use the notion of immersion interchangeably with the notion of presence. We would like to note, however, that some works explicitly distinguish between presence and immersion (Witmer & Singer, 1998). While immersion refers to the fidelity of the technologies used, such as auditory or visual output, presence rather refers to the user's quality of experience, see also IRIS Deliverable D7.1.

(Hansen, Kortbek, & Grønbæk, 2008) found that the environment, surroundings, and even passers-by contributed greatly to the perception of a digital story: the participants of their IS experience stated that the city environment the story was based on helped them to dive into the story; strangers in the streets seemed to be involved in the play. Fitting sensory effects, such as lightning, animations, sounds, also increase user immersion into a scene (Lindley, Le Couteur, & Berthouze, 2008). Designers should thoroughly consider the environment the system will be played in, in order to match the effects to the surroundings and take advantage of them.

A complex and exploratory environment also has potential to increase immersion (Nacke & Lindley, 2008). Linearly structured levels are likely to bore players and diminish their motivation to proceed playing.

The experiment of (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007) has shown that Augmented Reality can increase people's sense of presence. Unlike the desktop-based version, the AR-version of Façade afforded motions in a physical space. It made the users feel like being in real life, and not in a computer game. It enabled them to readily use their every day knowledge and experiences to interact with the system.

In the context of interactive IS, immersion relates to the user's ability to feel in the role of a character and act for him or her. This process can be facilitated by appropriate scene, character and interaction design.

1.2.4 Story Flow

An IS system should guide users through a meaningful story scenario. As noted by Rowe and

colleagues, setting, plot and characters need to be consistent in order not to destroy the believability of the story. Consistency also refers to the use of interaction devices and modalities which should match the story. For example, using a mobile phone to communicate with a character from the 19th century would be in conflict with the user's conception of the story.

In addition, events and actions should follow a logical and causal order, see (Rowe, McQuiggan, & Lester, 2007). That is the user should understand how a story evolves. As a consequence, the impact of the users' interactions onto the story unfolding must be made visible and salient for the users. This basic experiential quality is described by the term **effectance** which is borrowed from the area of video games research. Effectance shows how clearly the user understands the causal dependency of his actions and the effect the actions have on the story. Effectance is considered an important precondition for meaningful user experiences; it is mostly connected to technical features such as processing speed and explicitness of feedback given to user inputs.

Particularly for IS experience it is critical to inform the user about the possible interaction possibilities, exits, and interaction borders. This can be done either by assisting technologies (such as virtual guides) or by constraining the interaction. For example, guidance can be achieved by means of the interaction space. The designers of the Mobile Urban Drama (Hansen, Kortbek, & Grønbæk, 2008) found that audio assistance can be beneficial for outdoor mobile IS experiences. However, guidance should then be provided in an unobtrusive way, such as "voices in your head".

Another important issue is story pacing. That is the speed of the story should match the users' means of interaction.

1.2.5 Conversational Flow

The deficiencies of current technology to process natural language input are a major threat to a consistent and coherent conversational flow. Thus, effective strategies are required to cope with these limitations. Based on an evaluation of the desktop-based version of Façade, (Mehta, Dow, Mateas, & MacIntyre, 2007) come up with a number of guidelines and recommendations for dialogue design in IS, such as avoiding shallow confirmations of user input and supporting the user's abilities to make sense of recognition flaws, see also the discussion of the Façade system in chapter 2.

Another important issue is the timing of user input and system output. An experiment by (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007) explores and contrasts two different interaction paradigms studied for Façade: in case of the desktop-based setting the interaction with the system happens in discrete steps; in the AR-environment interaction is perceived as continuous. Either paradigm has certain advantages. In continuous interaction, users face the constant possibility of intervention. In the case of speech input this interaction paradigm can be perceived as more natural: in a real-life dialogue, in principle we have the opportunity to post a phrase at any time. Moreover, in an explorative environment like AR, continuous interaction affords direct manipulation of objects. If an AR system supports a speech interface, users can explore the environment while simultaneously interacting by speech. These advantages significantly contribute to the perception of the interface as natural. Discrete interaction makes user intrusions more ordered. The cues for user responses are given in a much clearer fashion than in the case of continuous interaction. Moreover, the accuracy of user input is often much higher; typing usually allows more control over the responses. As a consequence, the interpretation of user input by the system is easier and the overall result can be much more robust.

Summary

The literature review provided us with insights and starting points to build the design guidelines for IS experiences. In particular, we identified four factors to be considered for IS interaction design: basic usability, engagement, immersion, story flow and conversational flow. It is important to note that most factors have been originally researched in related areas of IS, such as computer games. Therefore, an adjustment and refinement of these factors seems necessary. In the subsequent chapter, we will analyze four prominent IS using these four factors with the aim to extract concrete guidelines for interaction design in IS.

2. Discussion of Existing IS Systems

In this section, we analyze four prominent IS systems in order to identify promising ideas for interaction devices and modalities in IS. We do not discuss all strategies employed in the single systems, but limit ourselves to the most interesting ones. The systems surveyed support multimodal interaction via multiple interaction devices including text-based input, voice-based input, tangible as well as emotion-based interaction. Due to the specificity of the analysis, only systems that were available to IRIS partners could be considered.

2.1 ORIENT

2.1.1 ORIENT Story

ORIENT (Aylett, Vannini, André, Paiva, Enz, & Hall, 2009) was developed for teenagers aged 13 to 16 years by UOA in collaboration with other European partners within the e-CIRCUS project. The main goal of the system is to teach teenagers empathy with people from other cultures by making them aware of the cultural differences, including people's habits and customs. Beside this main objective, ORIENT also addresses other underlying goals, such as the objective to foster collaborations between users. To meet these goals, the teenagers go through a scenario simulating their visit of an unfamiliar planet called ORIENT. The culture the users meet on ORIENT are the Sprytes, a tribal genderless fantasy culture. The scenario is played by a group of three users each of them playing the role of a member of a spaceship crew. Their mission takes them to the small planet ORIENT, which is inhabited by an alien race. Since a fictional culture is portrayed in the scenario, the application is flexible and suitable for users with a different cultural background. In order to communicate with the aliens the users have to move in space, explore the environment, and perform actions.

2.1.2 Interaction in ORIENT

The scene with the virtual characters is shown on a large display in front of the players (see Fig. 1, left). Interaction in ORIENT is enabled by three different interaction devices: a dance pad, a mobile phone and a WiiMote. Navigation within the ORIENT world is via walking on the spot using the dance pad. The Sprytes speak a 'gibberish' related to the language output generated on the fly by the character minds, and this is represented in English (or German) text on the screen with the story world explanation of a high-tech translator device embedded in a mobile phone carried by a second user. This phone also allows the user to speak 'magic words' that act as symbols within the culture and for SMS communication with the characters. It can recognize RFID tags attached to real world objects that also have an existence in the virtual world. The third user carries a WiiMote, and this is used to replicate important gestures in order to successfully enter into greetings rituals for example.

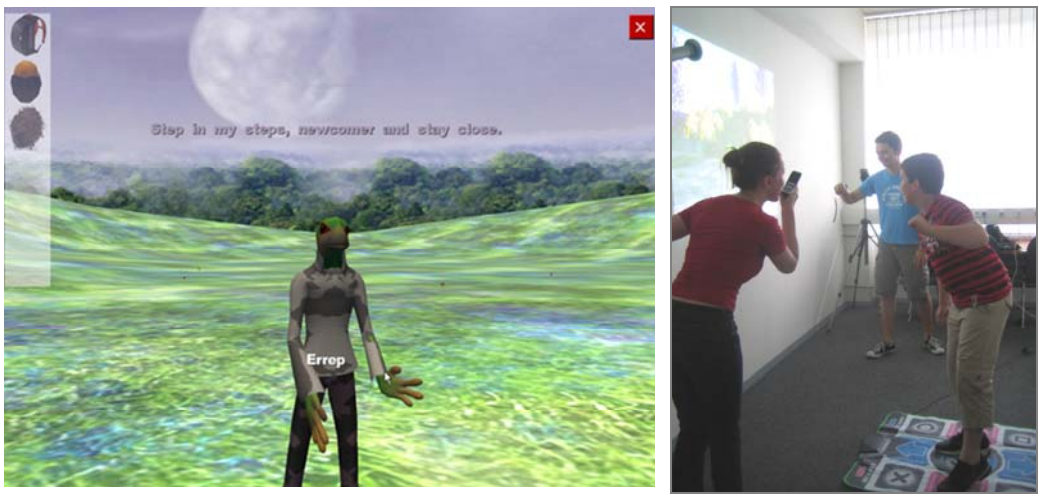

Fig. 1. ORIENT scene (left) and players interacting in a group (right)

The final version of the system introduced a mobile-based assistant, called the Oracle. This assistant provides the users with help how to proceed with the story. The Oracle was implemented on a second mobile device and belongs to the user responsible for the navigation with the dance pad. Figure 2 summarizes the interaction devices used in the ORIENT system.

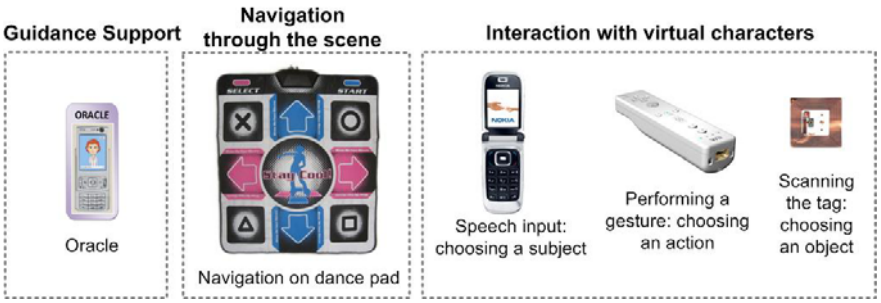

Fig. 2. Interaction devices in ORIENT

2.1.3 Analysis of ORIENT

Below we analyze the interaction devices and modalities used in ORIENT. We group the insights according to the factors identified in the previous chapter.

a. Basic Usability

Consider the Users' Cognitive, Motor and Perceptual Constraints

Since the children found it hard to learn WiiMote gestures to communicate with the Sprytes, the number of gestures should be reduced. The users could not remember them and often asked for help. A longer training period is no option since it would distract from the actual goals of ORIENT. It is crucial to consider the users' cognitive load during play in order to avoid frustration during interaction while still preserving the challenge.

Support Intuitive Interaction

Even though the artificial language used to enable communication with the Sprytes had a rather single structure and followed grammatical principles from Western languages, some

children did not always build sentences in the intended manner. Communicating with the Sprytes required a consultation of a manual.

Consider Deficiencies of Input Interpretation

Other sources of confusion were failures of the gesture recognition system which could also be improved by reducing the number of gestures.

Provide Clear Interaction Borders

The scope of the utterances understood by the system was not always clear. In IS where users interact using natural language or languages bearing some resemblance to natural languages, as in ORIENT, ideas from prompt design might help show the user how and when they can interact.

b. Engagement

Increase Engagement by Active User Involvement

The distribution of input devices based on the findings of the study (Leichtenstern & André, 2009) mentioned earlier helped involve all children actively in the story. Each interaction device has a different function, but all of them are necessary to accomplish the overall goal of the game.

Increase Engagement by Bodily Involvement

User interaction in ORIENT is based on bodily activity and manipulation of physical objects, for example, by scanning them using the mobile phone.

Increase Engagement by Inspiring Curiosity

The use of popular input devices, such as the WiiMote, made the interaction for the children more enjoyable and contributed significantly to their engagement despite of difficulties to memorize the gestures.

Increase Engagement by Believable Character Performance

In ORIENT, an agent architecture was used for synthetic agents in which emotions and personality take a central role in influencing behavior. In addition, the architecture allowed for cultural adaption. In this way, different characters were enabled to exhibit different behavior patterns contributing to their believability.

Increase Engagement by Social Presence

In ORIENT, several users engage in collaborative game play to learn cultural empathy. Having several users interact with ORIENT at the same time is supposed to increase their engagement in comparison to a single user scenario.

c. Immersion

Assure Immersion through Scene Design

Audio and video effects can increase user immersion into the story. ORIENT uses a background soundtrack of nature sounds (birds, trees) to immerse the users into the green planet scenario. This idea could be developed further, helping the user to “feel” the navigation along the scene or the moods of the Sprytes.

Assure Immersion through Interaction Design

In ORIENT, user interaction is based on the real, physical and tangible objects surrounding users and involves physically activity. Movement in physical space supports social behavior (gestures, speech, movements) and full body interaction that are particularly important in supporting the social nature of culturally-specific interaction. In this way, interaction design supports narrative immersion.

Assure Immersion through Character Design

In ORIENT, different characters were enabled to exhibit different behavior patterns contributing to their believability (see discussion of character believability in the paragraph on engagement).

d. Story Flow

Support Story Plot by Interaction Design

In ORIENT, we aimed at seamless embedding of the interaction devices into the story plot. For instance, the decoder device draws on the metaphor of a communication device which fits to the story scenario of a space command mission. Interaction devices and techniques should harmonically match the story plot in order not to break the illusion.

Provide Guidance through the Story

Guidance through the ORIENT story was supported by the Oracle assistant on the mobile phone. In case of confusion, users consulted Oracle about their further actions. The Oracle turned out to be a successful approach for user assistance; it was integrated smoothly into the story. Nevertheless, it has to be improved to act more intelligently. For example, if a question is formulated incorrectly or does not match the current scene, the Oracle currently just answers “The question is irrelevant”. This caused user frustration, since the users would be left without knowing how to proceed.

e. Story Flow

Leave Space for Interpretation of Deficient System Output

Dow et al. (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007) recommend to design communication in an IS in such as way that system failures in understanding human input can be interpreted by users as a proper reaction of the story. The scenario chosen in ORIENT supported such interpretations. In ORIENT the failures in gesture recognition could be interpreted as misunderstanding by Sprytes. If a part of the phrase (Subject, Action, or Object) was incorrectly given or recognized, the users could interpret it as language difference or wrong pronunciation.

2.2 FearNot!

2.2.1 FearNot! Story

The FearNot! system (Paiva, et al., 2004) was designed for school pupils in order to increase their awareness of bullying and prevent bullying in schools.

The drama unfolds in a school environment; it shows a pupil being bullied by the classmates. Through watching scenes of the victim’s school life, the user is expected to understand the problems of bullying and form suggestions and advice how to help the victim.

2.2.2 Interaction in FearNot!

FearNot! is a desktop-based system which uses keyboard input for interaction with the story characters (see Figure 3). The scenes of the story are shown to the user in a cartoon-like style: the short episodes each describe a situation where the victim, the main character of the story, is bullied by another pupil, the bully. The user is supposed to analyze the situations and can later give his or her advice how to cope with bullying.

Fig. 3. A scene of FearNot! (left) and subsequent dialog with the user (right)

After each episode the user may interact with the victim character in a text-based chat. The user enters the text from a keyboard. After applying a spelling corrector, the text is analyzed using a template-driven semantic parser. When the dialogue is finished, the story continues influenced by the suggestions and advice of the user.

2.2.3 Analysis of FearNot!

Below we analyze the interaction devices and modalities used in FearNot!. Again, we group the insights according to the factors identified in the previous chapter.

a. Basic Usability

Support Intuitive Interaction

The users can input their text in a free form. Although this may cause errors in input and interpretation of typed sentences and thus cause usability problems, the developers of FearNot! decided to use free-style natural language input. First, children should be able to express themselves without any limitations. Second, unconstrained input helps encourage children to improvise, to think about the bullying problems displayed, and propose their personal advice to the victim. In order to facilitate the communication of the children with the characters, the developers equipped the system with a spelling corrector. That is also erroneous input by the children could be in many cases correctly interpreted. In addition, the use of a parser that is also able to come up with an interpretation if only part of the input can be recognized by the system ensured that even complex sentences could be assigned in most cases a meaning by the system.

Consider Deficiencies of Input Interpretation

In text-based chat systems, the system may not only fail to recognize a user is still typing and interpret long phases of inactivity as lack of input: the system may furthermore fail to understand the typed input correctly, e.g. due to missing keywords in the system dictionary. Finally, the system may parse user input successfully, but be unable to react appropriately, e.g. due to missing strategies for the concrete case. In order to avoid user frustration and

mask the erroneous recognition or missing strategies, the IS system should provide acceptable fallback reactions for such situations.

In FearNot! the text interpreter routes user input into one of three directions, depending on whether the input has been recognised or not, or whether no input was made:

- If the user types a reasonable sentence that can be interpreted successfully by the system, the victim character continues the dialogue by developing the topic: “Why do you think it will help?” Afterwards, independent of the user reply, the system adjusts the strategy to the user suggestion; the victim character thanks the user and ends the dialogue.
- If the user does not provide any suggestion, the victim character starts to propose suggestions on his or her own. The victim discusses in a monologue which means could help, until input from the user occurs. However, if there is still no input, the victim will end the dialogue, choosing one of the suggestions they proposed.
- If the user’s input cannot be interpreted correctly by the system (or the user gave some unreasonable input), the victim again starts to suggest the next steps themselves. A similar coping strategy is chosen as in the previous case. The same strategy is applied if the system recognized the input, but the agent is not able to follow it due to technical limitations, such as missing graphical content. The user is supposed to agree or disagree with the strategy. In case of disagreement, the system will make more suggestions. Finally, after repeated disagreement, the system chooses one of its own suggestions.

The system thus attempts to intelligently ignore erroneous or deficient user input and provide suggestions for the further unfolding of the story. This style is in line with the story scenario: in a human dialogue we usually propose own topics or suggestions if we do not understand our counterpart, or if the counterpart is silent.

b. Engagement

Increase Engagement through Active User Involvement

The interaction with the system was enabled only during the dialogue sessions between the scenes. The children appreciated these interaction moments, they felt important because the victim was seeking their personal advice.

In order to involve the children even more, interaction could be extended also to the bullying scenes. For example, a child could represent and control one of the victim’s friends. The helping value of the child would grow and thus probably their involvement into the story would increase.

Increase Engagement through Believable Character Performance

In FearNot!, an agent architecture used for synthetic agents in which emotions and personality take a central role in influencing behavior and thus achieving more believable agents.

c. Immersion

Assure Immersion through Scene Design

The scene design of FearNot! system was created in a computer-game style. The user sees a scene with animated cartoons supported by audio. The voices of virtual characters are synthesized to sound natural and childlike. Flattering emotional statements like “you’re a good friend!” or “thanks a lot!” occur often in dialogues; these phrases are appreciated by children and often taken seriously by them.

However, in some scenes the dialogues between the characters appear artificial and

unnatural. For example, in one scene a pupil invites four girls to her birthday party by repeating the same invitation phrase four times. Such a “computerization” of the story disrupts the story atmosphere and immediately makes users realize it is just a computer animation. Such flaws should be carefully validated and tested against. It is particularly important if the system imitates a style of a familiar medium, such as a cartoon. The children are used to watch the cartoons which may have imperfect graphics and unrealistic characters, but the dialogues are perfectly articulated, realistically structured, and adequately address the scenes. Correctness and more diversity in the language used by the characters thus was a major point of criticism by the children.

As mentioned before, the reaction of the victim sometimes did not match the actions proposed by the user. This sometimes happened due to the limited strategies included in the agents’ behaviour repertory, sometimes because the emotional state of the victim prohibited actions such as attacking the bully. As a result, the system response and further unfolding of the scenario was difficult to understand. Such misunderstanding led to frustrations and thus influenced user immersion negatively.

The visualization of the scene was found appropriate by the majority of young users: the cartoonish appearance of the characters entertained the children and helped them to tune themselves into the school scenario.

Assure Immersion through Believable Character Performance

In FearNot!, agents were parameterizable as individuals contributing to their believability (see paragraph on engagement).

d. Story Flow

Support Story Plot by Interaction Design

The interaction in the form of a dialogue was chosen for FearNot! since this reflects a typical problem-solving situation in a school bullying scenario. If a pupil faces bullying problems, they go to a friend or parent and talk to them in an intimate quiet atmosphere.

Still, text-based chatting is not the most natural way to interact in such situations. Usually people (still) use speech to describe their problems: we meet our friends to talk personally or call them by phone. Therefore, a better interaction modality for FearNot! would have been a speech interface with free speech input (as discussed above, free input encourages users to generate personal advice and helps them immerse into the scenario).

However, a serious disadvantage of a speech interface would be the increased error rate while processing the input. A compromise in the FearNot! case could be provided by a text-based interaction (less error prone) offered through real communication devices used in everyday life. For example, typing the advice and suggestions as text messages in a mobile phone would look realistic and fit the problem-solving scenario. On the other hand, reality is quickly catching up with the current setting, with e.g. the diffusion of netbooks also and particular among school pupils.

Finally, the dialogues seemed to be too short to be realistic for advice-asking scenarios. Indeed, when people are in a trouble, they tend to talk significantly longer to a friend, not just to ask for their help but to also feel their participation and support. The victim character in FearNot! closes the conversation rather quickly each time the current point was clarified.

Support Guidance through the Story

Guidance in FearNot! is provided by text overlaying the scene. The text explains the situations and helps the user to proceed through the story. The dialogue interface via which the children interacted with the characters was designed with the aim to be self-explanatory. However, it is important to mention that limitations in input or offering a vocabulary of possible input key words may have also beneficially provided guidance through the story,

guaranteeing that the user would stay on the plot line or divert from it in predictable ways and preventing unexpected reactions from the story characters (as in case of wrongly interpreted input), and thus supporting the overall flow of the story.

Give Users Means to Express Themselves

The users can input their text in a free form. Although this may cause errors in input and interpretation of typed sentences, we decided to use free-style natural language input. First, children should be able to express themselves without any limitations. Second, unconstrained input helps encourage children to improvise, to think about the bullying problems displayed, and propose their personal advice to the victim. As a result, the degree of immersion into the story was expected to be increased, and interruptions due to input limitations were avoided.

Generate Plausible Responses to User Input

At the end of each interaction episode, one coping strategy was always selected and communicated to the user: either the strategy proposed by the user or a strategy suggested by the system. As a result, the user was expecting to see the victim following the chosen coping strategy. However, as the victim character was autonomous in its actions in order to make the story more interesting and emergent as well as realistic, its emotional state often prevented them to apply the coping strategies and confront the bully. However, it was often not obvious to the child why the victim did not apply the strategy announced. To avoid such problems, the reasons behind the characters' actual decisions need to be communicated to the user more plainly. For example, if the character is too scared to follow the user's advice and does not dare to fight back, the character's body posture, gestures and facial expressions should communicate its emotional state more clearly or the character should begin the next interaction episode by explaining that they were e.g. too scared to fight back.

e. Conversational Flow

Synchronization of User Input and System Output

As typical for text-based chatting systems, FearNot! suffers from issues of overlapping text input and system output. Although the speed of typing differs from user to user, the system interprets longer delays in user input as missing input. The fact that the system is targeted at children (of roughly 10 years of age) further aggravates this problem because children at that age still tend to type slowly. Thus, the system produces a response for missing input – for example, it prompts again to propose a coping strategy – even though the user is not yet ready to post their response. Since the user is now prompted to start over and reply to the new phrase generated by the system, this may cause the player to get stuck with this issue.

A similar problem arises if the user input arrives just after the system has posted a new message, since the system then expects an answer to this new message, not the previous one. Such asynchronicity of input is another classical issue in text-based chatting systems. A solution approach could be to make the system aware the user is still typing. The system may recognize that the user types something into the text field and wait until the input is finished. In this case the user should get a visual feedback that the system perceives they are typing and waiting for them to complete. However, pauses in the typing activity due to pondering over the strategy may not always be distinguished correctly from other pauses.

The problem of differing typing speeds (the victim was often significantly faster than the users) was seen as a severe issue hindering the interaction experience: "*I could not finish because it went on too fast*".

Provide Clear Interaction Prompts

The pauses between the scenes of FearNot! appeared to be too long during the first trials of the system. As a result, it was anticipated that users might get the impression that an input or an interaction from their side was required where in fact it was not. On the one hand, this

observation can inform designers how to afford interactions, how to convey soft cues prompting for interaction. On the other hand, long pauses without opportunity for interaction may lead to frustration if users do not know how to cope with the pause.

Tests showed that users who tried the system several times in fact adapted to these pauses easily. The children understood that only the dialogue sessions are interactive, and that they were expected to watch the other scenes passively. Nevertheless, the children could have been given clearer hints regarding the time point of interaction phases.

Leave Space for Interpretation of Deficient System Output

Errors in input interpretation or deficient input are processed with the coping strategies described earlier. Whenever the system cannot recognize the sentence entered and cannot extract any reasonable cue from it, the victim will kindly ask the user again whether they can think of any solution. After a couple of unsuccessful attempts the system will start to propose its own suggestions and finally follow one of them.

Although this approach may appear to address human behaviour and errors in human interpretation, it was not well accepted by the users. Indeed, if the user types in some reasonable sentence that cannot be processed they are left wondering why the victim keeps asking for advice, or suddenly proposes something else. As already mentioned, such reactions were attributed to as the victim's ignorance. As a consequence, users felt not attended to and thought the victim did not hear them or found their advice to be useless. As a consequence, this caused aggression against the victim – a much undesired result for a bullying-preventing system.

As already explained, this problem is due to the fact of that misinterpretation and error handling was hidden from the user.

2.3 Façade

2.3.1 Façade Story

A family drama unfolds in the Façade story (inspired by E. Albee's play, "Who is afraid of Virginia Woolf?"). A couple married for ten years experiences a crisis in their relationship. The user represents a friend of the couple who is invited for an evening to the couple's flat. During the evening the user notices the tension between them which is reflected in their dialogues and actions. The user communicates with the couple and is able to influence the course of the story.

2.3.2 Interaction in Façade

The initial version of Façade was implemented as a desktop-based IS. The user interacts with the system by means of keyboard and mouse: the keyboard is used to type in phrases and to navigate inside the scene, and the mouse is used to select and manipulate objects. As mentioned in the first chapter of this deliverable, an augmented reality-based version of the system was also developed. Here, the scene is displayed by means of AR equipment; the user interacts with the characters by speech.

Fig. 4. A scene of Façade, with the characters, Trip and Grace (source: www.cc.gatech.edu/arfacade).

The study we provide below is related to the first version of the system: i.e., the desktop-based Façade (see Figure 4). We analyzed the system following the scheme used in previous sections.

2.3.3 Analysis of Façade

Below we analyze the interaction devices and modalities used in two different versions of Façade grouping again the insights according to the factors identified in the previous chapter.

a. Basic Usability

Support Intuitive Interaction

Interaction with Façade occurs by means of the keyboard and the mouse. The letter keys on the keyboard are used to maintain the dialog with the system. The arrow keys are used for navigation inside the scene. The mouse is used to manipulate the objects inside the scene. Although such interaction means may seem intuitive for computer game players, they are not self-explanatory for inexperienced users. Computer illiterate users have to look up the instructions in advance.

A not yet covered issue with text-based IS systems regards the fact that the users often believe they can split long utterances over multiple conversational turns. In fact, the system interprets every inserted utterance separately and generates a related response.

Provide Reasonable Feedback

The Façade experience provides several ends of the story. Depending on user actions and phrases, the couple, for example, may be reconciled or the quarrel develops so extensively that the couple sends the user out of the flat. Along the way to the story end, the user contributes to the development of the conflict with their phrases and questions. By means of the characters' reaction the system informs the user about the success and effect of these actions.

b. Engagement

Increase Engagement through Appropriate Level of Complexity

As discussed in the first chapter of this deliverable, even though the setting of desktop-based Façade does not provide any embodied or tangible interaction, users reported higher engagement compared to the AR-based setting (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007) since they felt cognitively stressed by the AR version.

Increase Engagement by Believable Character Performance

An evaluation of the Façade system (Mehta, Dow, Mateas, & MacIntyre, 2007) gave an interesting insight into the phenomenon of engagement in IS. Among other findings, the authors state that believable character performance maintains engagement. Indeed, even during a clear conversational break, the facial expressions of the characters, their behavior, and reactions support user engagement. The study reports how users still perceived the characters and the scene positively, even during system flaws ("Look at her, she is staring at me, straight faced"). The various positive comments indicate that, even during conversational breakdowns, believable verbal and nonverbal character performance can help maintain engagement.

c. Immersion

Assure Immersion through Scene Design

In spite of 2 1/2D graphics, the Façade scene makes a very natural impression. The interior of the room and the layout of the flat are very realistic and show sufficient details and objects to sustain an extended conversation, the authors made significant investments in ensuring smoothness of animation. An important aspect in Façade is the audio support of the scene. The voices of the characters are very natural; they speak with realistic intonations, and utter reasonable phrases. Ambient sounds, such as of wine being poured, strengthen the perception of the scene as natural.

d. Story Flow

Support Story Plot by Interaction Design

The dialogue format of user interaction matches the story plot of Façade. The problem unfolds around a family drama; the user's aim is to engage with the couple and e.g. try to solve their problems in a conversation. The dialog format is the most natural and suitable way for this. However, the issues with dialogue pace hamper the idea behind the interaction design. The interruptions and resulting abrupt phrases by the characters can prevent users from formulating constructive help.

Support Guidance through the Story

The story starts with a telephone call against a dark scene. The husband of the couple, Trip, invites the user to the evening. The beginning of the story is given, in a natural and dramatic way. Then the first scene of the evening is shown: the user stands in front of the entrance door to the couple's flat. A quarrel is heard from inside the flat.

The user thereby gets an initial grasp of the story and can anticipate the atmosphere of the upcoming encounter. Since the situation of a quarrel is familiar to many users, they get an idea of how they could behave in such a situation.

The introductory scenes explain very well the problem unfolding in the story. Basically, no additional guidance is needed, since people mostly know from their own life experience how to behave in such situations, and what steps to undertake e.g. in order to try to influence the behaviour of the quarrelling couple.

The authors provide an additional description of the story at the beginning, along with interaction instructions.

Balance Interaction Freedom and Predefined Story Plot

Since the user input in Façade is realized by means of free text input, the user can choose and develop infinitely many different topics. The system, however, maps the phrases that are input to a limited set of reactions. These reactions define the further behaviour of Façade

characters; they are aimed at unfolding the story in one of the predefined directions.

If the user happens to "dig" into one topic too deeply, the system may not find a proper response on it, or it may already have used up all the available responses. In such cases, Façade generates a so called Push-Too-Far reaction: the characters respond negatively to repetitive questions. For example, if the user keeps asking questions about the interior, the character Grace first kindly comments on every question. However, at some point she just responds aggressively that she does have noticed the user's interest about the flat's interior and does not want to develop this topic any further. On the one hand, such reaction may seem unfriendly and offensive. On the other hand, it fits the story scenario well where the user maintains the conversation with a quarrelling couple.

Another plot-supporting strategy used in Façade is the Generic-Deflect reaction. If the system is unable to interpret a user utterance, or cannot find a suitable reaction strategy, it tries to believably ignore the utterance and move on with the story.

The mechanisms of Push-Too-Far and Generic-Deflect aim at believably limiting the depth of user intervention to the predefined story plot.

Adequate Pacing

The experiences of Façade evaluation (Mehta, Dow, Mateas, & MacIntyre, 2007) show that players need an appropriate 'timing' in order to interact well with the system. For instance, some players felt that the conversation in Façade had a pace of a "run-away train". The characters were moving on before they had sufficient opportunities to address a particular topic. As a consequence, these players felt that losing the timing during the interaction prevented them from having a better experience: "*At this point I was feeling a bit removed because I lost my timing… Once I lost it, it kind of felt like it was gone for the whole rest of the time*". In contrast, some players felt that characters "paused" in response to player's input and it was not possible to say anything at any time as it "disrupts the flow".

e. Conversational Flow

Synchronization of User Input and System Output

The user interacts with the Façade system by means of text input via the keyboard; the output of the dialogue from the side of the virtual characters is, however, rendered as speech. Therefore, mixed interaction styles are involved in the communication. It goes without saying that the process of typing is usually much slower than pronouncing a phrase. Thus a timing problem arises in Façade: while user still types the reply to the last phrase of a character, the characters often already starts a new topic, or already asks the next question. This replicates the problem already encountered with the FearNot! system. The nature of text-based chats causes delays in user replies which are often interpreted by the system as silence.

These synchronization issues severely impact the fluency of dialogue in Façade. In order to attend to the user, characters will interrupt a phrase and try to generate a reasonable reply. Such interruptions may in principle appear to be natural (i.e., mirroring how we would do in real life), but their recurrence decreases user motivation to write complex phrases. Indeed, there is no time to write reflected, deliberated pieces of advice – the characters take over the initiative and develop the dialogue in their way. This problem directly relates to the conversational pacing of story discussed below.

Another product of synchronization issues is the wrong interpretation of user intentions. While users reply to the characters' previous phrase, the system may generate a next phrase implying an opposite meaning and reverse development of the topic:

Trip: No we need -- we need to talk about us both, not just one.
(Player starts typing "ok" in response to Trip, however Grace says the following while the player is typing)
Grace: Adam, you -- you blame me for all this, don't you?

Player: ok
System interpretation: Agree with Grace

In this case, the player means to agree with Trip. Since Grace's phrase is generated as the player is still typing, the system switches to Grace as implicit addressee. Therefore, the user's agreement "ok" is finally addressed to the wrong phrase and person, hence messing up with the original intention of the user.

Provide Clear Interaction Prompts

Façade's interaction exploits the metaphor of a natural dialogue. Therefore, the users are automatically aware of the opportunities for their turns. Just as in real life, the users can post a reply when the characters expect their answer or when there is a pause in the dialogue.

As we mentioned before, this natural way of interaction is hampered by the differences in the paces of input and output. Delayed user replies cause interruptions in the dialogue. Intuitively, we want to minimize such interruptions, leading to short replies (that furthermore should be typed with some dexterity).

Leave Space for Interpretation of Deficient System Output

Failures of input interpretations are masked in Façade by means of the dialogue-based scene. According to the scenario, the couple experiences problems in their relation. The replies and suggestions of the user shape the further development of the dialogue. If the system is unable to choose an appropriate development based on user input, it may take time to generate an alternative continuation. During this time the characters may not produce any response to the user. However, this system delay does not appear to be distracting: it is perceived as a process of considerations and thinking that the couple needs to act further.

Provide Plausible Response to User Input

The dialogue system of Façade intelligently processes deficient user input or erroneously interpreted user input. Since three persons take part in the conversation, the two virtual characters take over the dialogue initiative in case of missing or insufficient user input. The responses of the characters towards user silence are designed in a natural, believable manner.

Avoid Shallow Confirmations of Input Interpretation

The evaluation results of Façade indicate that the users react negatively to a shallow level of information about the system's understanding of their input. Instead, the system should generate believable reactions from the characters' side, but keep it on the level similar to human conversations. Shallowly understood player input incorporated into verbal output gives players a clearer perception of the actual understanding capabilities of the characters. This however decreases the feeling of leading a real conversation.

Avoid Reverse Meanings

Wrong interpretation of user input is, unfortunately, a typical issue of any free-input based system, whether the input is given as text, speech, or other modality. In the worst case, the interpretation error will generates a system reaction which is the exact opposite to the one intended by the user. The evaluation of Façade confirmed that the players have strong negative reactions to meaning reversals. They experience frustrating communication breakdowns, with the characters seemingly having heard the opposite of what they actually said. The authors conclude that a better strategy would be to ignore user input altogether when the system detects an interpretation conflict. This ignoring can be played out as if the characters did not understand the user phrase and kept on maintaining the conversation.

2.4 EmoEmma

2.4.1 EmoEmma Story

The interactive installation described in (Cavazza, Pizzi, Charles, Vogt, & André, 2009) and further developed within IRIS illustrates an episode from Flaubert's novel "Madame Bovary". The main character, Emma Bovary, is bored by her life at the country side with her husband, a local doctor. One day a rich landlord, Rodolphe, visits her. Emma feels empathy towards Rodolphe and is ready to go for a story with him.

The IS system represents the scene of Rodolphe's visit. Two persons participate in the scene: the virtual characters of Emma and Rodolphe (see Figure 5). The dialogue between them is supposed to decide the future development of their relationship.

2.4.2 Interaction in EmoEmma

The scene of the IS system is displayed on the screen (desktop screen or large immersive vertical screen). The character of Emma is located in the centre; she talks to Rodolphe by means of speech. The user provides the phrases from Rodolphe's side by means of a natural speech input with a microphone.

Emma's reaction to user replies does not depend on the content of the user utterance. Instead, it is solely generated based on affective information extracted from the user's voice.

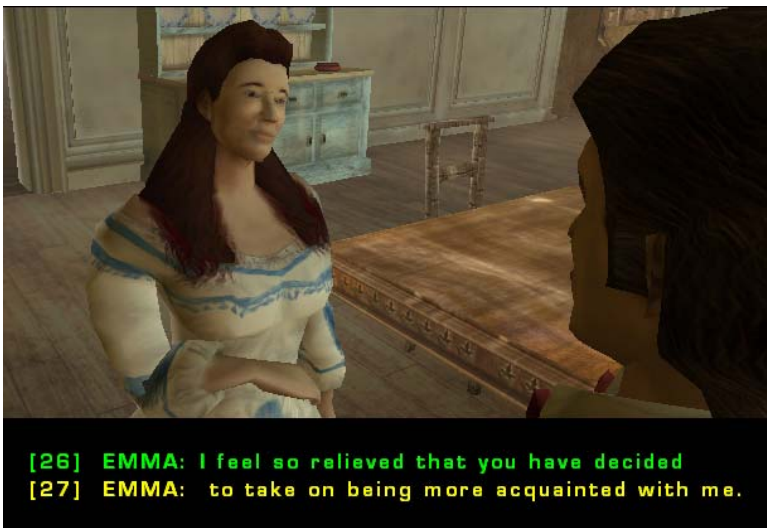

Fig. 5. The scene of EmoEmma

2.4.3 Analysis of EmoEmma

Below we analyze interaction in EmoEmma grouping the findings into the factors introduced in the previous chapter.

a. Basic Usability

Provide Interaction Guidance

Subtitles are displayed in parallel to the voice. They provide a valuable support for the users not well versed with English. The subtitles appear in different colours (white, yellow, and

green), and the lines are numbered. There is no meaning encoded in the colours of lines, which could give rise to user confusion.

b. Engagement

Increasing Engagement through Active User Involvement

Playing the role of Rodolphe, the main character in the scene, taking on a first-person perspective, had a positive influence on user engagement (Cavazza, Pizzi, Charles, Vogt, & André, 2009). For example, users familiar with the story tried to behave and reply the way a player of a seducer role would do. In contrast, alternative approaches of assigning the user the role of a third person in the scene or of just a spectator giving advice to Rodolphe could be expected to decrease user involvement into the scene.

Increase Engagement through Emotional Involvement

EmoEmma makes use of a novel interaction technique based solely on emotional speech recognition which helps users to get emotionally involved. To drive the story forward, the user is requested to express emotions via voice.

Increase Engagement through Believable Character Performance

The user's input is analyzed in terms of the current narrative context, which includes characters' beliefs, feelings and expectations, to produce a specific influence on the target character, which will become visible through a change in its behavior, achieving a high level of realism for the interaction

c. Immersion

Immersion by Scene Design

The scene in Madame Bovary is centred on Emma. This viewpoint addresses the situation of dialogue represented in the scene. The user plays the role of Rodolphe. Only Rodolphe's head is seen in the foreground of the scene. This is to help the user to immerse in the situation: the perspective view of the Rodolphe's head is to make the user identify with this character in the foreground.

The user has no control over navigation of the Rodolphe character. However, the design of the scene (the automatic camera system is centred on Emma, with Rodolphe standing in front of her) does not require the user to navigate Rodolphe. The scene aims to simulate a real-life dialogue situation: the counterparts stand in front of each other; they focus their views on each other, and usually do not move much in physical space. Moreover, such a setting addresses the user's position while interacting with the system: the user sits or stands in front of the microphone, watching the monitor and is not supposed to move.

In order to increase immersion in such a setting, a larger screen can be used, for example, a CAVE-like screen. The virtual characters can then be of human size and the room ambience can take on a more realistic look.

d. Story Flow

Support Story Plot by Suitable Interaction Devices:

As mentioned earlier, interaction devices and techniques should harmonically match the story plot in order not to break the illusion. Madame Bovary uses speech and emotional input for story control since this interaction technique is most appropriate for the setting and the scenario (Cavazza, Pizzi, Charles, Vogt, & André, 2009).

Provide Guidance through the Story

A background voice assisted by subtitles on the screen introduces the initial story and draws the plot to the visit of Rodolphe. The animation on the screen illustrates the narration.

Subtitles are displayed in parallel to the voice. They provide a valuable support for the users not well versed with English.

Give Users Means to Express Themselves

The analysis of emotions from speech allows the user to take part in dialogue with virtual actors without any constraints on style or expressivity, by mapping the recognized emotional categories to narrative situations and virtual characters feelings.

Generate Plausible Responses to User Input

The emotional category extracted from the user utterance can be analysed in terms of the current narrative context, which includes characters' beliefs, feelings and expectations, to produce a specific influence on the target character, which will become visible through a change in its behavior

e. Conversational Flow

Leave Space for Interpretation of Deficient System Output:

Playing the part of Rodolphe, the user speaks utterances into a microphone. Depending on the interpretation of the user's dialogue actions, the story develops in two directions: either Emma leaves the scene in despair (negative ending) or she engages with Rodolphe (positive ending). Even though the system just extracts the emotional tone from the user's voice input and does not conduct a semantic analysis, the setting gives enough interpretation space for Emma's reactions. Indeed an evaluation of the system showed that users more or less had the impression that Emma understood what they were saying and appropriately responded to their input. The fact that Emma did not interpret the semantics of their speech, but just analyzed the emotional tone did not have any documented adverse effects on the users' experience; they perceived Emma as a realistic character.

2.5 Discussion: Comparing Interaction Specifics of Evaluated Systems

In this section, we summarize the observations collected in the previous section. The summary and analysis play a critical role in deriving guidelines for interaction design of IS systems. We compare the reviewed systems and look at advantages and disadvantages of their designs.

2.5.1 Input Strategy

Text-based Input.

Free text input has certain advantages and disadvantages. On the one hand, free input encourages creativity, enabling users to develop ideas more broadly. This is especially important in systems with pedagogical goals such as FearNot! On the other hand, free input yields many sources of recognition errors. First, typed sentences may contain spelling errors. Second, the interpretation mechanism may be unable to find a suitable reaction to successfully parsed input. Finally, the user may split input into parts, in which case a reactive interpreter will look for suitable replies to each of the individual parts, which does not match user intention.

Keyword-based text input is much less error prone. Even more robust performance can be reached with menu-based input. However, such interaction styles are easily received as boring, less intuitive, and restrictive.

Speech-based Input.

Free speech input can be seen as the most natural way for a dialogue, mirroring the way we interact in real life. However, interpretation errors are even more probable for speech input than for text-based systems.

An interesting way to exploit speech was offered by the designers of EmoEmma (Cavazza, Pizzi, Charles, Vogt, & André, 2009): they only extracted emotions from speech in order to control the unfolding of the story. The approach ignores the content semantics of the pronounced phrases and bases the character reaction only on affective cues. This method appears to deserve further investigation, also to clarify actual performance characteristics. Particular potential could be given by the fact that users may be induced to behave more artistically it may also inspire their creativity, and encourage to experiment with the system.

As for the typed variants, keyword-based speech input is less error prone than free input. If the system is trained accurately and the restricted speech input fits the story scenario, keyword spotting may support harmonic user interaction. For example, in the ORIENT system keywords are used to identify aliens by name: a limited vocabulary that mirrors how we address people in real life.

Gesture-based Input.

Gesture-based interaction usually implies a limited set of gesture-keywords that trigger certain actions. If the system is properly trained and gesture recognition rate is sufficiently high, this kind of interaction can positively contribute to user engagement. Since gestures imply bodily activity, user involvement into the story is likely to be increased. Moreover, bodily activity may enhance the user's feeling of playing a specific role.

Direct Manipulation.

Direct interaction is also known to enrich user involvement into the story. Interaction by means of tangible objects or graspable devices that fit the story scenario enhances user experience and makes them feel the story to be "closer". This approach is especially valuable for IS systems for children: young users appreciate graspable toy-like objects. This kind of interaction is easy to understand: control over the digital story is achieved via objects similar to those known from real life. No technical bridges need to be built in order to understand abstract concepts such as for keyboard, mouse, or other auxiliary interaction devices.

2.5.2 Interaction Devices

The critical point when choosing interaction devices for an IS experience is to provide a harmonic fit to the story. The appearance of the devices, their functionality, and the interaction they offer should supplement and support the story plot. For example, in ORIENT innovative devices (Wiimote, Dance Pad, mobile phone) perfectly match the story about a visit to an alien planet.

Innovative interaction devices have shown to contribute to the engagement of users. Experimenting with modern devices seems to increase users' interest in the story along with the innovative interaction techniques. This holds especially for children, since their curiosity is often higher that that of adults, and their life experiences are still limited. Care must however be taken for attention to remain focused on the story.

2.5.3 Affording Touching / Bodily Interaction

Experience reports from evaluations of the Façade and ORIENT systems showed that bodily interaction may increase user immersion. For example, an immersive AR-environment affords direct interaction with the objects, it affords "touching" and thus brings users the feeling of presence on the stage. Natural settings can be an important factor in building this kind of experience: interaction in an AR environment reminding (or simulating) real life environments. This feeling of presence was not observed with desktop-based environments, where the users interact with the scene by means of keyboard and monitor interface.

However, natural settings and induced presence do not necessarily increase user engagement (Dow, Mehta, Harmon, MacIntyre, & Mateas, 2007). Desktop-based settings and text input do have their advantages: even though users feel more isolated from the scene, they feel to be afforded more time, e.g. to consider their responses and verify the spelling of their phrases. Moreover, some users liked the feeling of being not permanently present on the stage: they felt less stressed and less obliged to respond immediately.

In a multimodal setting, like ORIENT, bodily interaction is aimed at increasing user engagement. Since the IS experience was designed for children, it is critical to offer them a graspable interface or the interaction which involves body motions. In this way the IS experience is received as a kind of play: graspable interaction devices facilitate playability.

The opposite phenomenon is observed when children interact with text-based desktop IS experiences. The evaluation reports of FearNot! show that children were not as willing to play again with the system; basic robustness issues corroborated the formation of negative impressions.

2.5.4 Balancing Interaction Freedom and Predefined Story Plot

IS systems use various interpretation mechanisms to decode user input and adjust their reactions. The bottlenecks here are the situations when the system recognizes a conflict in the interpretation process, is unable to interpret the input, or cannot find an appropriate reaction to user input. From the experiences of the observed IS systems we can reach the following conclusions:

- In case of the conflict in interpretation process or if the system is not able to interpret the input, it is often better to ignore the input completely. This holds for dialogue-based interaction, particularly if more than two characters participate in the dialogue. Ignoring an input phrase will not harm the dialogue in most cases; unless it does not occur too often, it may even improve the impression of a natural interaction and will not interrupt the overall flow of conversation.

  If the dialogue occurs only between the user and the character, ignoring of input will likely be perceived as annoying. Experiences from the evaluation of FearNot! show that ignoring user suggestions even induced aggressiveness in children. In this case, a more fine-grained strategy should be followed, for instance, attempting to identify phrases that could mask gaps in the interpretation, but at the same time convey clear clues that the system failed to accept the input.

  Ignoring of user input can also be masked by the story plot: for example, in ORIENT problems with interpretation can be subsumed as communication problems with aliens.

- If the system cannot find a suitable reaction strategy to reflect the user input, it should generate a robust fallback reply. The reply should fit the overall story plot as well as the interaction style. For example, designers of Façade implemented the mechanisms of "Push-too-Far" and "Deflect".

  FearNot! processes such situations in a slightly different way: if the system cannot find an appropriate reaction to the user input, it offers standard alternatives. For example, if the user types a pieceof advice, but the system does not have a suitable episode, it proposes

another advice to the user, and gently asks if for the player's opinion.

Restricting user input generally helps the interpretation. It avoids sources of errors and improves guarantees that the system has an appropriate reaction. However, as discussed above, restrictions in input often impact user experience negatively.

- An interesting factor supporting user interaction and story unfolding is the presence of virtual characters on the screen. Depending on the characters' roles in the story, their number, and their mutual relations, they may cope with and compensate situations of erroneous input, missing input, or problems in interpretation.

  For example, in the example of Façade, the characters of Grace and Trip may realistically play out episodes in case of user passive behaviour (missing input) or misunderstanding of user input. The characters would then start a dialogue between each other or bring up an alternative topic of discussion.

  The same phenomenon can be observed in ORIENT system: the characters behave quite autonomously if the user is passive or the input cannot be interpreted. The characters have their own routines, according to the scenario. Thereby, characters can keep following their own "lives" in the virtual world even over protracted periods without user input.

  Another benefit of several characters populating a stage can be given by improved naturalism of input prompts. Being embedded in a conversation, users may perceive more easily opportunities post an utterance – just like we do in real life (see also the next item).

2.5.5 Interaction Prompts

Continuous interaction settings, as those of Façade AR or Madame Bovary simulate natural dialogue, where (in principle) the user can interrupt and post phrases at any time. Continuous interaction increases user immersion and feeling of belonging to the scene and story.

In contrast, in case of discrete interaction, such as the text-based dialogue in FearNot!, the user receives clear prompts to post replies to.

The ORIENT system offers an explorative style of interaction: the users are encouraged to explore the environment and discover interaction cues.

It is important is to ensure that the user input and system output are correctly synchronized – in terms of order and pace. For example, in FearNot! the pace of the victim character was much faster than the user's, leading to user frustration and discouragement to interact with the character.

A similar phenomenon was observed in interaction with desktop-based Façade, due to the asymmetry of modalities employed: speech-based system output vs. typed user input.

3. Initial Design Framework for IS Systems

It is a challenging task to design an interactive storytelling experience. Designers need to consider a wide range of aspects that are critical for the success of the IS system.

First of all, the design should address the overall goal of the system. For example, a mobile-based IS system can be a reasonable choice for the unfolding of a story in a city environment (Hansen, Kortbek, & Grønbæk, 2008), or in an outdoor historical park. The mobile device can be used to guide the users through the story, to convey story content, and to record user actions and decisions for future analysis[1] (Costabile, De Angeli, Lanzilotti, Ardito, Buono, & Pederson, 2008).

Another important aspect for the design of an IS system is the target user audience. Systems aimed at the young users should e.g. offer playable interaction, exploit embodiment and active user participation. The visual design should use comic or fairytale styles, with appropriately matched sounds and voices. For children, motion-affording and innovative devices can be preferable choices. Availability of tangible objects for story control is also appreciated by children.

Finally, the setting should be adjusted to the chosen format of the story. For instance, if user interaction is limited to speech input, immersion can be supported by technical environments such as a CAVE installation or AR equipment.

In order to summarize the findings of this work, we gather the results of our survey into a conceptual framework aimed at informing designers of IS experiences.

Conceptual Framework

1. Assure Basic Usability

The basic usability and error free performance are mandatory requirements for an IS experience.

- **Consider the user's cognitive, motor and perceptual skills**

  In the ideal case, the interaction devices should be intuitive to use without requiring extended training sessions. Interaction devices that put too high demands on the user's cognitive, motor and perceptual skills bear the danger that they distract from the actual story.

- **Consider deficiencies of input interpretation**

  The system should be checked for reliable sensing (e.g. recognition rates for gesture or speech-based input), correct functioning of output (against performance measures such as of speed or intelligibility under expected user capabilities and ambient conditions), and technical issues such as lighting, computer performance, and processor load. The possible "space" for user interpretation of erroneous system output should be analysed carefully and covered. Strategies should be provided to cope with unrecognized user input in an unobtrusive manner, see also the section on conversational flow.

- **Consistent use of interaction devices and modalities**

  Consistency is a basic usability principle which applies to IS systems as well. It is important to note, however, the user's input should be interpreted in the

[1] Given the users' informed consent.

context in which it is given. In particular, in natural language communication one and same utterance may have different meanings in different contexts.

- **Support intuitive interaction:** Designers should exploit metaphors, mappings and constraints with which users are familiar. In the ideal case, users should be able to interact with an IS system without any prior training.
- **Provide clear interaction borders:** Users should be readily aware of interaction possibilities. If required, training sessions before having the user participate in the story should be included. Ideally, interaction happens, however, in a natural way and supports the story scenario.
- **Provide reasonable feedback:** Appropriate feedback should be provided to give users the feeling that the story develops along a line matching their choices and input. Users should be aware of the outcomes (success or failure) of their actions. Here, it is however important not to provide shallow feedback that the system accepted input and interpreted it in a specific way: rather, space should be left for user interpretation and freedom of fantasizing.
- **Provide interaction guidance:** Particularly for IS experience it is critical to inform the user about the possible interaction possibilities, exits, and interaction borders. This can be done either by training sessions smoothly integrated into the story or by assisting technologies (such as virtual guides).

2. Increase Engagement

Engagement or user involvement can be increased in various ways. We summarize possible approaches in the following. The actual choice or combination of specific approaches should be based on the IS setting (e.g. outdoor mobile-based IS vs. indoor AR experience), target user group (e.g. children or teenagers), and the goal of the IS installation (e.g. entertainment vs. pedagogical aims)

- ***Active User Involvement***

Designers should encourage users to participate actively in the interaction. This can be achieved, for example, by assignment of roles: each user then has to play a certain role in order for the story to proceed. The roles should be distributed among the users according to their interaction possibilities, the goals of the system, and the personal characteristics and preferences of the users.

Interactions required from users should users permanently involved. However, the amount of user interaction should be balanced, in order to prevent the user being of being overloaded by the system.

Particularly in single-user IS systems, designers should provide a first-person perspective for the user. This relates to systems that demonstrate the story scene on a screen, as well as mobile-based systems, where the user can be assigned the main role on the story.

- ***Bodily Involvement***

The design should consider options to involve the whole body into the interaction. Interaction design may explicitly afford and encourage physical motion. Devices employed for navigation, manipulation, and other control actions can both induce and exploit body motions.

- ***Emotional Involvement***

Interaction devices and modalities should help users feel in the role of the story character they impersonate. Users should identify with the character in order to get

emotionally involved in a story.

- ***Inspire Curiosity and Fantasy***

Interaction should inspire the user's curiosity. There should be a close relationship between the story world and the use of interaction devices and modalities (intrinsic fantasy).

- ***Stimulate with Intermediate Achievements and Awards***

In order to be motivated to continue the interaction with the story, users should be stimulated with intermediate achievements and rewards. If the IS experience as organised along stages or levels, the successful completion of such protracted episodes by the user should be rewarded. Local achievements, such as conquering, winning a fight, solving a problem, should be also rewarded, e.g. by discovering something important for the story, or finding a key to a further story line. In order to ensure that users get aware of such intermediate achievements, appropriate feedback to user interactions need to be provided.

- ***Appropriate Level of Complexity***

In order not to distract from the story, interaction devices and modalities should be intuitive to use.

- ***Believable Character Performance***

'Mechanical', 'shallow', 'dumb' or otherwise non-convincing characters should be avoided. Instead, characters should be designed in such as way that they are perceived as individual personalities. This includes the emulation of human-like behaviours, such as the expression of emotions.

- ***Exploit Social Presence***

Designers should exploit social presence, depending on the setting and the user group of the IS system. For example, if the system is to be used outdoors, the presence of spectators (passers-by on the street) can be exploited in order to improve story experiences. Designers should consider the use of interaction devices and modalities that enable several users to interact at the same time – both as actors and spectators.

3. Increase Immersion

User immersion into the story should be favoured by scene design and by interaction design:

Scene Design. The design of the scene should reflect the story scenario and narration style. Designers should exploit multiple modalities, including sounds, voices, graphics, and animation, to enhance and support the story. An increased sense of presence may be achieved by embedding a story in the real world. For example, if the system is to be used outdoors, the presence of spectators (passers-by on the street) can be exploited in order to improve story experiences.

Character Design. To increase the user's sense of presence, the characters driving forward a story need to be compelling. This is not only a question of graphical rendering and animation. At least equally important is the provision of conversational skills as well as the simulation of believable behaviour including affect and peculiarities induced by individual personality traits.

Interaction Design. Suitable and encouraging interaction techniques should be

used, considering the particular properties of the target audience and the environmental conditions of deployment (including ambient conditions and learning curve). The potential of innovative interaction techniques should be considered (considering both, pros and cons).

4. Assure a smooth story flow

This basic story-specific requirement has to be met in order to provide an actual "storytelling" experience.

Support Story Plot by Interaction Design

The interaction style in general should match the story scenario and the style in which the story is narrated. Modalities and capabilities of interfaces need to support the semantic granularity and richness of scenario and style, but also consider performance aspects such as of robustness, precision, and fluency of use. Correct choice of interaction devices should be used to enrich user experiences with IS systems and support the story flow. For example, a space scenario could be beneficially supported by innovative interaction devices, reminding transmitters and apparatus used in fictitious or real space ships.

Provide Guidance through the Story

The user should be able to understand how the story unfolds, how the story flow can be influenced, and what has to be undertaken for that purpose. Ideally, such guidance is integrated into the plot. However, external (but not necessarily obtrusive) assistance may be indicated.

Balance Interaction Freedom and Predefined Story Plot

System reactions to user input should be designed in a way that, on the one side, the story unfolds according to user's actions, but, on the other hand, the user actions always address existing branches of the story. One possibility to ensure that the story evolves in an intended manner is to change the behaviour of controls in a way that it matches the story plot.

Adequate Story Pacing

The story should move forward at a speed that fits the user. Thus, the pace of user interactions should be in line with the pace of the story. Furthermore, we need to avoid that users are either starved or overloaded with perceptual input. Particularly, designers should be careful with the systems with mixed interaction patterns: for example, when the system output is given by voice, and user input is given textually. Unbalanced pacing leads to user frustration and feeling of exclusion from conversations and thus seriously affects the overall story experience.

Give Users Means to Express Themselves

Interaction devices and modalities should help users to feel in the scene and in the character.

Generate Plausible Responses to User Input

Since many characters in IS act in an autonomous manner, their behaviour might not be in line with user input. System designers should make sure that users understand the rationale behind the characters' behaviours, for example, by adding expressivity to their behaviours.

5. Assure a smooth conversational flow

Synchronization of User Input and System Output

User input and system output should be orchestrated in such a way that disruptive interruptions from both sides are minimized. This concerns, for example, text-based chats where coordination of turn-taking may be lost. Unsynchronized conversation leads to confusion, misunderstandings and misinterpretations from the user side, and analogous interpretation errors from the system side.

Provide Clear Interaction Prompts

The interface of an IS system should generally give the user clear cues whenever there are opportunities to interact. Synchronization of multiple channels, in particular of user input and related system output should be carefully considered as well.

Leave Space for Interpretation of Deficient System Output

Experience shows that system gaps, including also errors and bugs, are often interpreted by users as a part of the narrative. The reason for this is the interpretational latitude of the human mind: we tend to find explanations for almost any observed phenomenon, engaged users will actively uphold the achieved suspension of disbelief. Therefore, the designers should bear in mind such an opportunity to avoid possibly poor or unpredictable system performance up front: rather than trying to tackle technically difficult issues, user collaboration may be relied upon to solve such challenges.

Provide Plausible Response to User Input

Similarly to the previous point, reasonable interpretations should be found also for deficient user input. Designers should consider erroneous input variations, such as missing input, an input that makes no sense in the current context of the story, as well as input that cannot be matched to any story branch. If the system should be unable identify such a reasonable reaction, it is suggested to rather ignore user input altogether rather than risking a false reply.

Avoid Meaning Reversals

The problem of meanings reversal is often a direct consequence of pacing and synchronization issues (see above). Designers should carefully consider how highly interactive situations or episodes with largely undetermined sequencing may play out and provide repair and coping strategies, in terms of for example, backtracking and explicit re-synchronisation policies, by introducing neutral replies, topic switches, or ignoring the user input. The concrete choice solution should be adjusted to static properties such as the specific challenges of the IS system and risky places, as well as to the interaction history and acquired user profile.

Avoid Shallow Confirmations of Input Interpretation

Since an interactive story should leave users space for varied scenario interpretation, system reactions to user input should not reflect processing of user input in an immediate and shallow way. For instance, replies of story characters should contain a reflection on user input and at the same time introduce new lines or nuances

unexpected by the user.

To summarize the current framework, we provide a graphical representation. This illustration enables a quick overview of the identified challenges and their relevance to interactive storytelling design.

Fig. 6. Initial Version of Conceptual Framework

Basic Usability	Engagement	Immersion	Story Flow	Conversational Flow
Consider the User's Constraints	Active Involvement	Scene Design	Support Story Plot by Interaction Design	Synchronize User Input and System Output
Consider Deficiencies of Input Interpretation	Bodily Involvement	Interaction Design	Provide Guidance through the Story	Provide Clear Interaction Prompts
Consistent Use of Interaction Devices and Modalities	Emotional Involvement	Believable Character Design	Balance Freedom of Interaction and predefined Story Plot	Leave Space for Interpretation of Deficient System Output
Support Intuitive Interaction	Inspire Curiosity		Adequate Story Pacing	Provide Plausible Response to User Input
Provide Reasonable Feedback	Awake Fantasy		Give User Means to Express Themselves	Avoid Meaning Reversals
Provide Interaction Guidance	Stimulation with Intermediate Achievements		Generate Plausible Responses to User Input	Avoid Shallow Confirmation of Input Interpretation
	Appropriate Level of Complexity			
	Believable Character Performance			
	Social Presence			

4. Conclusion

Within this work, we have presented a first version of an interaction design framework for IS. We structured our discussion using five factors that should be considered when designing interactions for IS: basic usability, engagement, immersion, story flow and conversational flow. From a literature study and an analysis of four prominent IS systems, we extracted a set of guidelines for interaction design in IS as a basis for the resulting IS interaction design framework. The framework may be used as a design tool for the creation of interactions of new IS systems and as an analytic tool to evaluate existing IS systems. Unlike WP7, we focus here on an analytic evaluation as opposed to an empirical evaluation, for example, by using questionnaires.

In our future research, we will use the framework to evaluate and refine the framework by analyzing new IS systems to be developed by IRIS partners.

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