1. The Storification of Chances

Corporate Training with Life-like Characters in a Virtual Social Environment

Helmut Prendinger and Mitsuru Ishizuka

Department of Information and Communication Engineering
Graduate School of Information Science and Technology
University of Tokyo
7-3-1, Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
email: {helmut,ishizuka}@miv.t.u-tokyo.ac.jp

Summary.

Chance discovery concerns itself with the identification of events that are significant for human decision-making. One difficulty of chance discovery is to provide techniques and environments that allow agents (human or artificial) to become aware of chances, so that they may take an opportunity or avoid a risk. This chapter presents a view on how to use a virtual social environment inhabited by life-like characters to train the awareness of chances. Here, a user is immersed into a virtual story world where he or she interacts with animated agents and can make decisions that effect the future development of the story, eventually leading to positive or negative consequences. Our *storification of chances* approach to chance discovery relies on existing real-world stories that are either 'mistake stories' or 'success stories'. The web-based interaction scenarios serve as a training environment for users striving to acquire practical knowledge that is typically tacit (that is, not explicit). As such, storified chances can be considered as valuable additions to corporate memories.

1.1 Introduction

The term "chance" is characterized as information about an event or situation that has significant influence on the decision-making process of a human or artificial agent. Depending on whether this information suggests a desirable or undesirable future development, a chance is perceived as an opportunity or as a risk. Chance discovery can be described as the process of becoming aware of an opportunity or of a risk. After the situation or event is identified as a chance, it can 'be taken' (or ignored) and constitute an essential part of the decision-making process (Ohsawa and Nara [1.22]).

Chances, or knowledge about chances, do not necessarily have to be 'new' in the sense of an opportunity or risk never encountered before. Often, chance knowledge is part of the experience of humans who managed to turn an opportunity into success or were able to avoid some risk. In organizations, this kind of knowledge is known as *tacit* knowledge, and is typically contrasted with *explicit* knowledge (Nonaka and Takeuchi [1.21]). While explicit knowledge is formal knowledge that is documented in reports, manuals, patents,

pictures, video, software, etc., tacit knowledge refers to personal knowledge based on individual experience that is typically exchanged in direct human-human communication. The importance of tacit knowledge about corporate success has been discussed extensively in the area of knowledge management (Borghoff and Pareschi [1.3]). Since tacit knowledge is essentially practical knowledge on 'how to do things' or 'how to decide', it is an important candidate for inclusion in *corporate (or organizational) memories*. Specifically, corporate memories should contain process knowledge related to problem-solving and decision-making activities, and allow for different points of view on relevant issues (in order to prevent the delusion of 'objectivity' often conveyed in explicit knowledge sources).

In this chapter, we will propose *interactive stories* as a technology to communicate knowledge in a corporate context. Our approach is influenced by Lawrence and Thomas [1.16], who suggest storytelling in order to build up a (corporate) story-base. They show how social power, possible risk of telling a story, and collaboration (where the audience interrupts with additions, questions, and comments) influence the way a story is told. Most notably, the usefulness of 'mistake stories' is pointed out in the business context. Story-bases in their approach essentially refer to textual information resources. Instead, we will suggest the use of life-like characters inhabiting a virtual social environment to deliver stories. Rather than simply telling a story—as virtual story-tellers—life-like characters may illustrate events by performing in specified roles of the story. Virtual environments even allow the user to participate as a character in the story. Thereby, the user may influence its development and learn to cope with difficult situations or, in other words, train his or her awareness of chances (risks or opportunities). Similarly, Mott *et al.* [1.20] motivate stories (or narratives) in the context of learning environments where students are to be actively involved in 'story-centric' problem-solving activities. Their fundamental hypothesis is that "[...] by enabling learners to be co-constructors of narratives, narrative-centered learning environments can promote the deep, connection-building meaning-making activities that define constructivist learning." ([1.20, p. 80]). The authors argue that stories lend themselves to active exploration of a domain through challenging and enjoyable problem-solving activities, which is essential for constructivist learning. As a particular case, we will employ interactive stories as a technology to sharpen a user's sense ('awareness') of opportunities and risks in real-life situations, which we call the *storification of chances* and propose as a novel approach to chance discovery.

Some clarification on the meaning of the terms "narrative" and "story" is in order. By *narrative* we mean a certain type of artifact that satisfies artistic criteria (in a broad sense), instantiated in various forms such as novels, theater, movies, games, and so forth. A *story* refers to the succession of events that constitute the a certain type of narrative (see Szilas [1.33] and references therein). Without any deep concerns about the nature of a 'good' story, we

briefly introduce some properties of narrative discussed in Bruner's theory [1.4] (as reported in [1.27]).

- *Narrative Diachronicity.* A basic property of narrative is diachronicity which means that events are understood the way they relate over time rather than on their moment-by-moment significance.
- *Intentional Stance Entailment.* This property says that what happens in a story is less important than what the involved characters feel about it. It is suggested that characters explicitly express the reasons for their actions and the emotions that trigger their actions.
- *Canonicity and Breach.* A narrative is pointless when everything happens as expected. There must be some problem to be resolved, some unusual situation, some difficulty, someone behaving unexpectedly. However, norm deviations can themselves be highly scripted.

Although the mentioned properties do not directly lend themselves to suggest a certain implementation of story systems, they clearly point out issues that deserve consideration in the design of such systems.

The remaining chapter is organized as follows. The following section depicts a motivating example for the storification of a chance. Next, we will illustrate two different ways in which a story can be experienced, observation and immersion. After that, we will briefly describe life-like characters as embodied agents that may convey social cues by speech and gesture, and hence perform as actors in story environments. The following section provides a comprehensive overview of existing plot-based and character-based approaches to interactive story systems. We will then demonstrate the storification of chances with a web-based scenario that allows the user to interact with life-like characters in a corporate setting. The final section summarizes and concludes the chapter.

1.2 Motivating Example

The following is the beginning part of Kenshi Hirokane's [1.14] story "Suspicion" of the *Division Chief Kosaku Shima* series:

> *Shima-san:* I'm Shima of the advertising division. I believe we've entered an era in which enterprises must tackle environmental problems head-on. I propose that we at Hatsushiba declare our intention to "Protect the Earth."
>
> *Nakazawa-san:* What specific actions would that involve?
>
> *Shima-san:* There are any number of approaches. Chief among them, the disposal of discarded products.
>
> *Participant of the meeting:* Disposal?

Shima-san: Yes. The streets overflow with discarded appliances. In times of material abundance, who bothers to repair old appliances? It's become quite a social problem. You often see appliances left out as oversized trash. Why don't we, the manufacturers, take the responsibility for their disposal?

Another participant of the meeting: That's absurd. Think of the cost.

Shima-san: The cost would have to be passed on in the prices of products.

Kawauchi-san: Chairman!

Nakazawa-san: Yes, Mr. Kawauchi?

Kawauchi-san: I object to Mr. Shima's proposal. How can we compete if we have to jack up our prices? This is sheer idealism. It's just not realistic.

Shima-san: We'll need our technicians to help us reconsider materials, for one thing. Construct TV cabinets from recyclable resins, for example. Or use inexpensive, easily incinerated substances.

Further participants of the meeting: And where are the R&D funds to come from?

Yeah! Why do we have to be the first?

Hirai-san: Chairman!

Nakazawa-san: Laboratory Chief Hirai?

Harai-san: I agree with Mr. Shima. Profits will decrease. But protection of the environment is a social mission all enterprises must accept from here on. We at Hatsushiba can lead the way for companies the world over. Isn't this the utmost significance?

In this story excerpt, members of a company discuss Mr. Shima's idea to consider environmental issues in product development. Some argue against the idea, others are in favor of it. Arguments are brought forward from different viewpoints, such as the cost of development and products, or the reputation of the company.

In the setting of this chapter, the following features of the story (excerpt) are of key importance. *First*, different opinions are 'personified' by individual actors of the story. This allows the audience to associate viewpoints to individuals. A similar idea is realized in the car presentation scenario introduced by André *et al.* [1.1], where two animated buyer characters represent different points of view, specifically the pros and cons of a certain car (see next section). A related approach is taken by Don [1.10] in interface design who proposes the use of techniques from oral storytelling in order to organize information in a knowledge base. A narrative structure suggests to view multi-modal contents as 'events' that can be experienced in temporal

sequence (as a 'story') rather than as objects in virtual space, and hence supports users in organizing the information in memory.

Second, the excerpt provides the initial sequence of a story where actors follow their goals and associated plans and will eventually succeed (opportunities turn into success), or fail (risks lead to failures).

In summary, stories provide a compelling training context where the audience may experience chances being taken and chance awareness is instantiated by the dramatis personae of a story, possibly by the user as a protagonist. The following section illustrates two different ways a story may be experienced, from the spectator or the protagonist viewpoint.

1.3 Observation vs. Immersion

There are two major ways in which the audience may perceive story events performed by virtual agents. Users may either passively observe a story as spectators or they may actively participate in the development of the story, being immersed in an environment. In the following, we will illustrate both types of involvement with a story.

1.3.1 Inhabited Market Place

The *Inhabited Market Place* (IMP) is a web-based system developed at DFKI that uses multiple animated characters, so-called 'presentation teams', to convey information about products such as cars (André *et al.* [1.1]). IMP can be seen as a virtual showroom where a seller agent presents products to one or more buyer agents. In Fig. 1.1 (reproduced from [1.1, p. 229]), the seller agent "Merlin" presents a car to two buyer agents, "Genie" and "Robby". All agents shown in the car sales scenario come with the Microsoft Agent package [1.19].

Although IMP does not directly support a narrative interpretation, it provides a multi-party sales dialogue with different viewpoints taken by the actors involved, depending on their role (buyer or seller), personality profile (agreeableness, extroversion), and interests (comfort, cost, sportiness, and so on). The spectator of a simulated sales dialogue is offered a multi-facetted perspective of a product, with the pros and cons pointed out by animated characters. The IMP designers argue that user-agent interaction is not necessarily the most convenient or effective method for product presentation. However, a development in this direction can be found in their successor work (see, e.g., Baldes *et al.* [1.2]).

1.3.2 Mission Rehearsal Exercise

The *Mission Rehearsal Excersise* (MRE) project at the USC Institute for Creative Technologies (ICT) aims to create a virtual reality learning system

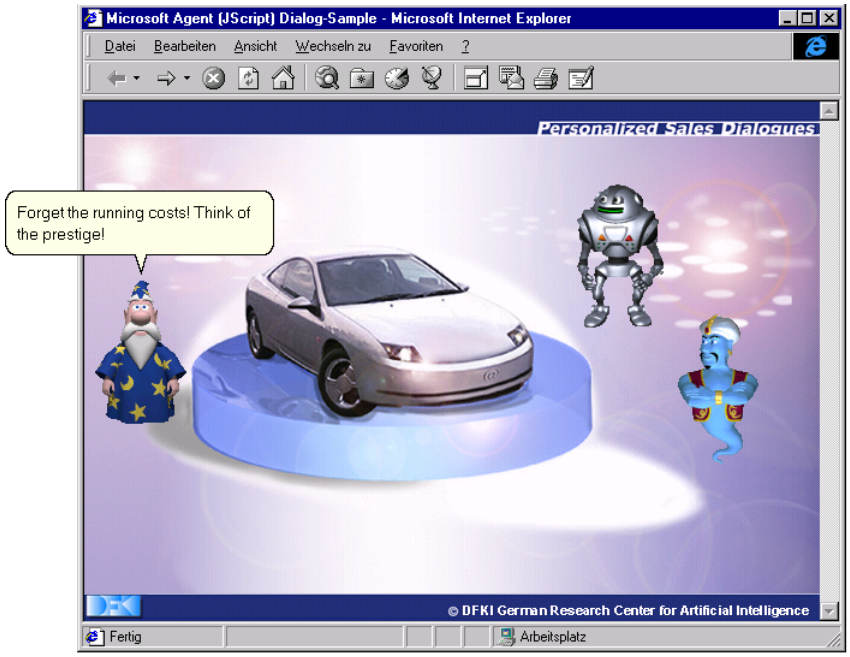

Fig. 1.1. Inhabited Market Place.

where participants (Army students) are immersed in a highly stressful environment in order to practice for real-world scenarios (Swartout *et al.* [1.32]). The student, e.g., an Army lieutenant, will stand in front of a large curved screen (8.75 feet tall and 31.3 feet unwrapped) and interact, e.g., with a sergeant to make decisions in a peacekeeping mission. Fig. 1.2 (reproduced from [1.32, p. 412]) shows a shot which was taken during setup of the system.

The kind of envisioned immersion in a MRE-style story and the types of chances encountered are best described in [1.32, p. 409]:

> A young Army lieutenant drives into a Balkan village expecting to meet up with the rest of his platoon, only to find that there has been an accident (see Figure 1.2). A young boy lies hurt in the street, while his mother rocks back and forth, moaning, rubbing her arms in anguish, murmuring encouragement to her son in Serbo-Croatian. The lieutenant's platoon sergeant and medic are on the scene.
>
> The lieutenant inquires, "Sergeant, what happened here?"
>
> The sergeant, who had been bending over the mother and boy, stands up and faces the lieutenant. "They just shot out from the side street, sir. The driver couldn't see them coming."
>
> "How many people are hurt?"
>
> "The boy and one of the drivers."

Fig. 1.2. Mission Rehearsal Exercise.

> "Are the injuries serious?"
>
> Looking up, the medic answers, "The driver's got a cracked rib, but the kid's...." Glancing at the mother, the medic checks himself. "Sir, we've gotta get a medevac in here ASAP."
>
> The lieutenant faces a dilemma. His platoon already has an urgent mission in another part of town, where an angry crowd surrounds a weapons inspection team. If he continues into town, the boy may die. On the other hand, if he doesn't help the weapons inspection team their safety will be in jeopardy. Should he split his forces or keep them together? If he splits them, how should they be organized? If not, which crisis takes priority? The pressure of the decision grows as the crowd of local civilians begins to form around the accident site. A TV cameraman shows up and begins to film the scene.

Student users of the MRE system have to make decisions in order to overcome dilemmas as the one described above, by instructing virtual humans, e.g., the sergeant or medic. The visual experience and audio effects add to the user's immersion to the peacekeeping environment. Obviously, the scenario is highly demanding in terms of the user's chance (especially risk) awareness, where wrong decisions may lead to drastic consequences (in military terms). Unlike the previously introduced Inhabited Market Place, interactions with MRE are driven by a story line that is imposed by a so-called 'Story Net'

[1.32], consisting of nodes that allow for confined interactive 'freeplay' with the characters, and links that are linear sequences of events beyond the user's control and serve to carry on the story (more details are given below).

Our approach to 'immerse' users to a scenario will be less dramatic or impressive, but more accessible as we will focus on web-based interaction scenarios. In the following section, the characters we envision as interaction partners for users will be described.

1.4 Life-like Characters

Life-like characters are intended to communicate like real people and be able to engage naturally in conversation with humans and other agents. The synthetic characters we will use are cartoon-style 2D animations that run in a web page based JavaScript interface. We also use MPML (Ishizuka *et al.* [1.15]), a tool that facilitates scripting the behavior of agents controlled by the Microsoft Agent package [1.19]. The package comes ready with controls for triggering animation sequences, speech recognition and a Text-to-Speech (TTS) engine. MPML provides an interface to a system called SCREAM that supports autonomously generated affective behavior, depending on the character's emotional state, personality, and other parameters of the social interaction context (Prendinger *et al.* [1.24]).

The life-likeness of animated characters derives from their ability to convey social cues. When humans communicate, they employ a variety of signals in combination with verbal utterances, such as body posture, gestures, facial expressions, and gaze. In a similar way, animated characters may use their bodies to convey meaning and regulate communication. The most extensive study of non-verbal behaviors for synthetic characters, especially gestures, can be found in Cassell's work on embodied conversational agents [1.6].

Emblematic gestures are culturally specified gestures, e.g., signalling "okay" by a "thumb-and-index-finger" ring gesture. An example of a *propositional* gesture is the use of both hands to measure the size of an object in symbolic space while saying "there is a big difference". There are four types of gestures that support the conveyance of communicative intent (so-called 'co-verbal' gestures [1.6]).

- *Iconic* gestures illustrate some feature of an object or action, e.g., mimicking to hold a phone while saying that someone has been called.
- *Metaphoric* gestures represent a concept without physical form, e.g., a rolling hand gesture while saying "let's go on now".
- *Deictic* gestures locate physical space relative to the speaker, e.g., by pointing to an object.
- *Beat* gestures are small baton-like movements to emphasize speech. A special form of a beat gesture is the *contrastive* gesture [1.7] that depicts a

Fig. 1.3. "Contrast".

Fig. 1.4. "Surprised".

"on the one hand ... on the other hand" relationship if two items are being contrasted (see Fig. 1.3).

An important class of gestures (including facial gestures) serves the expression of an agent's *emotional state* such as "suddenly raising arms with widely open eyes and mouth" to signal surprise (see Fig. 1.4). Although face may express emotions most succinctly (Ekman and Friesen [1.11]), we will rely on signals involving the whole body, as the size of the characters displayed in the web browser is relatively small.

Gestures also realize *communicative functions* including conversation initiation, turn taking, back channelling ("nodding"), and breaking away from conversation [1.5]. The communicative behavior corresponding to the (communicative) function of "giving turn" is typically realized by looking at the interlocutor with raised eyebrows, followed by silence, whereas "taking turn" is signalled by glancing away and starting to talk.

1.5 Approaches to Interactive Story Systems

Paradigms of interactive storytelling can be classified into two categories, depending on the way the story is created.

- In *plot-based story systems* a plot manager is assumed that controls the succession of events (scenes) and specifies what the characters can do (e.g., Sgouros *et al.* [1.28] or Mateas and Stern [1.17, 1.18]).
- In *character-based story systems* the plot results from the behavior of autonomous characters (e.g., Hayes-Roth and van Gent [1.13] or Cavazza *et al.* [1.8, 1.9]).

Most of the existing interactive storytelling systems, however, follow a hybrid approach that integrates features of both categories. In the following sections, some representative systems will be introduced.

1.5.1 Story-Morphing

Story-morphing is a technique to achieve a simple form of a plot-based (interactive) story system (Elliott *et al.* [1.12]). Story-morphing relies on a given fixed base plot structure (a 'script') that allows to generate numerous distinct stories (*story-morphs*) by varying the affective models of the involved characters. Optionally, the user may change the evolution of events by interacting with the characters. Story-morph 'tags' refer to emotionally meaningful units in the story, e.g., that a character likes or dislikes a certain activity which leads to different appraisals of events. For instance, depending on a character's interest in racing, it will react differently when losing a race.

In line with Bruner's property of 'Intentional Stance Entailment' [1.4], the authors argue that what makes stories interesting is not solely based in what happens but in the way characters feel about the events in the story. In Prendinger *et al.* [1.24, 1.25]), the story-morphing method is employed to generate morphs of a Black Jack game and a Japanese comics scenario, where the 'story' is given by the rules of the game and the make-up of the comics. In the Casino scenario the user is guided by an animated advisor to play the Black Jack game whereby the advisor's reactions vary according to its goals and personality profile as well as the user's decisions ("hit", "stand") and the outcome of the game. In the second scenario, an animated version of a Japanese comics, the user may control an avatar to interact with a female character, and try to guess her wishes correctly. The character's affective reactions depend on the user's choices and her personality. However, the downside of easy creation of distinct event sequences in those scenarios is that the resulting 'stories' depict the same succession of scenes. The approaches discussed below allow for a more flexible composition of scenes.

1.5.2 Plot Control in Interactive Stories

Sgouros *et al.* [1.28, 1.29, 1.30] develop a framework for plot-based interactive story systems. The main component is a *plot manager* (PM) that controls the behavior of the characters and determines what the protagonist (the user) can do. The plot manager comprises three modules:

- A set of rules for social action.
- A specification of the role of each character in the story.
- The user interface manager.

As input, the PM assumes a story map consisting of a set of 'points', e.g., the destinations of a travel story. Each point (location) in the map has an

associated *(local) plot structure* that specifies the cast of characters, their roles and relations. The arcs between points of the story map are *transfer plans*, a set of conditions under which the user can move between points.

The role specification of characters defines their 'motives', the types of goals they pursue, the types of norms they try to uphold, and what kind of interference they undertake, divided into favorable interference (helping) and unfavorable interference (causing loss). For instance, a character in the *Judge* role tries to enforce legitimate power and watches out for transgressions of norms (laws). Furthermore, social action rules are applied to drive the interaction between characters. Social action includes cooperation, (positive and negative) reciprocation, group performance and exchange (of resources).

For each interaction situation (point of the story map), the PM prepares a set of possible actions for the user, based on the protagonist's role and the activity of the other characters. Sgouros' approach follows an Aristotelian notion of plot, where the emphasis is on the concept of 'conflict' between antagonistic roles. After the climax is reached through a series of conflicts, a solution is presented at the end that answers all open questions.

1.5.3 Interactive Drama with User-Controlled Character

Szilas [1.33] proposes another plot-based approach to interactive drama. Since the focus of this work is strong emotional involvement of the user, it is argued that characters should be designed to comply with narrative constraints in order to guarantee an engaging story. The 'conflict' of the protagonist, i.e., some action which is incompatible with its values, is motivated as the core of dramatic narrative. The responsibility of the *Story Engine* is to set the stage for a conflict, consisting of four units.

- A goal is a state-of-affairs the character wants to achieve.
- An obstacle is a state-of-affairs or event that prevents the character from achieving the goal.
- An 'overstepping task' are actions the character must perform in order to achieve the goal.
- 'Values' is a set of the norms the character maintains, with respect to which character actions are evaluated.

A conflict occurs when the overstepping task is not compatible with the character's values. The conflict is resolved by either ignoring ('overstepping') the values, thereby achieving the goal, or by deciding not to ignore the values, and not reach the goal. The narrative structure is realized by showing the possibility of 'overstepping' actions, the performance of actions (possibly including 'overstepping' actions), and then showing the consequences of the character's behavior.

The architecture of Szilas' Story Engine contains the story world, the narrative logic, the narrator, a (rudimentary) user model, and the theater (the interface). The narrative logic, a set of rules, encodes a particular narrative

theory. The 'narrator' module is based on the rules in the narrative logic module and decides on the next steps in the story—which rules will 'fire'—by either executing events or prompting the user to choose the next action (from a choice list). The narrator's decision is based on artistic requirements from drama. The interaction between the user and system is realized by the user controlling one (or more) characters of the story world.

Szilas' approach is similar to the previously introduced approach by Sgouros as both rely on some concept of conflict and a narrator (plot manager) to control the story events.

1.5.4 Interactive Drama with Human Player

Mateas and Stern [1.17] discuss a plot-based approach to interactive drama where the autonomy of the characters is governed by restrictions from a plot (drama) manager. In their view, character behavior in a story world should depend on the character's mental state, the current world state, the current story state, and the history of all previous interactions.

The basic building blocks of interactive drama are so-called (dramatic) *beats* which are events that 'turn a value'. A 'value' is characterized as "a property of an individual or relationship, such as trust, love, hope (or hopelessness), etc." [1.17, p. 116]. An event is considered as a story event (or dramatic action) if it turns a value. Beats are just action-reaction pairs between characters. *Scenes* are seen as larger units of value changes and composed of beats, such as "one character confesses his love to another character". The responsibility of the *drama manager* is to compose a sequence of scenes that generates dramatic action on a larger scale. Formally, a scene consists of preconditions, values that are supposed to be changed (and how they change), and a set of beats that create the scene. The preconditions of a scene test if that scene is adequate given story and character state. Scene selection depends on satisfied preconditions, the list of unused scenes, and which value changes satisfy the intended plot arc.

An important architectural entity in Mateas and Stern's approach are *joint plans* that are intended to guide character behavior within one beat. They describe the coordinated behavior of characters as one entity rather than having autonomous characters work out a joint plan (which would require complex reasoning, message passing, and so forth). However, joint plans are still reactive, letting the user to interfere with plan execution.

In [1.18], the authors define a language, called ABL (*A Behavior Language*), that allows to author believable characters for interactive drama. ABL is a reactive planning language with character behaviors written in a Java-style syntax, that may encode joint plans and other story constructs.

Unlike Szilas' [1.33] approach to interactive drama, the authors let the user experience the story from a first-person perspective. The difference to Sgouros' [1.30] approach is that user interaction is not restricted to specific 'points' in the story.

1.5.5 Storytelling with Anytime User Intervention

Cavazza *et al.* [1.8, 1.9]) propose an approach to character-based interactive storytelling. In this system, characters execute plans encoded as Hierarchical Task Networks (HTNs). In order to ensure narratively relevant agent behavior, characters are described in terms of their role-specific goals and actions. For instance, the top goal of the male character (Ross) described in [1.8] is to take out a female character (Rachel). In order to achieve this goal, subgoals include acquiring information about her, getting her attention, isolating her from other characters, and asking her. The goal of acquiring information about Rachel can itself have multiple (disjunctive) subgoals, such as asking her friend or reading her diary.

Users may interfere with the story's progression at any time, either by voice input or by manipulating the environment (e.g., moving an object). However, 'physical' interaction is limited to so-called 'narrative objects', i.e., objects that have narrative consequences (*dispatchers*). For instance, if the user decides to 'steal' Rachel's diary, Ross has to repair his plan to read it, and resort to ask her friend. In this way, the user can eliminate certain courses of actions (of the main character), and force other routes being taken. Speech intervention in the system of Cavazza and co-workers maintains the user-as-spectator paradigm and is restricted to giving advice to characters (e.g., "be nice" to Rachel's friend).

Since Cavazza's approach does not include a plot manager, the responsibility for a coherent story is shifted to the plan contained in the role specifications of characters. However, the plans associated with a particular role essentially encode the structure of the story.

A similar route is taken by Paiva *et al.* [1.23] where a story line is achieved by giving characters specific roles that correspond to pre-defined story functions (Propp [1.26]). For instance, a character in the role of a Villain strives to disturb, damage or harm a happy family.

1.5.6 Story Nets

One hybrid approach to story creation, that contains features of both (linear) plot-based and character-based approaches, is called *Story Net* (Swartout *et al.* [1.32]). A Story Net contains two types of concepts, nodes and links. A node refers to a situation where the user may 'freely' interact with the story characters. However, the interaction within a node is typically restricted by the verbal utterances characters are able to process. The main purpose of nodes is to play out a confined task or prompt the user to make a decision. Links, on the other hand, refer to linear sequences of events that form the connection between nodes. The user cannot influence the events in a link. Those sequences are used to prepare the next situation or demonstrate the consequences of previous decisions of the user. Hidden from the user, each link

has a set of conditions that must be satisfied before a link can be traversed to arrive at an outcome node.

The Story Net approach allows to combine linear and non-linear story elements, by using deterministic links and nodes including decision points and free interaction, respectively. The authors also think about employing a 'Director' agent that controls the flow of events and ensures that pedagogical or dramatic goals are met.

The concept of Story Net is closely related to the previously introduced plot manager of Sgouros [1.30], with the exception of the Natural Language Understanding based free play component in [1.32].

1.5.7 Digital Director for Interactive Storytelling

Spierling *et al.* [1.31] focus on the authoring aspect of interactive storytelling and take inspiration from film making where a whole team works on different levels of the product. Example roles are:

- The *Editor* is responsible for the topic and the content of the story.
- The *Playwright* plans the presentation of the content and engages in scriptwriting of the dialogues.
- The *Director* interprets the script and instructs the actors.
- The *Stage Director* handles camera, lights, and props.
- The *Casting Director* works out characters and their appearance.
- The *Actors* are responsible for playing a certain character and follow instructions of the director.

Based on the film making metaphor, the authors propose a four level modular storytelling system: story engine, scene action engine, character conversation engines, and actor avatar engines. Although not all of those modules are fully developed, the approach is very promising. Spierling and her co-workers adhere to the design philosophy of *scalable (or adjustable) autonomy* which allows the author (story creator) to decide on the degree of semi-autonomy on each level. The scale is between "pre-defined" and "autonomous", depending on whether the author chooses to predetermine each behavior (story development, scene selection, dialogue, character animation) or let the system autonomously select behaviors.

The story concept used by Spierling are Propp's narrative functions [1.26], where scenes are chosen if they satisfy a certain function in the narrative. The system may also handle user interaction by allowing for *polymorphic beats* [1.17] which have different outputs depending on users' choices.

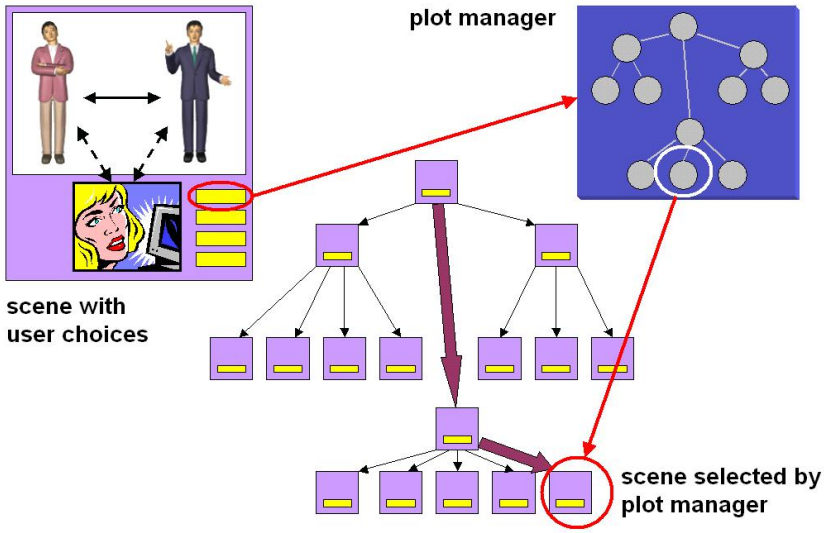

Fig. 1.5. Storytelling System.

1.6 Interactive Storytelling as a Business Training Environment

This chapter set out with the claim that stories can be used as an environment where users may become aware of opportunities and risks. A salient feature of interactive stories is that users may even (virtually) 'take' chances. The following items summarize the requirements of the "interactive storytelling as chance discovery" approach.

- *Immersion.* The user (student) is part of the story in the role a main character or protagonist.
- *Decisions.* The user is able to make meaningful decisions and hence influence the further development of the story.
- *Consequences.* The user's choices have (virtual) consequences in the course of the story.
- *Edutainment.* The user may achieve a pedagogical goal (chance awareness) in an entertaining way.

As a case study, we will storify a situation describing a decision-making process in a corporate setting. Fig. 1.5 illustrates the interaction environment employing a simple plot manager.

The requirement of *immersion* is met by having the user participate in the story. Following a story requirement proposed by Mateas and Stern [1.17], we use three story characters, two computer controlled agents and the user. This configuration allows for complex social relationships while avoiding too

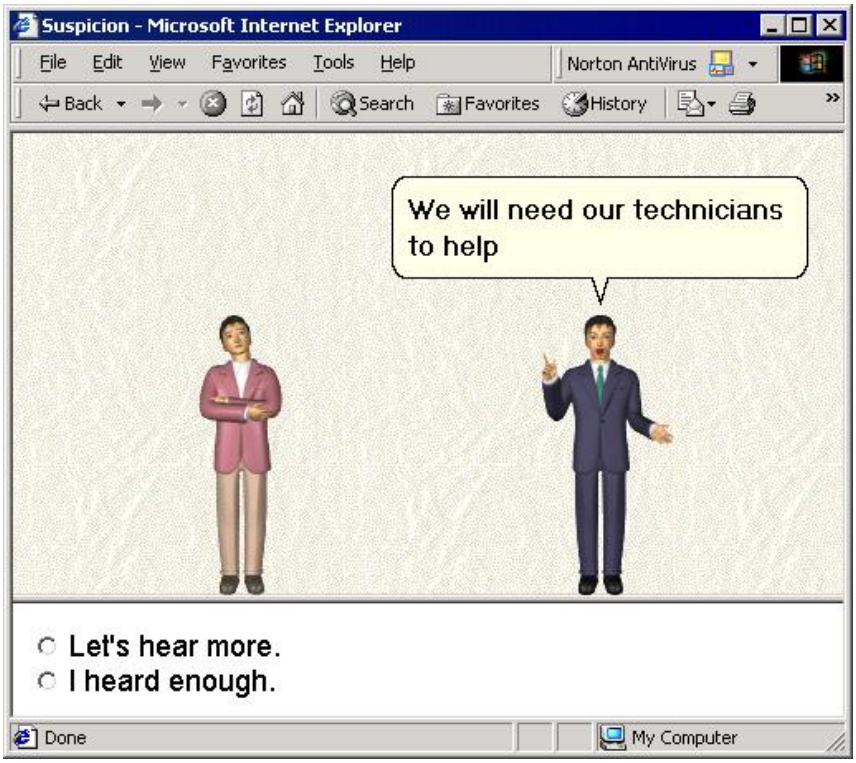

Fig. 1.6. Business Training Environment.

much readiness for interaction on the side of the user. Rather than having the user be the protagonist of the story, the user may 'side with' (i.e., support the opinion of) one of the characters, assuming that both animated agents have conflicting opinions. In this way, the second requirement (*decision*) is satisfied, and the user can influence the future development of the story. User choices are given by a set of pre-defined options. The user may select an option by pressing a button in the browser window or the speech recognizer will handle user input (see the bottom browser frame in Fig. 1.6).

Typically, the outcome of the story is decided in advance, and users—in cooperation with their virtual collaborator—will succeed or fail to achieve their goals. Recall that the chances we want to storify are success stories or 'mistake' stories with real-world counterparts that have known outcomes. It is important that the *consequences* of the user's decisions are clearly demonstrated in the course of the story. The pedagogical aim here is to confront the user with the consequences of his or her actions.

According to the *edutainment* requirement, the story should not only have educational value but also be entertaining *as a story* in an artistic sense. Currently, we use a very simple plot manager to select appropriate

scenes. The plot manager contains some rules that decide whether a scene illustrating a certain argument for (or against) a character's opinion should be played. Besides user choices, the plot manager also maintains a history of the interactions in the story. Scenes are realized as joint plans as discussed in [1.18], with no autonomy on the part of the characters. Unlike the concept of 'joint plans' developed by Mateas and Stern, our joint plans are non-reactive. That is, once a joint plan is triggered, a user cannot interfere until the scenario offers a choice to the user.

Fig. 1.6 is a screen shot from our implementation of the "Suspicion" story of the Division Chief Kosaku Shima series [1.14]. Our story is basically a (simplified) animated version and extension of the dialogue given in Section 2 ("Motivating Example"). The character on the right-hand side is in the role of Shima from the marketing division, and the character on the left is in the role of the manager of finance. The latter character is supposed to represent all counter opinions to Shima's proposal in the original story, and eventually grant funding for the proposal or refuse to do so. The participating user is in the role of an expert who is called by Shima to support his proposal. However, the user is free to interfere positively or negatively with Shima's suggestion, thereby influencing Shima's chance of acquiring funding.

The screen shot depicts the situation where the plot manager decides to let Shima explain more about his proposal. After the user utters "Let's hear more", Shima explicates his idea and proposes that technicians reconsider materials to construct TV cabinets. The finance manager character displays a "thinking" gesture while listening to Shima's proposal. In the future course of the story, the manager of finance asks the user whether the company should invest a significant amount of money to realize Shima's idea. The consequences of installing (or not installing) Shima's proposal are shown in a "Six months later..." episode (this episode is also shown when the user opts for "I heard enough" in the previously mentioned choice). Here, if the user decides to support the investment, the proposal will turn out as a success as customers accept to pay more for products that are produced in an environment-conscious way, and the company's sales go up. If the user declines the investment, the "Six months later..." episode shows a scene with no spectacular differences in the company's development. Consequently, if a chance such as investing in environment-conscious production is not taken does not necessarily imply a negative outcome of the story in terms of the company's well-being. On the other hand, if a storified risk situation is ignored, negative consequences will be communicated to the user.

Note that Hirokane [1.14] does not claim that his stories are based on real events, although they can be seen as entertaining introductions to the life in a Japanese company. Moreover, the further development of the story and its consequences are not described in the Shima Kosaku series. Storified chances that are intended to enter a company's corporate memory would have to satisfy more strict criteria than a fictional example story.

1.7 Summary and Conclusion

This chapter presents our approach to chance discovery and awareness of chances. A key assumption of our approach is that interactive storytelling featuring life-like characters is an adequate method to sharpen human awareness of situations that may contain chances (i.e., opportunities or risks). While most approaches to chance discovery rely on some technique to extract information essential for decision-making from a given situation, we follow an entirely different paradigm that *plays out* situations where chances are present and the user (student) may take chances online, by interacting with virtual agents in a story-like environment. The advantages of this approach can be summarized as follows.

- A significant number of instances of chance discovery are realized in human-human interaction. Environments that simulate those types of communication provide an effective training setting.
- Stories provide the possibility that the consequences of users' decisions can be shown to the user in the course of story development. This is important since in many cases, the result of a taken (or ignored) chance is only seen in a larger time frame, which can be simulated in virtual environments.
- Interactive stories with animated characters that perform relevant roles offer an entertaining way to immerse users in situations containing chances.

The storytelling systems discussed in this chapter constitute different ways to immerse the user in a narrative experience. Currently, our own training environment is simply an HTML file that embeds the Microsoft Agent package, JavaScript code, and a Java applet containing a basic plot manager. Future versions of the environment will use Flash technology to enhance users' interaction experience. Besides speech communication, we also intend to implement pseudo-physical interaction with objects in the environment, such as the 'narrative objects' discussed, for instance, by Cavazza *et al.* [1.9, p. 21]. Other extensions concern a more elaborate plot manager and a limited form of autonomy for generating characters' affective behavior.

Our approach is intended to make tacit knowledge accessible, which is often seen as complementing the retrieval of explicit knowledge (Nonaka and Takeuchi [1.21]). Further studies will show whether storified chances can be beneficially integrated to corporate memories and constitute an effective way to communicate practical knowledge in organizations.

Acknowledgments

This research is supported by the Research Grant (1999-2003) for the Future Program ("Mirai Kaitaku") from the Japanese Society for the Promotion of Science (JSPS).

References

1.1 Elisabeth André, E., Rist, T., van Mulken, S., Klesen, M., Baldes, S. (2000): The automated design of believable dialogue for animated presentation teams. In J. Cassell, J. Sullivan, S. Prevost, and E. Churchill, editors, *Embodied Conversational Agents*, The MIT Press, Cambridge, MA, 220–255.

1.2 Baldes, S., Gebhard, P., Kipp, M., Klesen, M., Rist, P., Rist, T., Schmitt, M. (2002): The interactive CrossTalk installation: Meta-theater with animated presentation agents. In H. Prendinger, editor, *Proceedings International Workshop on Lifelike Animated Agents. Tools, Affective Functions, and Applications, in conjunction with PRICAI-02*, 9–15.

1.3 Borgkoff, U.M., Pareschi, R. (1997): Information technology for knowledge management. *Journal of Universal Computer Science*, 3(8):835–842.

1.4 Bruner, J. (1991): The narrative construction of reality. *Critical Inquiry*, 18(1):1–21.

1.5 Cassell, J. (2000): More than just another pretty face: Embodied conversational interface agents. *Communications of the ACM*, 43(4):70–78.

1.6 Cassell, J. (2000): Nudge nudge wink wink: Elements of face-to-face conversation for embodied conversational agents. In J. Cassell, J. Sullivan, S. Prevost, and E. Churchill, editors, *Embodied Conversational Agents*. The MIT Press, Cambridge, MA, 1–27.

1.7 Cassell, J., Vilhjálmsson, H., Bickmore, T. (2001): BEAT: the Behavior Expression Animation Toolkit. In *Proceedings of SIGGRAPH-01*, 477–486.

1.8 Cavazza, M., Charles, F., Mead, S.J. (2002): Interacting with virtual characters in interactive storytelling. In *Proceedings First Conference on Autonomous Agents and Multiagent Systems (AAMAS-02)*, New York, 2002. ACM Press, 318–325.

1.9 Cavazza, M., Charles, F., Mead, S.J. (2002): Character-based interactive storytelling. *IEEE Intelligent Systems*, July-August, 18–24.

1.10 Don, A. (1990): Narrative and the interface. In B. Laurel, editor, *The Art of Human-Computer Inferface Design*, Addison Wesley, 1990, 383–391.

1.11 Ekman, P., Friesen, W.V. (1969): The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica*, 1:49–98.

1.12 Elliott, C., Brzezinski, J., Sheth, S., Salvatoriello, R. (1998): *Story-morphing* in the Affective Reasoning paradigm: Generating stories semi-automatically for use with *emotionally intelligent* multimedia agents. In *Proceedings 2nd International Conference on Autonomous Agents (Agents-98)*, New York, 1998. ACM Press, 181–188.

1.13 Hayes-Roth, B., van Gent, R. (1997): Story-making with improvisional puppets. In *Proceedings First International Conference on Autonomous Agents (Agents-97)*, New York, 1997. ACM Press, 1–7.

1.14 Hirokane, K. (1995): *Division Chief Kosaku Shima*. Kodansha Bilingual Comics, Tokyo. Translated by Ralph F. McCarthy.

1.15 Ishizuka, M., Tsutsui, T., Saeyor, S., Dohi, H., Zong, Y., Prendinger, H. (2000): MPML: A multimodal presentation markup language with character control functions. In *Proceedings Agents'2000 Workshop on Achieving Human-like Behavior in Interactive Animated Agents*, 50–54.

1.16 Lawrence, D., Thomas, J.C. (1999): Social dynamics of storytelling: Implications for story-base design. In *Proceedings 1999 AAAI Fall Symposium on Narrative Intelligence*, The AAAI Press, 26–29.

1.17 Mateas, M., Stern, A. (2000): Towards integrating plot and character for interactive drama. In *Proceedings AAAI Fall Symposium on Socially Intelligent*

Agents: The Human in the Loop, AAAI Press, Technical Report FS-00-04, 113–118.
1.18 Mateas, M., Stern, A. (2002): A behavior language for story-based believable agents. *IEEE Intelligent Systems*, July-August, 39–47.
1.19 Microsoft (1998): *Developing for Microsoft Agent*. Microsoft Press.
1.20 Mott, B.W., Callaway, Ch.B., Zettlemoyer, L.S., Lee, S.Y., Lester, J.C. (1999): Towards narrative-centered learning environments. In *Proceedings 1999 AAAI Fall Symposium on Narrative Intelligence*, The AAAI Press, 78–82.
1.21 Nonaka, I., Takeuchi, H. (1995): *The Knowledge-Creating Company*. Oxford University Press, New York, Oxford.
1.22 Ohsawa, Y., and Nara, Y.: Modeling the process of chance discovery. This volume.
1.23 Paiva, A., Machado, I., Prada, R. (2001): Heroes, villains, magicians,...: Dramatis personae in a virtual story creation environment. In *Proceedings International Conference on Intelligent User Interfaces (IUI-2001)*, New York, 2001. ACM Press, 129–136.
1.24 Prendinger, H., Descamps, S., Ishizuka, M. (2002): Scripting affective communication with life-like characters in web-based interaction systems. *Applied Artificial Intelligence*, 16(7–8):519–553.
1.25 Prendinger, H., Ishizuka, M. (2002): Evolving social relationships with animate characters. In *Proceedings of the AISB-02 Symposium on Animating Expressive Characters for Social Interactions*, 73–78.
1.26 Propp, V. (1968): *Morphology of the Folktale*. University of Texas Press.
1.27 Sengers, Ph. (2000): Narrative intelligence. In K. Dautenhahn, editor, *Human Cognition and Social Agent Technology*, John Benjamins Publishing Company, 1–26.
1.28 Sgouros, N.M., Papakonstantinou, G., Tsankakas, P. (1996): A framework for plot control in interactive story systems. In *Proceedings 13th National Conference on Artificial Intelligence (AAAI-96)*, 162–167.
1.29 Sgouros, N.M. (1997): Dynamic, user-centered resolution in interactive stories. In *Proceedings 15th International Joint Conference on Artificial Intelligence (IJCAI-97)*, 990–995.
1.30 Sgouros, N.M. (1999): Dynamic generation, management and resolution of interactive plots. *Artificial Intelligence*, 107:29–62.
1.31 Spierling, U., Grasbon, D., Braun, N., Iurgel, I. (2002): Setting the scene: playing digital director in interactive storytelling and creation. *Computer & Graphics*, 26:31–44.
1.32 Swartout, W., Hill, R., Gratch, J., Johnson, W.L., Kyriakakis, C., LaBore, C., Lindheim, R., Marsella, S., Miraglia, D., Moore, B., Morie, J., Rickel, J., Thiébaux, M., Tuch, L., Whitney, R., Douglas, J. (2001): Toward the Holodeck: Integrating graphics, sound, character and story. In *Proceedings 5th International Conference on Autonomous Agents (Agents-01)*, New York, 2001. ACM Press, 409–416.
1.33 Szilas, N. (1999): Interactive drama on computer: beyond linear narrative. In *Proceedings 1999 AAAI Fall Symposium on Narrative Intelligence*, The AAAI Press, 150–156.