Whose Story Is It Anyway?

How Improv Informs Agency and Authorship of Emergent Narrative

Ivo Swartjes

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Human Media Interaction group
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WHOSE STORY IS IT ANYWAY?

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by

Ivo Martinus Theodorus Swartjes

born on January 12, 1980

in Nijmegen, The Netherlands

This thesis has been approved by:

Prof. dr. ir. A. Nijholt, University of Twente, NL (promotor)

Dr. M. Theune, University of Twente, NL (assistant-promotor)

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Dankwoord

The End is dan eindelijk daar. In dit proefschrift is het resultaat te lezen van vier, of eigenlijk vijf jaar onderzoek, een lange spanningsboog. Een periode waarin ik een grote passie heb ontwikkeld voor interactieve media en verhalen, maar ook één waarin ik soms geen Donald Duck meer kon openslaan zonder dat mijn hoofd overuren maakte om de verhaalelementen ervan te doorgronden, en waarin films soms nachtmerries werden omdat ik me de complexiteit probeerde voor te stellen van interactieve versies ervan. Dit soort obsessies, die menig onderzoeker bekend zullen voorkomen, werden in de loop van de jaren gelukkig wel minder. En nu, met het afronden van mijn proefschrift, komt het verhaal ten einde. En het was waarempel een interactief verhaal, waar veel mensen direct of indirect invloed op hebben gehad. Deze mensen wil ik hier dan ook graag bedanken.

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Contents

1 Introduction **1**
- 1.1 Applications of Digital Interactive Storytelling 2
- 1.2 Research Challenges 4
  - 1.2.1 Agency 4
  - 1.2.2 Authorship 5
  - 1.2.3 A Wicked Problem 5
- 1.3 Contributions of this Thesis 6
  - 1.3.1 Theoretical Contributions 6
  - 1.3.2 Technical Contributions 7
- 1.4 Outline 7

I Narrative in Virtual Environments **11**

2 Interactive Drama, Story Generation and Authorship **13**
- 2.1 Interactive Digital Storytelling 13
  - 2.1.1 The Paradox of Narrative in Virtual Environments 14
  - 2.1.2 Agency Within Interactive Stories 17
- 2.2 AI-Based Interactive Drama 19
  - 2.2.1 *Strong Story* Approaches 21
  - 2.2.2 *Strong Autonomy* Approaches 23
- 2.3 The Trade-off Between Generativity and Authorship 26
  - 2.3.1 Existing Story Generation Systems 27
  - 2.3.2 Story Generators as Creative Systems 31
  - 2.3.3 The Computer as Expressive Medium 33
- 2.4 Conclusion 37

3 Emergent Narrative **39**
- 3.1 Introduction 39
- 3.2 The Emergent Narrative Concept 41
  - 3.2.1 Narrative Perspective 41
  - 3.2.2 Emergence of Narrative 44
  - 3.2.3 Narrative Control 48
- 3.3 Authorship of Emergent Narrative 49
  - 3.3.1 Authoring for Emergence: a Paradox? 50

3.3.2 The Story Landscape 53
3.3.3 An Authorial Impasse 55
3.3.4 Semiotics of Emergent Narrative Authoring 56
3.3.5 Implicit Creation: Debugging or Co-creation? 62
3.3.6 Authoring the Initial State 66
3.4 Conclusion 69

II Dramatic Improvisation 71

4 Poetics of Improvisational Theater 73
4.1 Introduction 73
4.2 Scope 74
4.2.1 Comedy Versus Drama 74
4.2.2 Form Versus Content 75
4.3 Poetics of Improvisational Theater 76
4.3.1 Collaborative Emergence of Narrative 76
4.3.2 Collaborative Pretend Play 77
4.3.3 Strategies for Improvising Drama 77
4.3.4 Johnstone's Poetics 78
4.4 Comparison with Neo-Aristotelian Poetics for Interactive Drama 79
4.4.1 Neo-Aristotelian Poetics for Interactive Drama 80
4.4.2 Negotiation of the Dramatic Frame 81
4.4.3 Formal and Material Constraints Through Offers 82
4.5 Design Implications for Emergent Narrative 83
4.5.1 Comparison with Emergent Narrative 83
4.5.2 Characters Become Actors 84
4.5.3 Offers and Accepts 85
4.5.4 Framing the Storyworld 86
4.6 Conclusion 86

5 Agency Within Improvised Stories 89
5.1 Introduction 89
5.2 Being Present in Drama 90
5.3 Dramatic Presence Within Improvised Stories 92
5.3.1 Pilot Experiment 93
5.3.2 Main Experiment 94
5.3.3 Results 97
5.3.4 Discussion 103
5.4 Agency in Emergent Narrative 104
5.4.1 Playing Versus Performing 104
5.4.2 Consequences for Agency in Emergent Narrative 105
5.4.3 Whose Story Is It Anyway? 106

III The Virtual Storyteller **107**

6 The Virtual Storyteller: Story Generation by Simulation **109**
6.1 Introduction . . . 109
6.2 Architecture of The Virtual Storyteller . . . 110
6.2.1 The Simulation Layer . . . 111
6.2.2 The Fabula . . . 112
6.2.3 The Presentation Layer . . . 113
6.2.4 Knowledge Representation in The Virtual Storyteller . . . 113
6.2.5 Limitations and Assumptions . . . 114
6.3 Earlier Work on The Virtual Storyteller . . . 115
6.4 Overview of the Following Chapters . . . 117

7 The Fabula Model and the Presentation Layer **119**
7.1 Introduction . . . 119
7.1.1 Reasons for Modeling the Fabula . . . 119
7.1.2 Story Comprehension and the Causal Network Theory . . . 120
7.2 The Fabula Model . . . 121
7.2.1 Fabula Element Types . . . 123
7.2.2 Causal Connection Types . . . 124
7.3 Recording the Fabula of a Storyworld Simulation . . . 126
7.3.1 Recording Fabula Elements . . . 126
7.3.2 Recording Causal Connections Between Fabula Elements . . . 127
7.4 Presentation . . . 128
7.4.1 The Narrator: Natural Language Generation . . . 129
7.4.2 COMICS: Comic Generation . . . 132
7.5 Conclusions . . . 133

8 The Simulation Layer **137**
8.1 Introduction . . . 137
8.2 Modeling a Storyworld Simulation . . . 138
8.2.1 Initial State . . . 139
8.2.2 Characters . . . 140
8.2.3 Virtual Environment . . . 145
8.2.4 The Plot Agent . . . 148
8.3 From Characters to Actors . . . 148
8.3.1 Emergence versus Story Control: Do the Right Thing . . . 148
8.3.2 Problems with a Separate Drama Manager . . . 151
8.3.3 Drama Management Properties for Autonomous Characters . . 152
8.3.4 Distributed Drama Management: from Characters to Actors . . 153
8.4 Late Commitment to the Initial State . . . 158
8.4.1 Modeling Late Commitment . . . 158
8.4.2 Using Late Commitment in the Storyworld Simulation . . . 161
8.4.3 Impro-POP: Planning with IC and OOC Operators . . . 163
8.4.4 Consistency Issues of Late Commitment . . . 167
8.4.5 Wrapping Up . . . 170

8.5 Conclusions 170

IV Reflection **173**

9 Discussion **175**
9.1 Two Case Studies 175
9.1.1 Pirates 176
9.1.2 Little Red Riding Hood 179
9.2 Some Issues of Autonomous Characters in Dramatic Interaction 181
9.3 Conclusion 184

10 Conclusions **187**
10.1 Towards Improvised Interactive Drama 187
10.2 Authoring Emergent Narrative 188
10.3 Late Commitment 189
10.4 Future work 190
10.4.1 Case-Based Reasoning for Narrative Inspiration 190
10.4.2 Plot Threads 191
10.4.3 Perceptions 192
10.4.4 Goal Selection 192
10.4.5 Making The Virtual Storyteller Interactive 193

Bibliography **195**

Summary **215**

Samenvatting **217**

SIKS dissertation series **221**

1

Introduction

> "We live immersed in narrative, recounting and reassessing the meaning of our past actions, anticipating the outcome of our future projects, situating ourselves at the intersection of several stories not yet completed."
>
> **Peter Brooks**
> Reading for the plot: design and intention in narrative

One of the more recent developments in interactive entertainment, art and media is the notion of *interactive digital storytelling*. Here, researchers are exploring ways in which technology can afford interactive forms of storytelling, in which the separation of author and audience that exists for storytelling in traditional media is diminished. One of the goals pursued here is to be able to build highly immersive, highly interactive fictional worlds in which a human user can have the experience of being a character in a story that unfolds based on what the user does.

This thesis aims to contribute to this goal, of which the technological reality is still in its infancy. We are either at the very early stages of the development of a whole new set of interactive experiences — a new gaming genre perhaps, or a new narrative medium as film was a century ago — or, from a somewhat more pessimistical outlook, battling technological and conceptual challenges that may ultimately turn out to be unresolvable.

For now, we can only try to imagine what such experiences would be like. Perhaps we can gain inspiration from classic science fiction portrayals of interactive murder mysteries told by Star Trek's Holodeck. Perhaps our fantasies take the shape of computer-mediated variants of contemporary cultural practices such as role play and improvisational theater. Perhaps we extrapolate from the ever-increasing role of stories within contemporary commercial video games. Feasibility concerns put aside, we might imagine a user, immersed in a fictional world, having a sense of dramatic presence (Kelso, Weyhrauch, & Bates, 1993) as one of the characters in a dramatic interaction. And we can imagine such experiences to be worthwhile, for serious purposes such as training and education, as well as for entertainment purposes. This may explain the numerous proposals, architectures and applications appearing within the interactive storytelling community for combining user interaction with storyworlds.

We might even be able to build systems that offer such experiences, if we can overcome a number of conceptual and technological obstructions. Perhaps the most important one is that highly interactive storyworlds of the kind sketched here require a large number of different story lines, or at least the illusion thereof, each catering to the choices that a user might make. Unfortunately, we cannot pursue the idea that we write them all out.

1.1 Applications of Digital Interactive Storytelling

Interactive stories find potential application as digital entertainment and art, as well as support for training and education.

Entertainment and Art

Entertainment software is one of the fastest growing industries in the world. In 2008, the video game industry reached a record $11.7 billion in the US alone, more than quadrupling sales since 1996 (ESA). In addition to a move towards ever greater graphical realism, computer games developers have attached much more importance to the story aspect of their games than in the early days of video games. This makes sense; story gives meaning to in-game action, and allows game developers to incorporate some of the rich repertoire of emotional experiences we can have from stories into their games. There is also a tendency to remediate aspects of narrative from movies to games (e.g., King Kong, The Matrix: Path of Neo, Jaws: Unleashed, Scarface: The World Is Yours), and from games to movies (e.g., Mortal Kombat, Tomb Raider, Resident Evil).

Games that offer the possibility for players to truly affect the story by their actions, have however been sparse, even though games are sometimes advertised with exaggerated claims about the interactivity of their stories (Thue, Vulitko, Spetch, & Webb, 2009). One of the main reasons, as we will see in this thesis, may be the high complexity and authoring effort it takes to create true story interactivity, especially with state-of-the-art techniques such as branching narrative.

One project that testifies to this is the independent game Façade (figure 1.1), which was published in 2005 by Michael Mateas and Andrew Stern (Mateas & Stern, 2005b).[1] In Façade, the user plays an old friend of a couple whose marriage is about to fall apart. Grace and Trip have invited the user for a get-together in their apartment. As the user walks around their apartment, picks up objects and communicates through seemingly unrestricted natural language, slowly but surely the tension rises as the marital conflict between Grace and Trip emerges. The relationship between Grace and Trip and the player continually shifts as the user answers questions or responds to the dialog of the couple. Several outcomes are possible, depending on what

[1] Façade can be downloaded from `http://www.interactive-story.net`

Figure 1.1: Screenshot of the interactive drama Façade.

the user does; from marriage breakdown to reconciliation to the user being prematurely sent away.

Façade is the result of an ambitious research project with the aim of combining player agency with drama. It is considered to be the first fully-playable instance of what is called ‘interactive drama’. Creating Façade was far from trivial and pushed forward on the state of the art in natural language understanding, believable characters, procedural animation and dynamic representation of drama. It was created within the context of a body of research aiming to advance the state of the art in interactive storytelling and interactive drama by exploring different architectures and conceptions of interactive drama (e.g., Crawford, 1999; Szilas, 1999; Cavazza, Charles, & Mead, 2001; Magerko, 2002; Young, 2002a; Fairclough, 2004; El-Nasr, 2004).

Training and Education

There is also a growing interest in the use of computer games for more ‘serious’ purposes than pure entertainment. Most of these so-called *serious games* are meant to educate users or train them in a certain competence. Similarly, many research prototypes have aimed at the development of training and education applications using interactive narrative. These are referred to as narrative-centered learning environments (NLEs) (Mott, Callaway, Zettlemoyer, Lee, & Lester, 1999). Two kinds of NLEs can be distinguished, as can be learned from the homepage of the Special Interest Group (SIG) on NLEs:[2] (1) the environment is a mediating tool for the development of narrative competence, as in TEATRIX (Prada, Machado, & Paiva, 2000), or (2) the narrative environment is a mediator for the development of other kinds of competence, such as: military leadership in Mission Rehearsal Exercise (MRE) (Hill, Jr., Gratch, Johnson, Kyriakakis, LaBore, Lindheim, Marsella, Miraglia, Moore, Morie, Rickel, Thiébaux, Tuch, Whitney, Douglas, & Swartout, 2001) and INTALE (Riedl & Stern, 2006a), shown in figure 1.2; coping strategies in Carmen’s Bright IDEAS (Marsella, Johnson, & LaBore, 2003) and FearNot! (Aylett, Louchart, Dias, Paiva, Vala, Woods, &

[2] The SIG homepage can be found at `http://nle.noe-kaleidoscope.org`

Figure 1.2: Screenshots of two interactive storytelling applications for military training. **Left:** Mission Rehearsal Exercise (MRE). **Right:** INTALE

Hall, 2006c), and microbiology in Crystal Island (Rowe, McQuiggan, & Lester, 2007). The combination of interactive drama with pedagogical goals is also sometimes referred to as *interactive pedagogical drama* (Marsella *et al.*, 2003). NLEs have the potential for offering *constructivist learning*, i.e., learning by doing; the main hypothesis underlying NLEs 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" (Mott *et al.*, 1999).

1.2 Research Challenges

Within the field of interactive digital storytelling and interactive drama, there are a number of challenges that are unresolved. Some of the challenges that have influenced the research direction of this thesis are introduced here. In the next chapter, these challenges will be examined in more detail.

1.2.1 Agency

The narrative paradox. The aim to give control over a character in a virtual environment to the user, clashes with the aim to provide a coherent and author-determined course of events within this environment (Aylett, 1999).

Agency within drama. The motivation for a user to act in an interactive drama may be very different from common gaming motivations such as competition and challenge. Assumptions about what it means to take meaningful action within an interactive drama partially dictate the approach followed for building interactive drama systems, whereas at the same time few fully working systems are being created to scrutinize these assumptions.

1.2.2 Authorship

The authoring bottleneck. Being able to fundamentally affect the course of events of a narrative means that the application has to offer a substantial number of variations. The field realized early on that explicitly writing out all the variations is intractable (e.g., Szilas, 1999; Rawlings & Andrieu, 2003). At the same time, alternative story representations for interactive storytelling still require much content to be authored (e.g., Magerko, 2005; Mateas & Stern, 2005b). For instance, authoring Façade, which offers a player an experience of about 20 minutes each run, took two persons about 5 person-years each, of which about 3 were spent on just authoring (Mateas & Stern, 2005b). This problem is also reflected in the fact that there are very few fully-realized systems, and has caused some researchers to turn towards creating authoring tools and methodologies to facilitate the authoring process (e.g., Spierling, Weiß, & Müller, 2006; Medler & Magerko, 2006; Iurgel, 2007) and to organize a series of workshops focusing specifically on the authoring process (Spierling & Iurgel, 2006, 2008; Spierling, Iurgel, Richle, & Szilas, 2009).

Human authorship versus story generation. To help overcome the authoring bottleneck, AI-based systems are being developed that can *generate* story lines or aspects thereof, making decisions in place of a human author. This can become a difficult balance of offering the right kind of authorial control over such systems and requires new answers to the question what authorship means and how an author might think and work to produce interactive drama applications.

1.2.3 A Wicked Problem

A methodological challenge is introduced by the fact that the design problem of an interactive storytelling application is a 'wicked problem', as is game design in general (Mateas & Stern, 2005a; Iurgel, 2007). This means the following:

- There is no definitive problem statement: the design problem is only clear once the game has been built.
- There is no stopping rule: there are no criteria for determining whether the design of the game is finished.
- Solutions are not correct/incorrect but rather better/worse or good enough/not good enough.
- Every wicked problem is unique: every game presents unique design challenges.
- The solution may change the nature of the problem space.

This means that to assess the value of research in interactive storytelling, it must be 'total' in the sense that it addresses conceptual, aesthetic and technical issues hand in hand. In other words, it involves building fully playable prototypes. However, this poses a certain methodological challenge, given the high authoring effort of building complete systems that have enough story content to be fully playable. The consequence that this observation has had for the research methodology of this thesis, is that conceptual and practical issues were addressed in the context of building a story generation system and example domains, while issues of interaction aesthetics were explored using a human-only interactive storytelling experiment.

1.3 Contributions of this Thesis

There are several approaches to creating interactive storytelling applications, as we will see in chapter 2. The work presented in this thesis was done within the context of the *emergent narrative* approach (Aylett, 1999). I understand emergent narrative both as a theory of narrative in virtual environments, and as an approach to authoring high-agency interactive narrative, in which the narrative is not prescripted but an emergent product of autonomous characters taking action and, through their actions, fundamentally affecting the course of events.

1.3.1 Theoretical Contributions

A model of authorship for emergent narrative. The notion of emergent narrative radically changes authorship as we know it from linear narrative, as there is no more room for an author to provide a plot. Still, there *is* authorship to be had over such a setup. In this thesis I will explore the nature of this authorship. I will show how building an emergent narrative can be seen as an attunement process: attunement must be achieved between the character models, the event sequences that happen as a result of these underlying models, and the 'point' of the narrative experience thereof, and between these three elements of the emergent narrative with similar elements in the author's vision and in the real world. Attunement here means that each of these elements may change, including the initial intent that an author may have for the system, so that ultimately there is a satisfying 'match'. Furthermore, an iterative authoring cycle is proposed for achieving this attunement, which is evaluated through a series of authoring experiments.

A poetics of dramatic improvisation. The thesis provides a poetics of improvisational theater, in which drama emerges from local interaction, which can be contrasted with the neo-Aristotelian poetics used in other interactive drama research (e.g., Mateas, 2001a; Tomaszewski & Binsted, 2006), in which an author-defined plot drives the action. The emergent narrative approach can be compared with dramatic improvisation in the sense that both are unscripted and collaboratively emergent.

A model of agency for improvised drama. Using the poetics of dramatic improvisation, the thesis attempts to provide a better understanding of the notion of agency within interactive drama, that is, the ability to take meaningful actions that have consequences for the way the drama plays out. An experiment is described in which participants were immersed in a story that was improvised together with two improv actors. The results of this experiment suggest that there can be meaningful action without a predetermined plot, and that we might expect a user to take on a performer role (rather than a player role), actively collaborating and seeking dramatic interaction.

Actor-level perspective for character-based interactive drama. I show how a poetics of improv can inform emergent narrative as a narrative theory and technical approach. While emergent narrative uses cognitive modeling to create virtual characters, these characters are not aware that they are co-creating a drama, nor do they have any intentions of achieving interesting drama. I borrow from dramatic improvisation the collaborative, actor-level perspective and propose that the incorporation of this perspective into the character models holds promise for generating better emergent narrative.

1.3.2 Technical Contributions

The Virtual Storyteller. The Virtual Storyteller is a story generation platform that is based on principles of emergent narrative. It first simulates the events of the narrative (simulation layer) and then produces a narrative text based on these events (presentation layer). Novel is that the agents that play the role of a character in the story also incorporate actor-level considerations in their decision making. Most notably, they can select events that are unintentional at the character level, and they can try to justify goals and enable actions.

A fabula model for emergent narrative. Based on the causal network theory of story comprehension (Trabasso, van den Broek, & Suh, 1989), a formal model is introduced of the *fabula* of a story (i.e., the events of a story as they really happened, independent of how these events are arranged and presented to the reader). This model is the output of the simulation layer and the input of the presentation layer.

Implementation of late commitment. Taking lessons from the poetics of improvised drama, a computational model is proposed for retroactively defining locations, objects, properties and character relationships, while aiming to ensure consistency with the information previously communicated to the audience.

1.4 Outline

This thesis is organized in four parts.

Part I: Narrative in Virtual Environments

The first part of this thesis explores the idea of narrative in virtual environments, where the free form interactivity of a user has ramifications for the way that narrative can be constructed and conveyed. The focus is on understanding user agency, and on how authorship changes in the face of using generativity in story construction.

Chapter 2 describes the paradox of narrative in virtual environments, namely that the freedom for the user to act in a virtual environment seems opposed to a system telling a story. It discusses the notion of AI-based interactive drama, and compares it with approaches to story generation on the aspect of human authorship, which is deemed important for both.

Chapter 3 zooms in on the *emergent narrative* approach to addressing the narrative paradox. In this approach, authors create AI-based virtual characters, which are unscripted (i.e., there is no predetermined plot), but whose interactions yield an event sequence that can be understood as narrative. In this chapter, the focus is on the specifics of authorship for this approach.

Part II: Dramatic Improvisation

The second part of this thesis explores how dramatic improvisation may inform interactive drama. Dramatic improvisation is particularly informative for emergent narrative, both having unscripted characters and a collaborative emergence of dramatic interaction.

Chapter 4 focuses on the *poetics* of dramatic improvisation, borrowed mainly from Johnstone (1979, 1999). It illustrates how improv actors, besides their enactment of a story character, have a collaborative, actor-level perspective on the emergent drama that is currently absent from emergent narrative. Notions such as offering, accepting, endowing and justifying operate at this level. The poetics of dramatic improvisation is contrasted with the neo-Aristotelian poetics used in other work on interactive drama.

Chapter 5 focuses on the *aesthetics* of participation within a dramatic improvisation, exploring the role an interactor may play within improvised drama. This exploration is done by means of an experiment in which two experienced improvisers attempt to immerse a third, inexperienced participant into the fictional reality of an improvised story. This illustrates that even without improv experience, users in such situations can be expected to pursue collaborative, drama-focused actor-level interests similar to those of improv actors.

Part III: The Virtual Storyteller

The third part of this thesis is a technical exploration of emergent narrative. It presents The Virtual Storyteller, a story generator based on principles of emergent narrative.

Chapter 6 provides an overview of The Virtual Storyteller architecture. To generate stories, first a simulation is run in which virtual Character Agents each play the role of a character in a storyworld. The result of this simulation is a *fabula*, a temporal and causal network of events that forms the basis for telling a story.

Chapter 7 provides a model of the fabula based on the causal network theory of Trabasso *et al.* (1989) and illustrates how such a fabula can be used for the production of a story; re-telling, as it were, the emergent narrative.

Chapter 8 describes the simulation phase itself. The important turn, in contrast to other character-centric work on interactive drama, is that the Character Agents are considered both from the perspective of a character in the story, and from the perspective of actors of the story, in the sense that they actively attempt to create more interesting narrative. The chapter presents a model of *late commitment*, that is, delaying choices as to the exact nature of the characters, locations, objects, relationships and backstories until they become useful for the narrative, similar to how improv actors endow the reality of the scene and justify their actions.

Part IV: Reflection

The final part is a reflection, both on The Virtual Storyteller and on the ideas proposed in this thesis as a whole.

Chapter 9 reflects on authorship in The Virtual Storyteller. The creation of two example story domains is discussed in detail, illustrating the operation of the simulation phase of The Virtual Storyteller, and assessing the quality of the authoring model introduced in chapter 3.

Chapter 10 wraps up with conclusions and provides directions for future work in line with the research direction followed in this thesis.

Part I

Narrative in Virtual Environments

2

Interactive Drama, Story Generation and Authorship

> *Ted:* "It's none of your business who sent us! We're here and that is all that matters... God, what happened? I didn't mean to say that."
> *Allegra:* "It's your character who said it. It's kind of a schizophrenic feeling, isn't it? You'll get used to it. There are things that have to be said to advance the plot and establish the characters, and those things get said whether you want to say them or not. Don't fight it."
>
> **eXistenZ (1999)**

This chapter discusses two research topics under investigation in this thesis: interactive storytelling and story generation. These topics can be seen as highly related, although they differ in purpose and means. In both however, human authorship plays an important role which is nevertheless different from traditional linear story authoring. The aim of this chapter is to visit challenges and approaches to interactive digital storytelling and in particular, to better understand how one might approach narrative authorship while considering the possibility of interaction with and generation of stories.

2.1 Interactive Digital Storytelling

In chapter 1, a few examples of interactive storytelling applications were mentioned. Achieving the aesthetic or pedagogical goals that one might set for the creation of such applications is made difficult by major technical and conceptual challenges that the scientific community is just beginning to address. The year 2003 saw the first conference on *Technologies for Interactive Digital Storytelling and Entertainment (TIDSE 2003)*. A major technical challenge is created by the fact that opening up the notion of 'story' to the possibility of interaction that fundamentally affects its sequence of events means that the application has to be able to offer a variety of alternative stories. If the content author of such an application needs to write out all the variations, this leads to a combinatorial explosion that becomes impracticable to maintain as soon as the user is offered more than a handful of meaningful alternatives. This calls for alternative, procedural ways to represent these variations, as a function of user interaction. The related conceptual challenge is that we might question to what extent the system is still *telling* a story, and in what sense one may still speak of the 'author' of this story, if the user in part determines it. A related conceptual challenge is that the user is no longer the *audience* of a story in the classical sense, but takes on an active role. A major interest of the community has been to enable the user to become a *participant* in a story as one of its characters. The first-person experience of being in a story is very different from watching it as an outsider (Kelso *et al.*, 1993), but there is currently only limited understanding of the aesthetics of participative interaction with stories. This section further explores some of these challenges, as well as some of the approaches that are being undertaken in order to address them.

2.1.1 The Paradox of Narrative in Virtual Environments

Virtual Environments (VEs), with which I will here denote Virtual Reality (VR) environments, game environments and text-based environments that give the user first-person control over a character within the environment, offer a way to immerse a user in an alternative, fictional world with a certain navigational and expressive freedom. For instance, the interaction afforded by many contemporary computer games implies a certain freedom to explore a virtual game world, to jump over dangerous pits, to enter caves, to rotate blocks, to `Use rubber chicken with a pulley in the middle on cable`, to smash monsters into bits or run from them while eating dots, to successfully land an Apache helicopter or crash it against a rock. As well as the freedom to go back and do things differently. The enjoyment here revolves around the notion of *agency*, the satisfying power to take meaningful action and see the results of our decisions and choices (Murray, 1998, p.126).

Storytelling, in contrast, implies that there is a story to tell, traditionally in reflection of past events. These events may be real or fictional: we tell stories about our days, about the days of our ancestors or those of characters we invented. So how can an author use a VE to tell a story, while the user determines its events? If we want to offer the user the chance to play the role of one of the characters of a story within a VE, there is a clash between the player's freedom and the idea of the system telling a story. This clash is known as the *narrative paradox* (Aylett, 2000).

Story Models in Computer Games

Let us briefly contrast interactive storytelling in virtual environments with computer games that contain a strong story component. Computer game designers often situate the narrative and the gameplay on different levels. The role of the story is to give meaning to in-game action, but the story *itself* is often static, and linear. For instance, Jordan Mechner's classic platform game *Prince of Persia* is framed within the following story. The Grand Vizier Jaffar aspires to the throne in the absence of the Sultan. He places the Sultan's daughter, his only obstacle, in a dilemma: "Marry me or die within

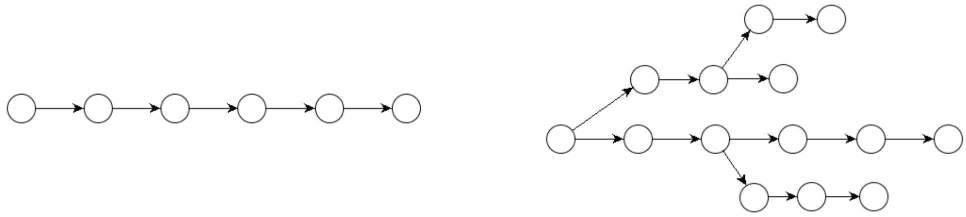

Figure 2.1: Combinations of narrative and gameplay. **Left:** linear narrative, also sometimes known as the "beads on a string" model. Local patches of interactivity are interleaved with non-interactive cut scenes. **Right:** Branching narrative. The branch followed depends on the actions undertaken by the player.

the hour." The princess puts her hopes in the hands of her lover, a prince who is being held capture in the dungeons of the palace. The user controls this prince as he escapes from the dungeons and has to free the princess. This story gives the player a meaningful purpose to act, but the focus for player engagement remains on the gameplay — interesting platform-based action — rather than on the story line. To help further frame the story, it is often the case that small sequences of game-like freedom for the user are interleaved with story transitions that advance the plot by temporarily taking away control from the user in the form of cut scenes (Costikyan, 2007). For instance, the story in Prince of Persia is introduced by two pages of text and a cut scene before the start of the game, and reinforced using cut scenes between the levels, in which we see the princess waiting. This *linear narrative* model underlies many computer games and is sometimes called the "beads on a string" model (figure 2.1). The way gameplay and story are combined is to make sure that at any point in the game, there is either player control or narrative control.

As a strategy towards interactive narrative, such a combination of interactive gameplay and linear story is not what we are after, at least according to Crawford (2004), who calls this the 'constipated stories' strategy. The story is fragmented by gameplay that does not advance the plot.

The wish to allow players to have an effect on how the story unfolds has caused some computer game designers to employ the *branching narrative* model (figure 2.1). Each branch point is a point in time where user action influences the further course of the story. This adds basic story interaction, and cut scenes can be employed to show the player the dramatic consequences of his choices (Salen & Zimmerman, 2003, p.408). However, adding many interaction possibilities creates a daunting task for the author; each new branch requires authoring at least one alternative plot continuation and ending. The number of alternative plots grows exponentially. This makes the explicit hand-crafting of branching narrative highly impractical for offering any substantial amount of user interaction (Crawford, 2004; Stern, 2008).

There are, of course, strategies to reduce the amount of authoring required while staying with the branching narrative model. One way is to make sure that different story lines end up at the same future point in the story. Such *foldback schemes* reduce the amount of authoring required, but also remove the possibility that these different story lines make a difference in the way the story ends (Crawford, 2004, pp.126-129). The plot representation for such a model is a directed, acyclic graph that is sometimes

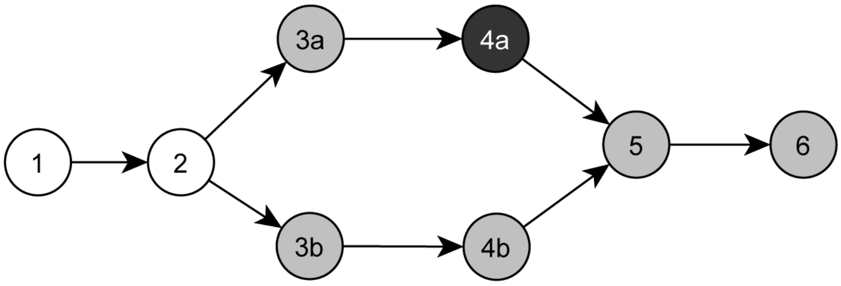

Figure 2.2: Example of a foldback of two branch subpaths (3a-4a and 3b-4b) of the narrative into a shared future point (5). If a significant event happens in one subpath but not in the other (e.g., 4a), the continuation from 5 cannot refer to this event.

referred to as a plot graph (Kelso *et al.*, 1993) or story net (Hill, Jr. *et al.*, 2001). Another strategy for keeping the amount of authoring limited is to 'cut off' choices by making sure that while some continue the story, others lead to a quick ending. For instance, the game *Dragon's Lair* presented a series of binary choices to the player, one of which always led to instant death. Ryan (2001, pp.248-258) discusses some alternative graph-based story models. The problem with such approaches is that while they reduce the authoring burden, they typically do so at the cost of meaningful variation. For instance, foldback schemes decrease the significance of following one subpath of the story instead of another. See figure 2.2. Both paths end up at the same future point, but even worse, the continuation of the plot from this point on cannot build on any event that happens in one subpath but not in the other.

The Role of Story Generation

The use of a branching narrative model is ultimately untenable for offering deep story interaction within a virtual environment. A tremendous amount of authoring is required in order to offer more than a few choices to the player. This remains true when finite-state machines (FSM) or petri net representations of the branching narrative are used (e.g., Brom & Abonyi, 2006). The enormous authoring effort is considered to be the main bottleneck for the development of interactive storytelling systems. Not only does this cause difficulty for experimentation by artists and researchers to advance interactive storytelling as a medium, it also complicates adoption by the general public to write their own interactive stories.

One way to alleviate this authoring bottleneck is to search for other ways to organize interactive story content. The computer, being a procedural medium, has the potential to generate aspects of the space of narrative variation. This puts the development of story generation AI on the research agenda for interactive storytelling (Stern, 2008).

For interactive storytelling, the role of story generation may vary from complete offline story generation in order to produce a rich enough branching narrative for a human player to explore at run time (Riedl & Stern, 2006a), to online moment-to-moment decision making to create (pieces of) story continuations as a function of user action. The latter is especially valuable when knowledge about the player that is not known beforehand is used by the system; this is called *delayed authoring* (Thue, Bulitko, & Spetch, 2008).

Whether we can still speak of 'story generation' in the latter case where the story is assembled piece-by-piece at run time, is questionable as the system never 'generates' a 'story'. Even so, in this thesis the term 'story generation' is used to refer to any form of dynamic (non-predetermined) construction of the event sequence with the goal of creating a story or offering a story experience to the user.

The Role of Narrative Theories

Narrative theories have often served as models for building interactive storytelling systems, developing some form of 'computational narratology' (Cavazza & Pizzi, 2006). Perhaps most prevalent has been the use of the work of Vladimir Propp (Propp, 1968), whose formal analysis of the different functions within Russian folk tales has formed the basis for a number of interactive storytelling systems (Prada *et al.*, 2000; Spierling, Grasbon, Braun, & Iurgel, 2002; Díaz-Agudo, Gervás, & Peinado, 2004; Fairclough, 2004; Tomaszewski & Binsted, 2007).

At least two issues need to be taken into account when adopting existing narrative theories for interactive storytelling. First, narratology studies narratives as static artifacts (i.e., texts) rather than investigating the cognitive process of narrative experience. Although narratology may provide insight into the 'building blocks' of stories, and is thus very useful for story generation research, its use for interactive storytelling must be considered with care. It may lead to systems that 'look like' interactive stories, in the sense that they are open to influence by the player, and the resulting event sequences from an outside perspective resemble that of stories, but are not *experienced* as such from the first person perspective of a user playing one of its characters. Although it is still unclear what this experience entails, there is anecdotal evidence that the experience of drama from a first person perspective is different from watching this same dramatic performance as a spectator (Kelso *et al.*, 1993).

Second, as Szilas (2003) mentions, no particular narrative theory can be considered normative for interactive storytelling; the choice for one over the other is arbitrary and often guided by practical constraints.[1] This may explain the prevalence of Propp-based approaches: Propps formula for the succession of narrative functions makes for easy algorithmic implementation. Tomaszewski & Binsted (2007) however pointed at the limitations of using a Propp-based model for interactive drama: the narrative variation is too constrained, strong cooperation of the user is required due to the normative value of Propp's functions for achieving well-formedness (e.g., the hero must violate the interdiction given to him), and the narrative does not scale well.

2.1.2 Agency Within Interactive Stories

As already suggested, the question how to reconcile user freedom with well-structured stories is not just conceptual but also aesthetic: what makes interacting with a story fun, engaging, and meaningful for the user? What will motivate a user to act within a VE that intends to offer a story-like experience to this user?

[1] This led Szilas to justify an approach that is inspired by existing theories but also influenced by practical implementation considerations.

Murray (1998) addresses three aesthetic categories of interactive narrative: *agency*, *immersion* and *transformation*. Agency is "the satisfying power to take meaningful action and see the results of our decisions and choices" (Murray, 1998, p.126). Immersion is "the experience of being transported to an elaborately simulated place" (Murray, 1998, p.98). Transformation accounts for the way in which such a place can cause one to become another person, taking on their identity. For interactive drama, Mateas (2002, p.24) considers agency to be the most fundamental category.

The pleasure of agency is one that is well-known to computer game players. Salen & Zimmerman (2003) consider meaningful play to be the goal of successful game design, and claim that it "emerges from the relationship between player action and system outcome; it is the process by which a player takes action within the designed system of a game and the system responds to the action." (Salen & Zimmerman, 2003, p.34). This description of meaningful play is complemented by an evaluative description: meaningful play occurs "when the relationships between actions and outcomes in a game are both *discernable* and *integrated* into the larger context of the game." (Salen & Zimmerman, 2003, ibid.).

The distinction between action/outcome relationships that are discernable and integrated is what Mateas & Stern (2005b) call local and global agency, respectively. *Local agency* means that the player is able to see immediate, clear reactions to actions taken. *Global agency* means that the long-term sequence of events experienced by the player is strongly determined by player interaction, in other words, what the player does in the moment should strongly influence which significant events or plot points occur in the future.

Mateas (2002) theorizes when a feeling of agency occurs: the environment should offer a balance between what the player is afforded to do (the *material constraints* of the environment), and what the player feels he is meant or supposed to do (the *formal constraints* of the environment). If either of these two is overrepresented, one ends up with a system that either offers a lot of possibility for action but too little feeling for why one should choose one action over the other (e.g., some of the classic adventure games afford the player a lot of navigational freedom with few or no clues as to where to go to achieve their goals), or a clear direction but with too few possibilities for action, or possibilities that are too forced (e.g., menu-driven dialog options in games that presuppose what players want to say or should be saying).

Different Conceptions of Agency

What makes taking action meaningful is determined by the type of interactive experience. For games — and this goes for board games as well as many contemporary computer games — the meaning of a player's actions is often strongly related to conditions for winning or losing, in other words, to competition or challenge. The adage of one of my own favorite games, the asteroids-based MMO[2] *Subspace* by Virgin Interactive Entertainment (currently still actively maintained in the public domain as *Continuum*) is characteristic of many contemporary MMOs: *Meet people from all over the world...then kill them!*

[2]Massively Multiplayer Online game, i.e., a game that is played online and in which many players — perhaps hundreds or thousands — can play simultaneously.

Roger Caillois (1961) distinguishes different types of games: those based on competition (*agôn*), on gambling and chance (*alea*), on role play, imitation and make-believe (*mimicry*) and on creating vertigo (*ilinx*). Of these, *mimicry* is perhaps of particular interest to interactive storytelling. Copier (2007) describes the experience of role play within the very popular MMORPG[3] *World of Warcraft*. Although most players in World of Warcraft engage in what she calls *instrumental play*, that is, fighting and character skill development, a smaller, but substantial group engages in role play, where the pleasure is derived from the imagination, narrative development, and dramatic interaction (Copier, 2007, p.52). Games like *Sim City* and *The Sims* are other examples of *mimicry* games.

Agency and the Narrative Paradox

Better understanding agency can reduce the tension of the narrative paradox: the player does not *want* complete navigational and expressive freedom per se, but wants to be able to pursue action that is *meaningful*. We can relieve ourselves of the impossible-to-attain task for an interactive drama system to be able to incorporate *any* user action into a meaningful dramatic plot.

If a predetermined narrative structure is used by the system, then the system must either (1) make sure that the narrative structure is not too dependent on what the user does, as in many computer games, (2) enforce this structure by means of more or less subtle rules and restrictions, for instance through the technique of *narrative mediation* (Young, 2002a) discussed further on, or (3) properly communicate the formal and material constraints so that the user comes to *intend* the experience to have this structure.

It may be clear that cases (1) and (2) limit global agency. In case (3), if formal constraints are properly communicated, one can expect a user to gain an understanding of 'meaningful things to do', and to act according to this understanding. The system should then be designed in such a way that these 'meaningful things' are accompanied by appropriate responses from the system. For instance, in Façade, when Grace asks what the player thinks of her decoration, a 'meaningful' response for the player is to say that she likes it or hates it, perhaps even to say "I don't want to talk about your decoration again." But the player also has the freedom to say "I bought a puppy" or to simply walk away. However, it is unlikely that the player will be motivated to perform such actions unless it is to test the possibilities of the system or disrupt its operation. In chapter 5, I aim to better understand agency in an improvised drama, in which notions of *offer* and *accept* serve to communicate and negotiate these constraints.

2.2 AI-Based Interactive Drama

Interactive drama is a form of interactive storytelling which makes use of conventions of *drama*, rather than literature, to offer first-person story interaction. Drama adopts the mimetic mode of story, whereas literary narratives adopt the diegetic mode of story. This distinction between mimesis (showing) and diegesis (telling) can be traced

[3]Massively Multiplayer Online Role Playing Game, i.e., an MMO focusing on role play.

back at least to Aristotle and Plato. In mimesis, the narrative is not told, but effected through imitation. The physical and temporal contingency of action in a VE makes it more comparable to mimesis and hence to drama, than to film and literary narrative (Aylett, 2006). Mateas (2001a) mentions two other differences between drama and literary narratives: (1) intensification (e.g., a condensation of time) versus extensification and (2) unity of action versus episodic structure.

So what is needed to build engaging AI-based interactive drama? Virtual characters are needed that are believable and responsive to user interaction. Loyall (1997) coins the term *believable agent* to refer to a combination of autonomous agents and the believable characters as we might know them from the arts in traditional media such as animation, literature and cinema. Such agents should appear to be rich in personality, and give the illusion of life. In addition, an interesting story should occur, in part as a function of player action. The characters should not only appear alive and responsive, but should also engage in meaningful dramatic interaction. A lesson often taken from the results of one of the earliest story generators TALE-SPIN (Meehan, 1981) is that representing story knowledge at the level of believable characters alone is not enough to create an engaging story (e.g., Murray, 1998; Mateas, 2002; Riedl, 2004; Wardrip-Fruin, 2006). There needs to be some component that makes sure that these characters perform the 'right' behavior to make sure an interesting plot occurs. Such a component is often called a *drama manager* (Mateas, 1997), *director* (Prada *et al.*, 2000; Theune, Faas, Nijholt, & Heylen, 2003; El-Nasr, 2004; Magerko, 2005; Mott & Lester, 2006; Si, Marsella, & Pynadath, 2009) or *plot manager* (Sgouros, 1999). The goal of a drama manager is typically to monitor and influence the event sequence as it unfolds so that certain dramatic goals are achieved. This may be, for example, the occurrence of a dramatic arc or the achievement of certain plot points. If the drama manager employs story generation techniques to achieve its dramatic goals, this is called *generative* drama management (Riedl, 2009).

Combining believable agents and drama management into one interactive story experience has proven to be far from trivial (Mateas & Stern, 2000; Assanie, 2002), and is one of the main technological challenges of interactive drama. A similar challenge occurs in story generation research; solving the dichotomy between plot and character was the main concern driving the story generation work of Riedl (2004). The challenge for drama management in interactive storytelling is first of all that the drama manager must make decisions in place of a human author, who is not present at run time (Thue *et al.*, 2008), and secondly that it must somehow keep character believability and consistency intact while affecting how events unfold. Mateas & Stern (2000) argue that a strict separation of concerns in the development of believable characters that are autonomous, and a drama manager that takes the responsibility for an engaging story to develop by sometimes guiding these characters so they do the 'right' things, is problematic because of the high interdependence of these concerns. This argumentation will be revisited in detail in section 8.3.

The presence of a drama manager and the degree to which it takes responsibility for the progression of the plot divides the AI-based approaches to interactive drama along a spectrum. On the one hand the *strong autonomy* extreme, where characters are autonomous in their decisions and the drama manager steers the unfolding of the drama only occasionally, if at all. On the other hand the *strong story* extreme, where the drama manager makes *all* the choices, including what each character should say and do at every moment in the drama (Mateas, 2002, pp.40-41).

2.2.1 *Strong Story* Approaches

Generally, approaches on the strong story side are better able to represent and incorporate story level considerations and author goals, such as the achievement of a dramatic arc, the incorporation of author-specified events, or constraints on the ordering of events. Their weakness is typically in character-level considerations such as maintaining character consistency, making sure the characters 'follow the plot' at the cost of local and global agency for the user. I discuss here two approaches on the strong story side: the story planning approach of MIMESIS and INTALE, and the beat sequencing approach taken by Façade. Other examples of systems on the strong story side are DEFACTO (Sgouros, 1999), IDA (Magerko, 2002), IDTension (Szilas, 2003), Mirage (El-Nasr, 2004) and Crystal Island (Mott & Lester, 2006). The OPIATE system (Fairclough, 2004) is perhaps also best placed on the strong story side, although Fairclough himself sees his system as being roughly in the middle of the spectrum (Fairclough, 2004, p.135).

MIMESIS and INTALE

The MIMESIS system of Young (2002a) and the INTALE system of Riedl & Stern (2006a) are both strong story approaches where a drama manager determines the actions that characters perform. In both cases, the drama manager makes use of a branching narrative representation of the story in the form of a partial-order, causal link (POCL) plan, in which the plan operators are the events of the story. POCL plans (Penberthy & Weld, 1992) form a good model of narrative structure (Young, 1999), due to the temporal and causal connections of the plan operators. This has inspired work in *story planning*, where the goal of the planner is to search for event sequences that constitute plots that adhere to author-defined goals.

At run time, user action is situated relative to this plan structure. Young (2002a) has explored the relationship between user action and the event sequence of a branching narrative within a game environment. Actions of the player can either be constituent to the plan, consistent with the plan, or exceptional to the plan. A *constituent* player action is one that matches the event that should happen according to the plan anyway. A *consistent* player action is one that is not in the plan, but does not disrupt the future events of the plan either. An *exceptional* player action is one that disrupts the plan, in which case intervention by the system is necessary. Either the exceptional action is incorporated within an alternative plan, or the effects of the exceptional action are changed in such a way, that it no longer disrupts the plan. This last technique is called *narrative mediation*. For instance, if the player decides to shoot a character that is needed later on in the story plan, a narrative mediation decision would be that the player misses, or that the gun is jammed.

The INTALE system, which offers an interactive story for military leadership is also based on this approach. To generate story plans, INTALE makes use of the FABULIST story planning algorithm, described further on. The desired outcome of the story (e.g., a bomb goes off as a dud) is given as a goal to the planner, so that it selects actions that lead up to this outcome. Story planning is performed offline due to its computational complexity, and contingency plans are made for each possible exceptional player action. The result is a branching structure of alternative plans that has the expressiveness of a traditional branching narrative (Riedl & Young, 2006). See figure 2.3.

For story planning, a challenge is to maintain believability of the characters featured in the story (Riedl, 2004). It is important that every character action in a story plan appears motivated from the perspective of the character that performs this action. Riedl ran into this problem with early work on the ACONF system (Riedl, 2002) in which story actor modules collaborated on achieving a plot goal using a blackboard system: "actor modules were selecting actions that fit into the plot without considering 'why' the character might want to perform that action in the first place." (Riedl, 2006, personal communication). To illustrate why this is a problem, consider the following example. The goal of the planner may be to create a plot in which a beggar becomes rich. Without considering character motivation, a plan that satisfies this plot goal might be that the beggar goes to the bank, the bank owner gives the beggar all of the bank's money, and the beggar is rich. This creates a believability problem upon execution of the plan: there is, for instance, no believable reason for the bank owner to simply give away the money. In the FABULIST system, an attempt was made to resolve this issue.

With story planners such as FABULIST, each plan leads to the same outcome, which makes its use for interactive storytelling (as in INTALE) essentially a foldback scheme. Whatever the user does, the outcome is never affected. A second problem is that planners typically search for the most efficient solution to their goal, whereas for stories, errors and convoluted event sequences might actually be desired. Recent work aims at expanding the amount of expressive control over the generated plans. Riedls notion of *author goals* (Riedl, 2009) allows an author to specify intermediate story states that a story plan has to adhere to. Similarly, Porteous & Cavazza (2009) use state trajectory constraints for the planner to specify desired intermediate events and required orderings of events. The work of Thomas & Young (2006) aims at creating an environment for human authors to encode their preferences through a domain metatheory. The work of Riedl & Sugandh (2008) aims at a more specific control over the events in the plan by allowing the author to add story *vignettes*: specific pieces of story that tie in with the planner.

Façade

In the interactive drama Façade (Mateas & Stern, 2003), as described in the introduction of this thesis, the user plays a visiting friend of the married couple Grace and Trip, whose marriage is falling apart. The global architecture of Façade is shown in figure 2.4. Content in Façade is organized around the notion of the *dramatic beat*. In film and drama, a dramatic beat is the smallest unit of dramatic action in which a value is changed, such as trust or love between characters. In Façade, a dramatic beat is represented by a data structure specifying character behavior at the beat level.

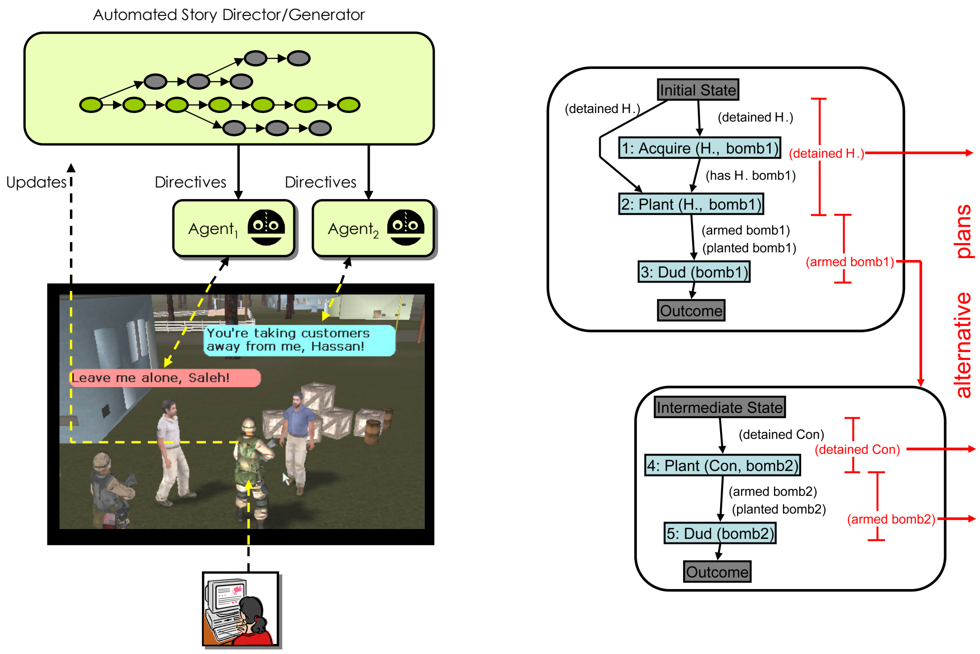

Figure 2.3: The INTALE system (Riedl & Stern, 2006a). **Left:** agents are controlled by directives from an automatic story director component. **Right:** story plan structure. Each possible disruption of a story plan is linked to an alternative plan.

Examples of beats in Façade are `PhoneCallFromParents` and `FixDrinksArgument` (Mateas & Stern, 2005b). A beat is only applicable in certain contexts and allows one to specify the joint behavior of both Grace and Trip in such a way that the story progresses within that context and achieves the beat goal (to change a dramatic value). The job of the drama manager is to sequence beats so that they best adhere to some desired dramatic arc.

2.2.2 *Strong Autonomy* Approaches

Generally, approaches on the strong autonomy side have the inverse advantages and weaknesses of approaches on the strong story side. They are better able to represent characters that act according to a consistent personality in a dynamically changing environment, offering both local and global agency in the sense that user actions and actions of other characters can fundamentally affect the course of events. Weaknesses are to be found in authorial control: making sure that the way the characters act satisfies author-level constraints, such as control over the course of events and timing and pacing of these events to achieve an envisioned user experience, which is difficult when characters are kept autonomous. As the approach pursued in this thesis is on the strong autonomy side as well, we will return to this issue in chapter 8. Here two applications on the strong autonomy side are discussed: the emergent narrative approach of FearNot! and the character-centric approach of I-Storytelling and EmoEmma. Some other examples of systems that follow this approach are *Improv Puppets* (Hayes-Roth & van Gent, 1997), the *Virtual Puppet Theatre* (Klesen, Szatkowski, & Lehmann, 2001), TEATRIX (Prada *et al.*, 2000), Erasmatron (Crawford, 2004), I-Shadows (Brisson &

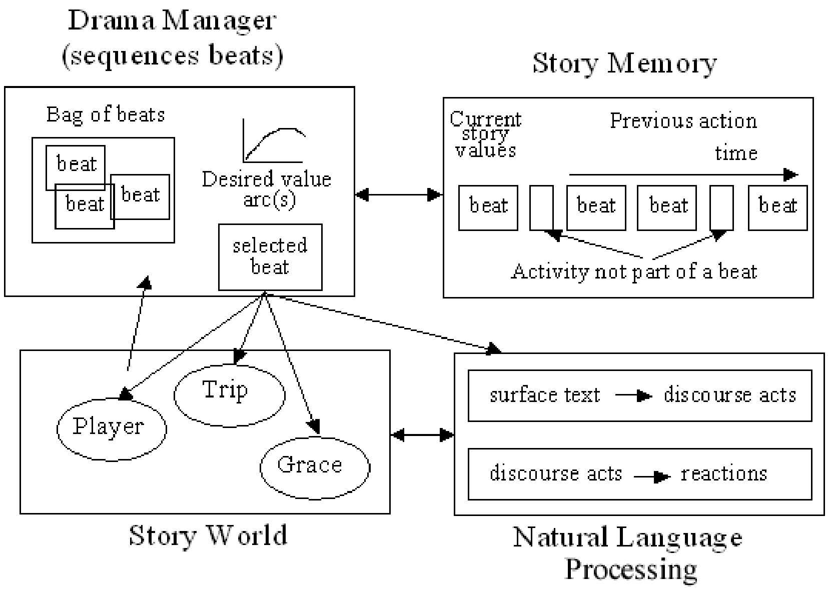

Figure 2.4: Beat sequencing in Façade (Mateas & Stern, 2003).

Paiva, 2007) and Thespian (Si, Marsella, & Pynadath, 2005).

FearNot!

FearNot! is an interactive narrative application designed as an intervention against bullying in primary schools (Aylett *et al.*, 2006c). FearNot! uses autonomous virtual characters that children can empathize with, and exposes some of the typical bullying interactions and coping strategies that children can recognize. Inspired by Augusto Boal's Forum Theatre, the user takes on the role of a spectator that sometimes advises the actors. In the case of FearNot!, the user is framed as an invisible friend to the victim, who occasionally comes to the user for coping advice.

The virtual characters in FearNot! are believable agents, each pursuing its own

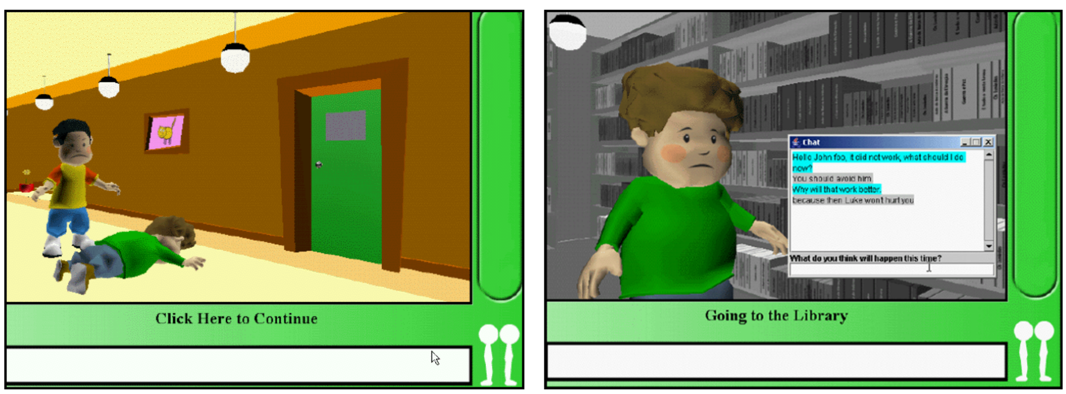

Figure 2.5: Screenshots of the antibullying application FearNot! **Left:** the victim is pushed to the ground. **Right:** the victim asks the user for help.

goals by making plans of action. Depending on the circumstances, characters experience emotions, for instance due to a discrepancy between their goals and the environment. A victim, wishing to avoid being harmed, experiences fear upon considering risky ways to deal with the bully. The social interaction between the characters in FearNot! creates a sense of narrative development that emerges from local autonomous character decisions.

The system is upscaled by organizing the narrative development in episodes. Each episode is a simulation run which is set up by a Story Facilitator (Aylett, Figueiredo, Louchart, Dias, & Paiva, 2006b) in terms of its *set* (the location), its *characters*, the *introduction* of the episode and the *goals* that the characters may adopt within this episode. The Story Facilitator manages the sequencing of episodes; within an episode the narrative emerges from character decision making.

FAtiMA architecture. The FAtiMA architecture (FearNot! Affective Mind Architecture), used for the minds of the virtual characters of FearNot!, builds on the cognitive appraisal model of Ortony, Clore, & Collins (1988) (the OCC model), and on work on the interplay between emotion and behavior (Gratch & Marsella, 2001), including an emotional planner (Aylett *et al.*, 2006b). See figure 2.6.

A FAtiMA agent receives events as they occur in the VE. These events are appraised at two separate levels within the agent: the reactive and the deliberative level. Appraisal at the reactive level consists of matching the event against a set of explicit rules for emotional reaction to the event. Appraisal on the deliberative level consists of matching the event against the plans that the agent is considering for its character goals, generating emotions of hope and fear depending on whether the event helps or threatens the plans. The result of this appraisal is an updated emotional state of the agent.

Subsequently, the agent starts coping with these emotions, again both on a reactive and a deliberative level. Coping refers to attempts by the agent to change the relationship between the agent and its environment, either by taking action to change the environment (problem-focused coping), or by changing its interpretation of this relationship (emotion-focused coping), for instance by denying that there is a problem in the first place (Marsella & Gratch, 2003).

Coping on the reactive level is done by matching generated emotions and perceived events against action tendency rules that, if present, directly result in an action to pursue. Coping on the deliberative level means that the agent deliberates about its intentions, makes or changes plans to achieve these intentions, or changes for instance the importance of goals or the intensity of emotions.

I-Storytelling and EmoEmma

The scenario of the I-Storytelling application of Cavazza, Charles, & Mead (2002) is based on the popular sitcom Friends. Each of the characters acts according to a hierarchical task network (HTN). The HTN decomposes top-level goals of the character (such as "ask Rachel out") into progressively lower-level goals (such as "find out Rachel's interests"), up to the level of primitive actions (such as "pick up Rachel's diary"). The hierarchical nature of the plans corresponds to episodic structures found

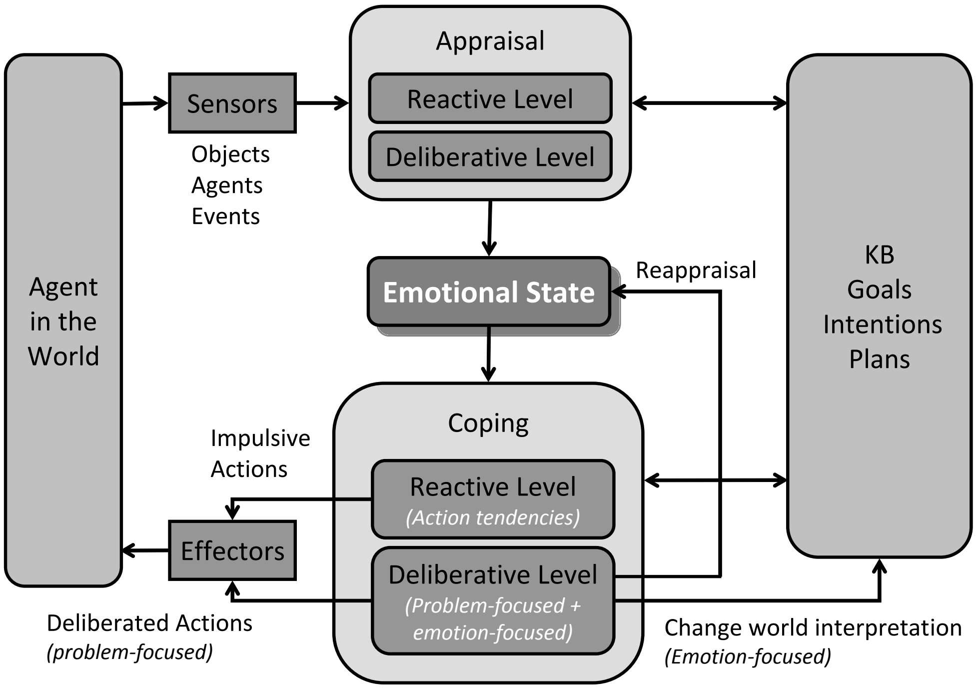

Figure 2.6: The FAtiMA agent architecture.

in simple narratives (Trabasso *et al.*, 1989). There are a number of alternatives for each decomposition; the choice of alternatives and the failure of plans due to actions of other characters ensures variability in the plot.

Recent work has abandoned the use of HTN planning in favor of an approach based on heuristic search planning (HSP), to create more emergence and variability because of (1) a more global re-planning capability in contrast to the fixed high-level character goals of HTNs, (2) the possibility of plan failure due to ignorance of long-term action dependencies, making (comical) misconceptions and blunders possible, (3) a more fundamental interaction between the plans of the different characters so that more variable story lines are possible than with HTNs (Charles, Lozano, Bisquerra, & Cavazza, 2003). In the EmoEmma system (figure 2.7), each character is driven by an HSP-based planner that selects actions and also plans the characters' feelings. EmoEmma is based on Gustav Flaubert's novel *Madame Bovary*, and uses Flaubert's own description of the feelings of the characters in the novel (Pizzi, Charles, Lugrin, & Cavazza, 2007; Pizzi & Cavazza, 2007).

2.3 The Trade-off Between Generativity and Authorship

As discussed earlier, an approach to help reduce the authoring bottleneck is to introduce story generation techniques into the authoring process. Now that we have discussed several generative, AI-based approaches to interactive storytelling, the aim of this section is to investigate the role of human authorship within interactive storytelling and story generation research. Parts of this investigation appeared in Swartjes, Vromen, & Bloom (2007).

In the context of interactive storytelling, story generation often has an applied

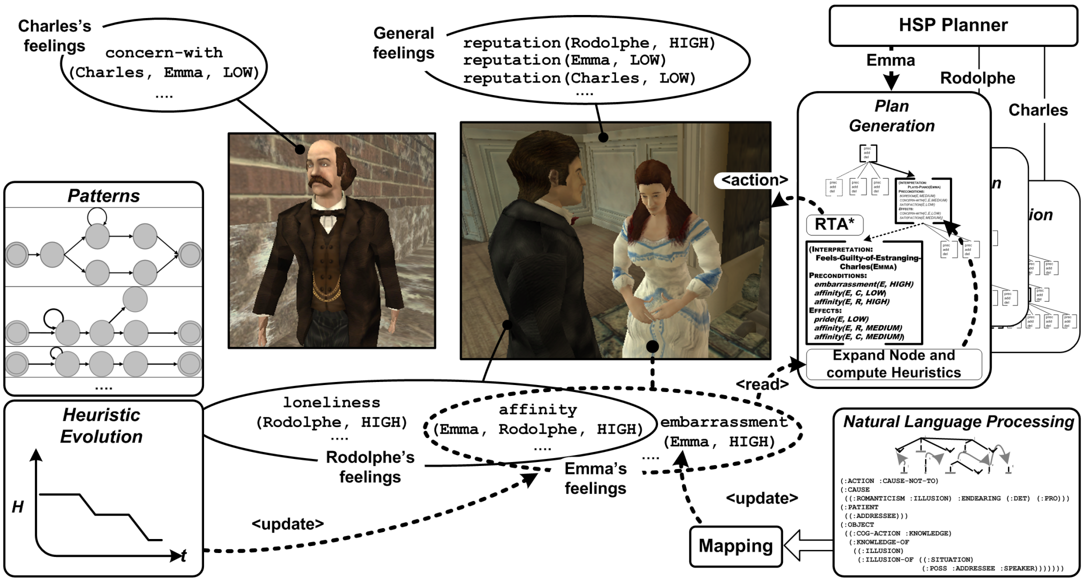

Figure 2.7: The EmoEmma system (Pizzi & Cavazza, 2007). Each character is driven by an HSP-based planner. Characters can be influenced using natural language.

nature, serving the goals of the application. This can be contrasted with more fundamental story generation research, exploring computer models of human problem solving (Meehan, 1981), planning and learning (Lebowitz, 1985), or human creativity (Turner, 1994; Pérez y Pérez & Sharples, 2004). In this section, we will see a few of the systems created for these purposes.

These two perspectives also have different implications for the role of human authorship. In the more fundamental cases, human authorship is often downplayed or even shunned. With an applied perspective, human authorship plays a more central role, because this is considered unavoidable (Bringsjord & Ferrucci, 1999) or desirable, as in many interactive storytelling applications. After first providing a short history of more fundamental story generation approaches, we will start exploring the role of human authorship in story generation and interactive storytelling. First, story generation is discussed from a computational creativity perspective, in which human authorship is shunned, and then from the perspective of Expressive AI (Mateas, 2001b), in which human authorship is brought to the foreground.

2.3.1 Existing Story Generation Systems

In order to describe existing story generation systems, it is useful to first make an ontological distinction between several approaches taken towards building story generation systems.

Liu & Singh (2002) make a distinction between *structuralist* and *transformationalist* approaches. In structuralist approaches, story generation works by combining specific structures into stories as a sort of slot-filling. In transformationalist approaches, the idea is that we can capture the rules that generate stories. Another distinction that is more commonly adopted is that between *author-centric, story-centric* and *character-centric* approaches (Bailey, 1999; Mateas & Sengers, 1999; Riedl, 2002).

Author-centric systems. Such systems attempt to model the thought processes that a story author typically goes through when constructing a story.

Story-centric systems. Such systems take the inherent structural properties of stories, such as story grammars, as a formalization of the story generation process.

Character-centric systems. Such systems attempt to model the characters that 'live' in the fabula of a story in an attempt to create stories by simulating the interactions between these characters.

Bailey (1999) has proposed a fourth category that might be described as *reader-centric*: a system in this category would be organized around the expectations and questions of the reader. However, to my knowledge, Bailey never finished his approach, nor are there any other story generators applying his reader-response approach to story generation.

With this ontological distinction in mind, what follows is a short historical overview of a number of story generation systems developed over the past few decades.

TALE-SPIN

One of the first AI systems that attempted to generate stories was TALE-SPIN (Meehan, 1981). The Yale school led by Roger Schank was just starting to explore issues of computer understanding, and realized that much of the sort of knowledge available to humans is narrative in nature. This put story understanding and story generation on the research agenda. Not surprisingly, TALE-SPIN was a character-centric approach, investigating the relationship between stories and problem solving. Theories of narrative comprehension developed earlier (Schank & Abelson, 1977), and in particular, theories of plan-based behavior deemed essential to story comprehension, were used by Meehan to simulate the problem solving of characters within a storyworld themed around the classic fables of Aesop. See figure 2.8 for an example.

UNIVERSE

Realizing that to produce stories it is not enough to simulate the lives of characters, as was the case with TALE-SPIN, Lebowitz (1985) took an author-centric approach for his UNIVERSE system, and explicitly considered the notion of *plot fragments* that model the kind of goals and plans an author of a story would have. Plot fragments have a certain similarity to the idea of beats in the Façade system of (Mateas, 2002), in that both organize the behavior of characters at a level above that of the individual characters. The system produces soap-like, never ending plot structures. Recently, Skorupski, Jayapalan, Marquez, & Mateas (2007) created a graphical user interface in which story content can be authored for the UNIVERSE system.

MINSTREL

The MINSTREL system of Turner (1994) was the first author-centric system in which the goal was explicitly to make a model of human creativity in storytelling. His author-centric story generator employed Case-Based Reasoning (CBR) techniques to tackle

ONCE UPON A TIME GEORGE ANT LIVED NEAR A PATCH OF GROUND. THERE WAS A NEST IN AN ASH TREE. WILMA BIRD LIVED IN THE NEST. THERE WAS SOME WATER IN A RIVER. WILMA KNEW THAT THE WATER WAS IN THE RIVER. GEORGE KNEW THAT THE WATER WAS IN THE RIVER. ONE DAY WILMA WAS VERY THIRSTY. WILMA WANTED TO GET NEAR SOME WATER. WILMA FLEW FROM HER NEST ACROSS A MEADOW THROUGH A VALLEY TO THE RIVER. WILMA DRANK THE WATER. WILMA WAS NOT THIRSTY ANY MORE.

GEORGE WAS VERY THIRSTY. GEORGE WANTED TO GET NEAR SOME WATER. GEORGE WALKED FROM HIS PATCH OF GROUND ACROSS THE MEADOW THROUGH THE VALLEY TO A RIVER BANK. GEORGE FELL INTO THE WATER. GEORGE WANTED TO GET NEAR THE VALLEY. GEORGE COULDN'T GET NEAR THE VALLEY. GEORGE WANTED TO GET NEAR THE MEADOW. GEORGE COULDN'T GET NEAR THE MEADOW. WILMA WANTED GEORGE TO GET NEAR THE MEADOW. WILMA WANTED TO GET NEAR GEORGE. WILMA GRABBED GEORGE WITH HER CLAW. WILMA TOOK GEORGE FROM THE RIVER THROUGH THE VALLEY TO THE MEADOW. GEORGE WAS DEVOTED TO WILMA. GEORGE OWED EVERYTHING TO WILMA. WILMA LET GO OF GEORGE. GEORGE FELL TO THE MEADOW. THE END.

Figure 2.8: Tale generated by Meehan's story generator TALE-SPIN (Meehan, 1981).

the problem of creating a story. Based on the observation that human creativity is driven by failure to apply standard solutions to a problem, Turners adage for creativity is that it involves recasting the problem into a different one for which a solution *can* be found. The interesting idea in MINSTREL is the use of a set of creativity heuristics for transforming problems into similar problems, and adapting solutions found back to the original problem space so it provides a solution to the original problem. Examples of these creativity heuristics are generalization (if a knight can kill a troll, a knight can kill any character), similarity of outcomes (being killed is similar to being injured), and switching intention (intentional killing can become unintentional killing and vice versa). By employing these heuristics together with a small 'episodic memory' consisting of a small set of specific cases (small story fragments), MINSTREL solves the problem of creating a story according to a set of author-level goals concerning the theme, consistency, artistic quality and presentation of the story.

JOSEPH

The JOSEPH system of Lang (1999) is a story-centric system that takes the idea of *story grammars* as the basis for story generation. In the early days of story comprehension research, there was a prevalent idea that the structure of a story could be captured in the form of a grammar, so we can speak of 'well-formed stories' in much the same way as we can speak of 'well-formed sentences' (Mandler & Johnson, 1977). Although this theory was soon abandoned and replaced by other theories (Trabasso, Secco, & van den Broek, 1982; Wilensky, 1983), Lang showed with his JOSEPH system that the story grammar theory with its top-down rewrite rules lends itself well to computation

$$\text{STORY} \rightarrow \text{SETTING AND EVENT STRUCTURE}$$

$$\text{SETTING} \rightarrow \left\{ \begin{array}{l} \text{STATE* (AND EVENT*)} \\ \text{EVENT*} \end{array} \right\}$$

$$\text{EVENT STRUCTURE} \rightarrow \text{EPISODE ((THEN EPISODE)}^n\text{)}$$

Figure 2.9: Some rewrite rules for simple stories (Mandler & Johnson, 1977).

ONCE UPON A TIME THERE LIVED A PEASANT. PEASANT WAS MARRIED TO WIFE. ONE DAY IT HAPPENED THAT PEASANT QUARRELED WITH THE WIFE. WHEN THIS HAPPENED, PEASANT FELT DISTRESS. IN RESPONSE, PEASANT TOOK A WALK IN THE WOODS. PEASANT FOUND A PIT WHEN HE LOOKED UNDER THE BUSH. WHEN THIS HAPPENED, PEASANT DESIRED TO PUNISH WIFE. IN RESPONSE, PEASANT MADE IT HIS GOAL THAT WIFE WOULD BE IN THE PIT. PEASANT TRICKED WIFE. WIFE WAS IN THE PIT. PEASANT LIVED ALONE.

Figure 2.10: Simple story generated by Lang's story generator JOSEPH (Lang, 1999).

and yields well-formed simple stories such as that of figure 2.10. Figure 2.9 shows some of the rewrite rules from Mandler & Johnson (1977).

BRUTUS

The author-centric BRUTUS system (Bringsjord & Ferrucci, 2000) uses many kinds of representations for story generation to "bestow the BRUTUS architecture with a counterpart to *every* substantive aspect of human literary genius" (Bringsjord & Ferrucci, 2000, p.xxiv): knowledge representations of theme, domain, linguistics and literature, as well as process representation of thematic concept instantiation, plot generation, story structure expansion and language generation. For the development of BRUTUS, Bringsjord & Ferrucci explored the borders of computational creativity, realizing that their system *is* not creative (as it does not understand the stories it produces), but only *appears* to be so due to the way it was engineered (Bringsjord & Ferrucci, 1999).

MEXICA

Following on the ambition to create a story generator that mimics the way that authors construct stories, and that exhibits some form of creativity, Pérez y Pérez & Sharples (2004) developed the author-centric MEXICA system, in which story generation is done by two alternating processes: *engagement*, in which ideas are generated for the continuation of the story, and *reflection*, in which the best ideas are chosen.

For an extensive comparison between BRUTUS, MINSTREL and MEXICA, see Pérez y Pérez & Sharples (2004).

ProtoPropp

The *ProtoPropp* system of Gervás, Díaz-Agudo, Peinado, & Hervás (2004) is also story-centric, using CBR to construct plots, like MINSTREL. It uses a case base of *moves*, such as *Villainy* or *Interdiction*, occurring in Russian folk tales as identified by the analysis of Propp (1968). CBR operations combine these moves with knowledge about characters and their possible roles (e.g., hero, vilain), places and objects.

FABULIST

The FABULIST system of Riedl (2004), used in the INTALE interactive storytelling application, is author-centric work that tries to combine two aspects that must be balanced in writing a story: believable characters, and a coherent plot. The system is implemented in the form of a planning algorithm, where steps in the plan correspond to events in the story. As an extra constraint, the planner makes sure that every event that corresponds to a character action is made to be believable from the perspective of the character that is supposedly performing the action.

2.3.2 Story Generators as Creative Systems

The field of computational creativity investigates the ways in which computer systems can be creative. Writing a story is a creative process; it provides a challenging case study to understand the possibilities and limits of computational creativity. This is reflected in the numerous papers on story generation that have appeared at the workshops on computational creativity that have been held in recent years.

Considering a story generator as an example of computational creativity creates a mindset in which human authorship is diametrically opposed to the generativity of the system. Authoring aspects of the story is seen as a ‘cheat’; it is the computer system that is supposed to be creative, and the system’s creativity is a central evaluation criterion. Obviously so, because if the only criterion were to be the quality of the stories produced, then the most effective story generator would opt for the trivial solution of simply producing a copy of a human-authored story (Yazdani, 1989). One criterion for evaluating the creativity of the system is the criterion of *creative distance* (Bringsjord & Ferrucci, 2000): how far off are the generated stories from the input given to the system, and how trivial do the stories generated seem to a user that has seen the input that the system used to produce these stories? Other criteria for evaluating the creativity of a story generator are the predictability and novelty of the stories (Pérez y Pérez & Sharples, 2004).

In order to understand story generators as computationally creative systems, we need a working definition of ‘creativity’. Wiggins (2001) uses the work of Boden (1990) to create a formal framework for defining and categorizing creative systems. His framework identifies the ingredients of an exploratory creative system (i.e., a system that selects and values partial or complete concepts that are found by traversing a conceptual space) and considers transformational creativity (i.e., creativity that changes the rules which define the conceptual space itself) as exploratory creativity at the meta-level. Placing systems that can automatically generate stories within this framework can help to expose design choices for building creative story generators.

In the discussion of automated story generation as a creative process, the following terms from the framework of Wiggins are relevant:

- $\mathcal{C}$: the conceptual space, which in the case of a story generator can be interpreted as the set of "well-formed stories" for a given domain.
- $\mathcal{R}$: the constraints that define $\mathcal{C}$, which can be interpreted as the rules that determine whether a potential story is well-formed.
- $\mathcal{T}$: the rules that specify how to traverse the conceptual space, which can be seen as the story generation algorithm.
- $\mathcal{E}$: the constraints that evaluate $\mathcal{C}$, which can be seen as the rules that determine the quality of the story.

An ideal story generator that exhibits exploratory creativity traverses the space of possible stories $\mathcal{C}$ using a story generation algorithm $\mathcal{T}$. It knows it has found *a* story by means of $\mathcal{R}$, and only returns those that have a certain minimal quality (determined by means of $\mathcal{E}$).

It has been shown possible to a certain extent to determine $\mathcal{R}$, i.e., the "well-formedness" of the generated stories according to a certain desired form, structure or genre. For instance, the form of a murder mystery dictates that someone must be murdered. The Russian folk tales that were under investigation by formalists such as Propp (1968) adhere to a certain formula that dictates their form. A definition of $\mathcal{R}$ at least allows a story generator to explore a space of possible stories. Story generation systems often use formalizations of $\mathcal{R}$ based on findings in narratology (e.g., Propp) or story understanding (e.g., story grammars as used by Lang (1999)). The FABULIST system (Riedl & Young, 2005) is based on two criteria: character believability and plot coherence. The first criterion (say, $\mathcal{R}_1$) is formalized by requiring that every action in the story is intended by a character; the second criterion (say, $\mathcal{R}_2$) is formalized by requiring that every action has a direct or indirect causal relation to the outcome of the story. Such a formalization of $\mathcal{R} = \mathcal{R}_1 \cup \mathcal{R}_2$ enables the traversal of the conceptual space by means of a story planner $\mathcal{T}$. The fulfillment of $\mathcal{R}_2$ is a direct result of using a partial-order causal link (POCL) planner which starts its planning process from the outcome of the story and plans backwards to satisfy causal requirements. Such a planner would never incorporate plan steps that have no causal relationship with the outcome.

However, determining $\mathcal{E}$ is problematic. Riedl & Young (2005) claim that the evaluation criteria $\mathcal{E}$ are not generally known or knowable in the domain of storytelling. It seems indeed impossible to define general rule sets that determine whether a story is of high or low quality. One definition of the quality of a story might be that it is interesting. Schank (1979) attempted to formalize the notion of interestingness in stories. He distinguishes absolute interests, and relative 'operators' that can be applied to absolute interest. For instance, stories about death, power, sex, money, destruction are interesting in the absolute sense, and stories in which unexpected events happen, such as an unexpected death, or in which something happens that relates personally to a character, such as the destruction of the protagonist's house, are interesting in the relative sense. Such a formalization is, in my opinion, a very limited account, based on stereotypical plots, of what makes people take interest in a story. Bringsjord & Ferrucci (1999) are not convinced by Schanks formalization either; they argue that the set of interesting stories is ultimately not computable. Crawford argues in a similar vein that "while architecturally valid stories can be created by algorithm, humanly interesting stories can be created only by artists" (Crawford, 1999).

If this is true, then this means that a creative story generation system must either be set up in such a way that it does not rely on evaluation by $\mathcal{E}$ (i.e., all found stories are good), or on an implementation of $\mathcal{E}$ that is a subjective, authorial encoding of the story quality (i.e., stories that adhere to the author's requirements for quality are good). In the first case, the system must deliver good stories without having knowledge about *why* they are good. This was also noted by Bringsjord & Ferrucci (1999). Whether the system generates high-quality stories or 'just' well-formed ones, is then determined by the input data given to the system combined with the way the system's processes are implemented.

In both cases (no $\mathcal{E}$ and authorial $\mathcal{E}$), part of the responsibility for the stories produced is with the developer of the system or the provider of its input. Taking this position emphasizes the role of human authorship, in which transparency of the relationship between input data, generation and evaluation processes, and how these affect the generated stories, becomes important.

2.3.3 The Computer as Expressive Medium

This conclusion suggests another way to conceive of the role of a story generator, namely not to ascribe a certain intelligent and creative autonomy to it, but to view it as a medium for artistic expression. A story generator may be designed so that it produces a variety of stories that the creator of the story generator wants it to produce.

Example: Generative Blossoming Trees

To better understand this, let us consider the tree generator *Blossom* I created as a small Flash-based experiment in procedural art.[4] Although *Blossom* generates trees and not stories, it serves here as a simple example illustrating how there can be some sort of distinction between the form embedded in the system's procedures (i.e., the system generates trees) and authorial control over the expression of this form (i.e., particular trees within a variation space).

In *Blossom*, a branching tree grows out of a single dot, with smoothly curving branches that become thinner and thinner and sprout little white flowers at their tips. The tree grows too early in the season; when the mouse is moved over the flowers, they break off with a frozen 'ting' sound and slowly — as if blown by the wind — fall down to the ground. The 'tree-ness' is captured in procedures, allowing an infinite variety of generated trees (figure 2.11 shows some examples).

Within the piece, there are a number of parameters that can be varied: the extent of the curvature of the branches, the average length of the branches, the average

[4] *Blossom* can be found at `http://www.ivoswartjes.nl/projects/Blossom/`

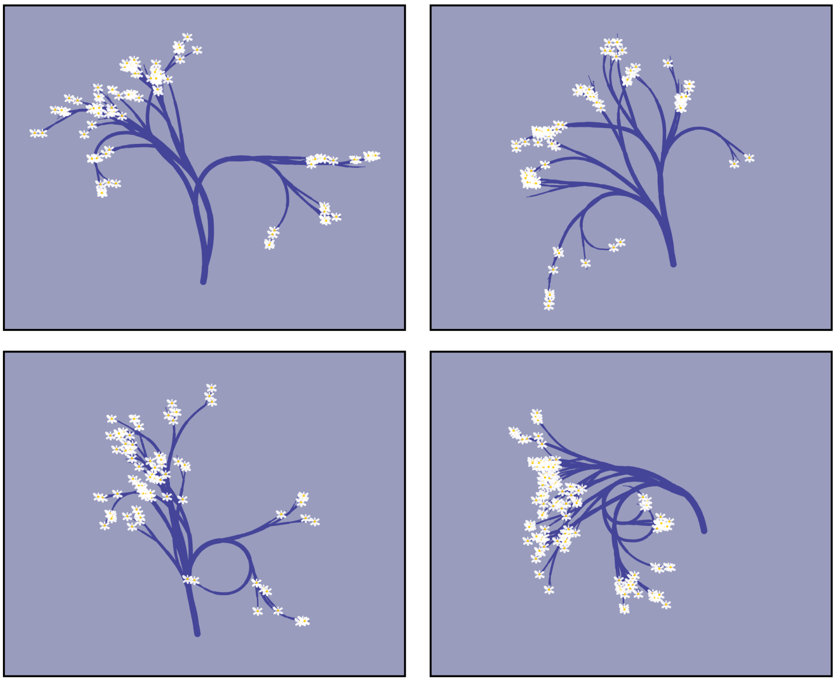

Figure 2.11: Four instances of trees generated by *Blossom*.

number of branches growing out of a split point, the relative angle at which sub-branches split off, the thickness of the root branch (affecting the number of splits as the branches become thinner with each split), and the chance that a flower appears at the tip of a branch. These parameters are appropriately labeled: `curvature`, `branchLength`, `flowerChance`, and so on. These labels signify their meaning within the execution of the tree generator and allow one to think about their effects in terms of output (e.g., if one wants an incredibly curved tree, one should increase `curvature`).

Blossom has no intelligence or creativity; it does not know whether a produced object is indeed a tree ($\in C$), let alone if it is a particularly interesting one ($\in E$). It simply executes its procedures (T), which describe — by author intention — part of the essence of tree-ness. The trees that *Blossom* generates are not realistic. For instance, the curvature is unnatural. This is not strange; I have not used any biologically correct model to implement them. I have encoded my own ideas of 'tree-ness' to create objects that *resemble* trees (although it will be hard to consider the bottom right 'tree' of figure 2.11 as anything but a bunch of wilted flowers).

Embedding authorial intent within the procedures of a dynamic system is what Murray (1998) calls *procedural authorship*. For interactive storytelling, procedural authorship means that "one must write the texts as well as the rules that produce them" (Murray, 1998, p.185). Spierling (2007) similarly coins the term *implicit creation*: one does not explicitly write the narratives themselves, but procedures that 'imply' the various possible narratives. This issue is revisited in chapter 3 for authorship of emergent narrative.

Expressive AI

Within AI research, the role of human authorship is often downplayed, focusing instead on the properties of the AI system itself as independent of any "content" authored within the system (Mateas, 2002, p.126). Early story generation research has been no exception. According to Mateas, this position is problematic for AI-based art such as interactive drama:

> "One way of conceiving the relationship between AI and art is to view these artworks as 'applications' of AI, that is, as the unproblematic use of 'off the shelf' AI techniques in the service of art. This impoverished view assumes that an artist develops a conceptual and aesthetic plan for her work, then chooses AI solutions off the menu provided by AI research scientists. On the contrary, AI-based artwork raises research issues for which AI scientists not only don't have answers, but have not yet begun asking the questions." (Mateas, 2002, p.5).

This claim was made within the context of the development of Façade, considered to be the first fully playable interactive drama. From the very beginning, the aim of Mateas and his collaborator Andrew Stern was to build a piece of interactive drama that is "artistically complete", that is, the piece should be valuable on its own regardless of the technological innovations made (Mateas & Stern, 2000). Such an approach is important because the conceptual, aesthetic and technical issues within such an AI-based system are deeply intertwined and mutually inform each other (Mateas, 2002). The inseparability of these issues was not only true for Façade, but was also an observation within the context of other interactive storytelling projects, such as the Mission Rehearsal Exercise project (Hill, Jr. *et al.*, 2001).

So an active consideration for human authorship, and interpretation by the observer, of the system's behavior, is necessary to build meaningful AI-based art and this has been one of the main concerns of Mateas' work on *Expressive AI*, a research practice that combines AI research and art making (Mateas, 2001b).

Expressive AI suggests an alternative goal for story generation. While most story generators were developed with the aim of exploring more general AI issues — issues of computational creativity, computational narratology or narrative intelligence — a story generator in the Expressive AI philosophy has the specific application *itself* as a goal, and considers AI technical choices as subordinate to this goal. Take the documentary generator *Terminal Time* (Mateas, 2001b). In the case of *Terminal Time*, documentaries are generated for a theater audience, based on knowledge of historical events. The interesting feature is that every so often, the audience is polled on ideologically biased questions. The answers to these questions influence the further rhetoric of the documentary. Where at first the documentary seems objective, over time, the documentary starts exposing its 'funhouse mirror' mechanism of reflecting the bias of its viewers in a distorted and exaggerated manner. Here, story generation is not investigated for its own sake, but serves the artistic purposes of *Terminal Time*'s authors.

Interactive Storytellers Must Program?

Both Mateas and Stern have been fierce proponents of the stance that creating interactive art requires a deep integration of technological development and artistic choices. Stern (2001) argues that artists must program:

> "There is no escaping the fact that to make an artwork interactive is fundamentally to build a machine with processes; anything less would simply be a reactive work without autonomy — 'push button' art. Artists must think procedurally to create truly interactive art, and fashion these procedures to express their artistic intentions. This requires the artist to have a firm foothold in both artistic practice and computer science." (Stern, 2001).

Driven by a similar concern, (Mateas, 2005) argues that 'procedural literacy' is important for new media theorists, in order for them to fully explore computation as a medium. Wardrip-Fruin (2006) uses the term *expressive processing* to refer to this procedural engagement with new media, and argues that for understanding process-based media, one should not only look at their surface, but also at their procedural operation as carrying meaning. Stern's goal to create "deeper conversations with interactive art" is also reflected in the rhetoric of Crawford, who similarly defines interactivity using a conversational metaphor: "a cyclic process between two or more active agents in which each agent alternatively listens, thinks, and speaks." (Crawford, 2004, p.29).

At first sight, this position can be contrasted to that of Spierling *et al.* (2006), who aim for the development of authoring tools that offer authors without an ability to program the possibility to author content for interactive stories. However, this authoring also takes on a procedural nature (Spierling, 2007), and Spierling considers it worthwhile to make a distinction between the course concept of "programming" and procedural authoring (Spierling, 2009, personal communication). This may not be without problems, as recent work by Spierling & Szilas (2009) also indicates, because of the high interdependence of aesthetic and technological concerns. As we will see in chapter 3, the distinction between authoring and programming is also difficult to make in the case of emergent narrative, where authoring includes cognitive modeling of virtual story characters.

Affordances for Authorship

If authors must think and work procedurally, as Mateas and Stern suggest, then this creates a focus on developing special-purpose programming languages or architectures, with appropriate affordances for procedural artistic expression. For Façade, the language *ABL* (A Behavior Language) was developed that can be used to specify coordinated character behavior for interactive drama. For personality-rich interactive characters such as Mr. Bubb (Loyall, Neal Reilly, Bates, & Weyhrauch, 2004), the *Gertie* language was designed so as to allow for the expression of procedural knowledge for interactive behavior. Such languages or architectures offer authorial affordances so the author can think and work in terms of the system, while the underlying system is generative and yields a space of possible performances that cannot be completely controlled by the author.

Relevant here are Mateas' notions of authorial and interpretive affordances. *Authorial affordances* are the 'hooks' that an architecture provides for expressing authorial intent. *Interpretive affordances* are the 'hooks' supporting the audience interpretation of the operation of an AI system. Interpretive affordances are what makes the audience able to describe how the system operates and — if the system is interactive — enable the audience to form intentions to act and understand how the system will respond to such action (Mateas, 2001b).

For instance, the parameters of *Blossom* are authorial affordances that allow an author to inscribe desired properties of the trees. Labeling these parameters appropriately makes a connection to the interpretive affordances of the system, if the system indeed produces more curved trees when `curvature` is increased. This way, authorial and interpretive affordances are closely connected and allow the author to inscribe his intent.

For story generation within interactive storytelling research, considering the authorial and interpretive affordances is not only interesting, but perhaps essential to its evaluation.

2.4 Conclusion

This chapter discussed the topic of interactive digital storytelling, focusing on a particular AI-based form called interactive drama. Interactive drama is a form of interactive storytelling which makes use of conventions of *drama*, rather than literature, to offer users first-person presence within a virtual environment salient with the potential for dramatic interaction. A central issue is the *narrative paradox*: the apparent clash between free-form user interaction and narrative structure in such environments.

The notion of *agency* is key here, referring to the feeling of being able to take meaningful action within the environment. Better understanding agency is important to be able to build meaningful interactive drama. This notion suggests a psychological investigation, rather than a narratological one, but requires building complete systems, which is currently very difficult. The complexity of the systems described in this chapter testifies to this. We can however learn from cultural practices that already, to some extent, aim for an interactive narrative experience. One may think of such practices as role-playing games, story games[5] and improvisational theater (e.g., Aylett, 2000; Louchart & Aylett, 2004b; Tanenbaum & Tanenbaum, 2008). The focus of this thesis is on dramatic improvisation, which will be treated in more detail in chapters 4 and 5.

Another issue is that of *authorship* over such experiences. The way story authors can craft their work changes significantly when the goal is to provide deep story interaction for a user (Spierling, 2007), i.e., local and global agency. Especially when

[5]A story game is a game in which the players create fiction, and the fiction can in turn influence the play of the game. Story games are a type of role-playing game experience with a lesser focus on "My Character" and a greater focus on "Our Story" (meaning the story that all the players at the table want to make). Source: http://story-games.com

story generation formalisms are used within the work in order to lessen the huge amount of story content that is otherwise required, a trade-off must be made between the wish for authorial control over the experience and the wish to offload authorial decisions to the system. We discussed limitations of each extreme: total authorial control and total generativity. As a consequence, the aim becomes to build systems that are generative to some extent, while offering sensible authorial and interpretive affordances so that authors can still express their intent into the system.

In the next chapter, the focus on authorship continues as the emergent narrative approach to interactive storytelling is discussed. Emergent narrative shuns the idea of author-given plots, based on the argument that this is incompatible with agency in virtual environments; rather, narrative is a direct result of autonomous action at the character level. This does not fit comfortably with traditional conceptions of narrative authorship in which plot-centric considerations are essential. Nevertheless, as we will see, alternative ways of thinking and working can be formulated that still allow for meaningful authorship.

3 Emergent Narrative

> "We've become bored with watching actors give us phony emotions. We are tired of pyrotechnics and special effects. While the world he inhabits is, in some respects, counterfeit, there's nothing fake about Truman himself. No scripts, no cue cards. It isn't always Shakespeare, but it's genuine. It's a life."
>
> **Christof**
> The Truman Show (1998)

The concept of *emergent narrative* was coined by Aylett (1999) as a way of looking at narrative in virtual environments (VEs) and has been further developed throughout the years (Louchart, 2007), both as a formulation of a narrative theory for virtual reality, and as an exploration of the use of AI technologies for realizing applications of this theory. As I situate my own work within the context of emergent narrative, the aim of this chapter is to provide an in-depth description of emergent narrative and to contribute to the formulation of the concept by considering emergent narrative from a simulation perspective, discussing the implications for authorship that follow. Parts of this chapter appeared in Louchart, Swartjes, Kriegel, & Aylett (2008b), in collaboration with the MACS group of Heriot-Watt University in Edinburgh, and in Swartjes & Theune (2009b).

3.1 Introduction

The fact that we cannot effortlessly transport traditional notions of 'story', 'narrative' and 'authorship' to VEs means that we either adopt a certain reluctance towards the possibility of 'telling stories in a VE', or that we formulate new terms, or give different meanings to these terms that are more amenable to the non-linear, high-agency demands of narrative in VEs.

The narrative paradox, that is, the clash between free-form interactivity that a VE provides, and the experience of some sort of satisfying narrative structure that authors may want to offer within such an environment, is a fundamental conflict, residing in the fact that VEs and narratives exist on different ontological levels. When we speak of *a narrative*, this is a structural *representation* of a sequence of events, whereas a VE is a *simulation* (Frasca, 2001). The difference between these modes of representation is that a simulation retains some of the behaviors of the object represented, allowing interaction, where a representation does not.

Rather than seeking a combination of representation (e.g., a linear or branching plot structure) and simulation (e.g., the physics of the VE and the autonomous behavior of its computer characters), a combination which — as we saw in the previous chapter — is far from trivial, the theory of emergent narrative solves the narrative paradox by removing the plot versus user interaction dichotomy altogether (Aylett, 2000). The narrative is emergent in the sense that there is no predetermined plot structure separate from characters pursuing actions in relation to this plot, as in Young (2002a). Rather, narrative is a direct result of the actions of characters featured in it. These characters are autonomous, driven by the same kind of internal psychology that an audience may attribute to characters in traditional stories. In this sense, emergent narrative is compatible with the simulation mode. The behaviors that are being retained are those of story characters imagined by an author.

Despite the weaknesses of a character-centric approach to interactive drama, as discussed in chapter 2, there are several reasons why I think such an approach holds promise for interactive drama:

(1) A character-driven model fundamentally supports local and global agency: user actions can have long-term consequences for the course of events. At any time in the simulation, a believable character acts in accordance with its personality and personal history. The consequences are *real*, in the sense that they follow from underlying models and have not necessarily been preconceived by the author. They may be surprising to both author and user. Good examples of this are the 'mis-spun' tales of the story generator TALE-SPIN (Meehan, 1981), a few examples of which will be given further on in this chapter.

(2) The experience of characters that are autonomous, appear to have a personality, emotions, a will of their own and make their own decisions, is pleasurable in itself, even when dramatic development remains limited. We can learn this for instance from the success of *The Sims* series and from Andrew Stern's popular and award winning believable Catz, Dogz and Babyz (Stern, 1999).

(3) The notion of 'character' provides strong authorial affordances. By specifying characters, authors can express what their characters should do in certain situations and, more importantly, *why* they do what they do (i.e., their underlying rules). The implementation of these underlying rules determines the behaviors and interactions of the characters. Here, the large body of work on creating believable agents can inform the creation of character-centric interactive drama.

For the rest of this chapter, it is important for the reader to have a general understanding of the kinds of generative processes employed for narrative generation in the emergent narrative concept, including the underlying rules of character behavior.

To this end, the emergent narrative application FearNot! and the FAtiMA agent architecture used for the characters in FearNot! (both described in chapter 2) will regularly serve as examples.

3.2 The Emergent Narrative Concept

The aim of this section is to provide an in-depth description of the emergent narrative theory and approach by highlighting some of its core concepts. This description serves as a basis for section 3.3, in which I discuss issues of authorship for emergent narrative.

As we will see, there are fundamental reasons why we cannot simply transport models of drama and film to a VE. Most importantly, none of these media offer user agency. In a VE, the user becomes part of the fabula by taking action, and influences the narrative *itself*. Being present in a VE rather than watching a film or a play also has implications for the narrative perspective, which becomes the first-person perspective of the user. These reasons invalidate *mimesis*, i.e., the idea that a story is being shown to an audience, as in drama. Here, I focus first on the issue of narrative perspective, to continue in sections 3.2.2 and 3.2.3 with a discussion of how emergent narrative treats narrative development in the face of user action.

3.2.1 Narrative Perspective

If a VE is to be perceived as an environment, there must be some sort of consistency of space and continuity of time and action, as there is in real life environments. The user can determine which part of the action going on in the environment is being perceived. With a spatial dimension, unlike on a stage, the user can potentially walk away from a dramatic situation to another location, or enter in the middle of one. For instance, a user that plays an interactive Little Red Riding Hood can go to Grandma's house as directed by mother, but might also decide to go to the woodman's house instead to see what he is doing in the mean time. This is different from drama, where scenes have a unity of place.

Unless we create an *illusion* of a continuity of action, as was done to Truman Burbank in the movie *The Truman Show*, this continuity must be *afforded* by means of a simulation. Nobody goes 'off-stage', as in drama, and events do not necessarily have a function within the unified whole of a plot. Indeed, to ensure continuity there might be boring events: while Little Red Riding Hood is being eaten by the wolf, the woodsman might be chopping some wood while listening to the radio. The first-person perspective and the fact that user agency can affect the events of the narrative leave little room for employing many of the literary devices that are used in traditional narrative, such as suspense, foreshadowing, focalization and ellipsis, i.e., 'leaving out the boring bits' (Aylett, 2000). Such devices require either control over the narrative perspective, or knowledge of future events, both being somewhat problematic when these events happen in real time.

Storification

As the fabula of the narrative might not only *unfold* differently depending on user action, but also be *understood* differently depending on what parts of the fabula have been witnessed, it is therefore also *subjective*. Each participant in the VE has their own perspective on the fabula, determining what they understand of it. The computer-animated family comedy *Hoodwinked! (2005)*, based on the Little Red Riding Hood folktale, is an excellent example of this. Each of the four main characters (Red, Wolf, Granny and Woodsman), has a different subjective interpretation of the fabula.

There need not be a narrator for the user to try and make sense of the events that take place in the form of some sort of comprehensible narrative structure, as we also try to understand our own lives in terms of narrative (Bruner, 1991; Mateas & Sengers, 1999). Aylett uses the term *storification* to refer to this process of assimilating events into some kind of narrative understanding (Aylett, 1999). This notion of narrative is one that is focused more on the ongoing process of narrative interpretation than on the narrative as an artifact or end product (Louchart & Aylett, 2005).

The strength of this notion of narrative is that it opens up possibilities for constructivist learning for educational applications (Mott *et al.*, 1999; Aylett, 2006), and that it goes beyond the one-dimensional message that a linear medium is bounded by. For instance, the FearNot! system does not tell children what the exemplary way of dealing with bullying behavior is. Rather, allowing them to advise the victim empowers them to see or try out for themselves 'how bullying works', and to consequently reach a more personal conclusion.

Agency

When a user is given freedom to act within the environment, the question is what offers the formal constraints necessary for evoking user agency. For the emergent narrative concept, Aylett (2000) proposes creating this by means of *social presence*. As in role playing games, the user has a social role in the environment, which is reinforced through social convention or pressure and by the fact that user actions have permanent consequences in the environment as opposed to having a restart facility. Completely limiting user action to a character role (i.e., stepping out of character as little as possible) is also considered important by role players in World of Warcraft (Copier, 2007). For computational feasibility reasons, the role of the user in FearNot! has been limited to that of an 'invisible friend' to the victim, who occasionally provides suggestions to the victim character for coping with its situation.

In addition to social presence, if the environment can create a desire for the user to understand the unfolding event sequence, this may be another important factor motivating user action within the VE. As a substitute for a narrator, who deliberately raises questions and suspends the answers to them, we can imagine that the interactors are likely to raise questions of their own and act in order to achieve answers. Hu, Bartneck, Salem, & Rauterberg (2008) created an interactive mixed reality installation based on Lewis Carroll's *Alice's Adventures in Wonderland*, which puts the user into Alice's shoes and aims at evoking experiences for the user similar to those Alice went through in her adventures. At the beginning of the experience, the user sees a white rabbit in a hurry. This raises curiosity, as when reading narrative texts or watching a dramatic performance: who is this rabbit and what is it up to? However, since the user *embodies* Alice rather than watching or reading about her, such questions will not be answered by a narrator but form a direct motivation for the user to act and follow the rabbit.

As an alternative conception of agency we may consider *collaborative creation* of narrative, as in TEATRIX (Prada *et al.*, 2000) and I-Shadows (Brisson & Paiva, 2007). Here, the pleasure of agency is not so much connected to social presence as it is to collaboration and creativity. In both systems, children can take on the role of a character and collaborate with computer-controlled characters to create stories. In TEATRIX, this interaction takes place in a VE, whereas in I-Shadows, the user can control Chinese shadow puppets, whose shadows can be recognized by the system and are mixed with computer-generated shadows to create one common narrative performance. In both TEATRIX and I-Shadows, the computer-controlled part of the performance is created by having the roles of the characters enacted by autonomous agents without a script.

In chapter 5, we investigate agency using an improvisational theater model, in which both conceptions can be detected: elements of social presence and role-play are combined with elements of collaboration and creation.

Narrative Closure

One question we can ask about the emergence of narrative is: when does it end? The process of narrative development is one that can in principle go on forever. If one needs proof for this claim, one only has to look at the endless dramatic development within television soaps.

For narrative to be satisfying, it is desirable to achieve some form of closure. Narrative closure can be defined as the phenomenological feeling of finality that is generated when all the questions saliently posed by the narrative are answered (Carroll, 2007). Narrative closure becomes an issue with the notion of narrative described here. The limited, personal and subjective perspective that a participating user has on the event sequence, combined with giving away control over what questions the user is asking within the narrative, makes it likely that there will be open questions at the end of the experience.

One way to achieve closure without relying on a narrator to present the necessary knowledge, is to use a kind of debriefing or discussion afterwards (Aylett *et al.*, 2006b), similar to sessions held after live action role play (LARP) (Louchart & Aylett, 2004a). Open questions can be resolved in discussion with other human characters, or with the makers of the system, or perhaps in dialogue with the virtual characters, in order to achieve a more complete understanding of the storyworld. Another way to resolve this issue is to develop an automated storyteller component that tells a story based on the fabula of the VE from other perspectives, such as the global, omniscient perspective or the perspective of other characters. This was done for example in *The Ambient Wood Journals* project (Weal, Michaelides, Thompson, & Roure, 2003). In the project, an augmented reality learning experience was created in which children's movements and actions in an outdoor environment (a woodland) are tracked using sensors and stored in log files. Later in the classroom, after their visit to the woodland, these log files are rendered into a hypermedia narrative to enable the children to further reflect on their experience.

Narrativity of a Virtual Environment

Of course, the events that happen should somehow *afford* a storification process. So how can we distinguish experiences in VEs that lend themselves to organization into some sort of narrative structure, from experiences that do not? For instance, what makes the events in FearNot! narrative, as opposed to most interactions happening in the social simulations of, let's say, Second Life? We make use of the definition of Schärfe (2004), who states that to understand the essential elements of narrativity, three fundamental principles must be taken into account. These are the principles of succession, transformation and mediation. The principle of *succession* encompasses the widely accepted fact that narrative entails a sequence of successively occurring and causally related events. The principle of *transformation* encompasses the fact that narrative portrays a change in states of affairs that can — by virtue of this property — be perceived as a whole, with a beginning, middle and end. For instance, a tragedy such as Sophocles' *Oedipus the King* portrays the transformation of a hero, from fortune to misfortune. The principle of *mediation* is a third necessary factor for defining narrativity. It encompasses the fact that the narrative as a whole refers to something outside of the text; we may associate it with such terms as premise, rationale, and 'point':

> "One of the extraordinary powers of narrative is that it enables us to make inferences across the borders of fictional and real worlds; that messages and systems of value are communicated in a way, not resilient to debate, but with convincing power by means of 'examples'. The interesting thing about this, is that the narrative points to something else than the elements of the text do." (Schärfe, 2004, p.58)

Where the principle of succession may be evident for narrative in VEs — after all, VEs already contain a temporal and causal dimension — we now take a closer look at the principle of transformation, as we investigate how narrative can emerge through character interaction. The principle of mediation is treated in section 3.3, where we show how the authoring of emergent narrative can be understood as a process of meaning creation.

3.2.2 Emergence of Narrative

Rather than having a predetermined plot that guides the experience, narrative may also be unscripted, emerging directly from the behavior of virtual and user-controlled characters. As Aylett notes: "...in an obvious sense, narrative is emergent, since it has emerged from human life experience." (Aylett, 2000). Still, as in life, narratives that emerge solely from character interaction may not always be interesting ones. According to the definition of Schärfe, we may not even always consider them narrative

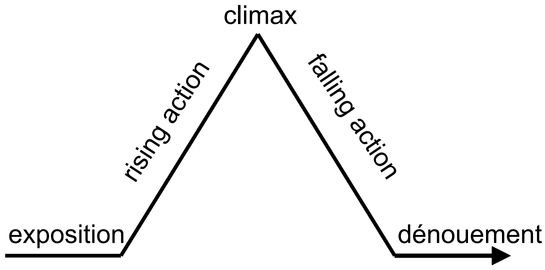

Figure 3.1: Freytag's pyramid, showing the different phases of a drama.

at all. Succession is accounted for; character actions form events that can be temporally and causally organized. But the 'boring' action discourse of a character walking home after work also contains succession — obviously it is not enough. As we have seen, two extra requirements are necessary for the experience to be understood by the user as a narrative: transformation of states of affairs, and mediation, i.e., the perception of some kind of 'point' that makes the narrative meaningful.

In FearNot!, both a transformation of states of affair and a 'point' can certainly be detected. For instance, in one episode, the bully's persistent insults gradually create an ever greater buildup of emotions for the victim, who considers risky plans to fight back but is too scared, until finally, he yells out: "shut up!" FearNot! also serves the 'point' of conveying the drama of bullying in real life.

To further understand transformation, there are several theories of narrative and drama that can be drawn from, some of which are difficult to integrate with emergent narrative as they prerequire certain structural arrangement of events, and/or limit the role of the character (Louchart, 2007, p.26). Well-known examples are the arrangement of functions by Propp (1968), Joseph Campbell's *monomyth* (Campbell, 2004) and Aristotles' own treatment of the tragedy, requiring the occurrence of conflict and reversal of fortune for the protagonist (Aristotle, 1907). For the same reason, story grammars as used in the JOSEPH system of Lang (1999) are also incompatible with the emergent narrative approach. This also clearly limits the kinds of stories we might expect from the emergent narrative approach: no well-formed Proppian folktales, no murder mysteries or intricate Hollywood plots.

We will see further on in this thesis that in order to attain desired properties of transformation, there *are* possibilities to influence the course of events, both in the form of environmental control and episodic organization (section 3.2.3) and in the form of modulating the mental processes of the virtual characters (chapter 8). With this in mind, two organizing aspects on the level of transformation in drama will be discussed here that seem more compatible with the unscripted and real-time unfolding of emergent narrative: the rise and fall of dramatic tension in relation to character emotion, and the 'shaping' of narrative necessity by contextualizing character actions.

Dramatic Tension

One aspect of transformation is the kind of development in dramatic tension that is found in drama. A famous model of this development is Freytag's pyramid (figure 3.1). According to this model, one can recognize several phases in the develop-

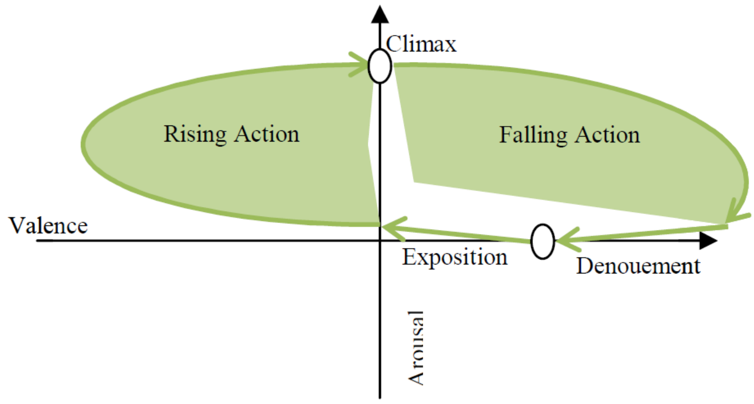

Figure 3.2: Dramatic tension model based on emotions (Brisson & Paiva, 2007).

ment of the drama. The drama starts in the *exposition* phase where there is a certain equilibrium as the audience finds out about the characters and their lives. Then, an inciting incident occurs after which the tension starts to rise in the *rising action phase*, building up to some sort of high-tension climax. After the climax, the tension drops again in the *falling action* phase, ending in the *dénouement* phase in which the tension has returned to a state of equilibrium.

Brisson & Paiva (2007) propose a method to model the dramatic tension of an interactive drama based on Freytag's pyramid. In this method, dramatic tension is associated with the valence and arousal of character emotions: emotional arousal determines the dramatic tension, whereas emotion valence determines whether the action is rising or falling. Starting from the exposition phase, which is emotionally relatively neutral and has a somewhat positive sum valence of emotion, an increase in negative valence emotions creates rising action, whereas falling action occurs after the valence balance of emotions turns to positive again. See figure 3.2. The idea for emergent narrative is that the system can track the phase of the drama based on this 'balance of emotions', and use this knowledge to appropriately affect the emotional development to follow this model.

The idea of using emotion as a substitute for dramatic value has also influenced the work of Louchart (2007), whose investigation suggested that "emotions could be used as a surrogate for dramatic intensity, thus allowing for the dramatic assessment of decisions according to their emotional impact" (Louchart, 2007, p.88). Elliott & Melchior (1995) even go so far as to claim that emotional interaction is sufficient for creating stories that have a 'point'. It is therefore not strange that in the emergent narrative approach, emotion receives a central role for narrative generation (Louchart, 2007, p.8). Emotion appears to be an important aspect of transformation, allowing us to empathize and 'feel along with' a character's development. This is also why it was made an important component of the character models of FearNot! But emotion alone does not fully account for transformation: if the bully in FearNot! had been scaring the victim and then grew tired and stopped, the victim's fear would perhaps decay with no ensuing transformation as may be intuitively understood: the narrative is in the same state of affairs as it was before this interaction. It would be different if for instance the interaction made the victim decide not to go to school the next

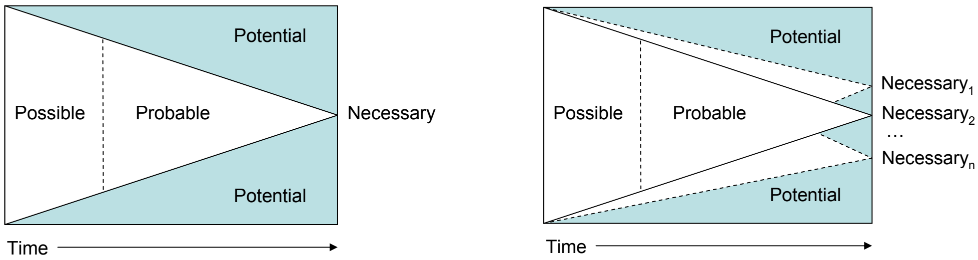

Figure 3.3: Laurel's "Flying Wedge of Possibilities" (Laurel, 1991, pp.67-81). **Left:** Flying Wedge in drama. **Right:** interactive version of the Flying Wedge.

day. Transformation also means a certain irreversibility of state, for instance through a change in character goals.

Building Towards a Necessary Ending

This brings us to another aspect of transformation in drama, found in the fact that throughout a dramatic performance, there is a developing sense of inevitability of its outcome (Laurel, 1991, pp.67-81). Laurel illustrates this through the metaphor of a "Flying Wedge of Possibilities" (figure 3.3). At the beginning of a play, there is a certain limitless potential for action. The action of the play then gradually reveals a dramatic frame, containing aspects such as characters, motivations, relationships and plot trajectories (Sawyer, 2001). At the same time, this dramatic frame constrains possible future courses of events to an ever narrowing probable outcome.

Laurel also presents an interactive version of this "Flying Wedge of Possibilities", in which the user affects this process, leading to a variation in possible endings, each gradually made necessary by the courses of events that precede them.

In emergent narrative, this dramatic frame is not 'revealed' as it does not exist prior to the narrative. Rather, it emerges as characters adopt goals and develop an internal state consisting of cognitions and emotions that persist through time and affect future decision making. See figure 3.4 (right). The further the drama evolves, the more specific this context becomes.

This can be contrasted, for instance, with the narrative events in many classic adventure games, which often only utilize local context (and global context is hard-coded in). See figure 3.4 (left). Whereas for instance the player would enter a store to be greeted by the store owner ("Hi there stranger!"), leaving the store would not create further (global) context; upon re-entering the store, the same text would appear. In a narrative context with global agency, we would expect the store visit to have created context for further interaction, creating a sense of global agency.

We can make an assumption that emergent narratives are better structured when characters make use of this global context, in other words, when past events affect future decisions. In order to achieve global agency, it is important that character decisions not just be based on the current and recent local context, but within the whole context created by the event sequence so far. This way, character decisions build on a fictional reality that matters because it forms part of the context for future events, creating a causally coherent whole. In chapter 4, we will see that this is related to the notion of *reincorporating* within dramatic improvisation.

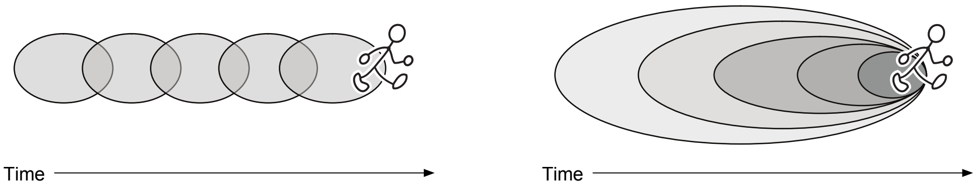

Figure 3.4: How characters use context in drama and non-drama. **Left:** Non-drama. Decisions of a character are based on the local context. **Right:** Drama. Decisions of a character are based not only on the local context, but also on the context of the whole event sequence so far.

3.2.3 Narrative Control

For the achievement of such kinds of dramatic structures, the use of autonomous characters only pursuing their own line of action is not enough. This is a conclusion commonly drawn from work on the TALE-SPIN system (see for instance the story of figure 2.8). There needs to be some component that takes care of narrative control.

The task of narrative control in FearNot! and I-Shadows is taken up by a *Story Facilitator* (Aylett *et al.*, 2006b; Figueiredo, Brisson, Aylett, & Paiva, 2008; Louchart, Kriegel, Figueiredo, & Paiva, 2008a), a term borrowed from educational role play discourse. Since emergent narrative is based on the fact that the characters of the story — including a potential user — are autonomous, there are immediate implications for the kind of story control possible. For instance, giving directives to characters to make sure they pursue action that fits within some form of intended story structure directly violates this autonomy. As argued by Mateas & Stern (2000), and explored in more detail in chapter 8, concessions in character autonomy must be drastic in order to be able to reliably enforce author-given story structures. Instead, the Story Facilitator exerts indirect narrative control by means of a set of *narrative actions*, such as loading a scenario, and adding and removing characters and objects.

For upscaling, the emergent narrative can be organized into episodes, as was done in FearNot! The Story Facilitator manages the sequencing of these episodes. An episode definition sets the boundaries for a small emergent scene, for instance by defining its set, i.e., the location and props, and a sensible limitation of the characters' range of choices, for instance by specifying a subset of goals available for the episode (Aylett *et al.*, 2006b; Louchart *et al.*, 2008a).[1] Each episode definition has preconditions that determine when it is eligible for selection, and finish conditions that determine when the episode ends.

Within each episode, the agents act autonomously, but the Story Facilitator still manages the course of events. For each episode, a set of *triggers* is defined, which are associated with a set of narrative actions that should be executed. For instance, an episode in FearNot! in which the victim is being mocked by the bully, might contain a trigger specifying that a bystander enters the scene as soon as the mockery takes place. Narrative actions add the character to the scene and make him move to stand

[1]Note that defining a subset of available goals in order to constrain autonomous characters is not the same as giving directives, because the remaining options are still being chosen from an autonomy perspective (i.e., are justified by the goals and beliefs of the agent).

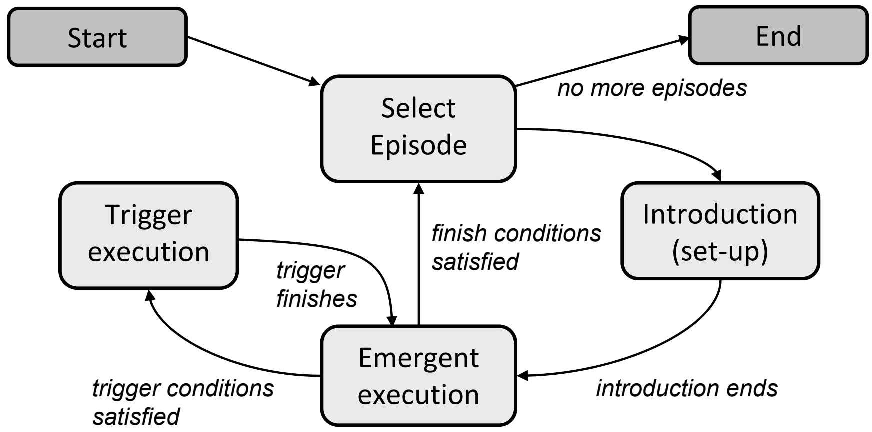

Figure 3.5: States of the Story Facilitator used in FearNot! and I-Shadows.

behind the victim. Figure 3.5 shows the states of the Story Facilitator (Figueiredo *et al.*, 2008).

This approach for upscaling adheres to the 'scalable autonomy' philosophy of Spierling *et al.* (2002), i.e., providing authorial control on different hierarchical levels of the narrative, each level having a certain amount of autonomous (generative) operation. One issue with this approach is that cutting the emergent narrative simulation into scenes means that the time in between scenes, and the changes that purportedly occur during this time, are not accounted for (Aylett, 1999). For instance, the victim in FearNot! often ends up crying at the end of an episode. If the next episode would take place ten minutes later, the audience would expect the victim still to be sad, or to express fear to go to school the next day; they would expect at least *some* emotional residue or in-between narrative progress. In FearNot! however, each episode starts with 'fresh characters', with new initial emotions, as if nothing had happened earlier. For FearNot!, this works reasonably well because the episodes have a high degree of independence from each other, i.e., do not 'build on each other'.

Work by Louchart (2007) has extended the approach to narrative control with the notion of *distributed drama management*. Here, the idea is that each character takes responsibility in managing the drama; one way they can do this as investigated by Louchart is by biasing action selection choices towards those choices that have the greatest impact on the emotions of other characters. In chapter 8, we return to this notion of distributed drama management and situate this in the larger conceptual framework of considering the virtual characters from the perspective of improvisational actors. But before doing so, we must first discuss some of the poetics and aesthetics of dramatic improvisation, which will be done in chapters 4 and 5.

3.3 Authorship of Emergent Narrative

So far, the discussion in this chapter has mainly focused on conceptual issues of emergent narrative. As we saw in chapter 2, it is also important to consider the affordances for authorship of generative interactive storytelling systems. In this section, I approach emergent narrative from the perspective of an author, aiming to provide more insight into the creative process of constructing an emergent narrative application.

Such insight would also be valuable given the fact that creating an emergent narrative has proven to be a large and complex task whereas at the same time the literature on emergent narrative — and this is true for the interactive storytelling field as a whole — has been relatively sparse in addressing the authoring process. As a panelist at the 2007 *AAAI Fall Symposium on Intelligent Narrative Technologies*, FearNot! collaborator Ana Paiva characterized the construction of FearNot! as an iceberg; it turned out more complicated than it seemed. Although creating FearNot! was somewhat simplified by having data available on bullying episodes, it still took a multidisciplinary team of researchers, graphic designers and psychologists to create it (Paiva, 2007, personal communication).

Most literature on emergent narrative has focused on conceptual issues and on the 'task of the author': an author must create interesting characters with a strong potential for dramatic interaction (Louchart & Aylett, 2005), by creating roles, environments, props, and relationships according to a global vision of the whole experience (Aylett *et al.*, 2006c). Characters must be given a rich repertoire of actions and corresponding graphical animations. The author has to "fully develop characters with respect to a potential 'narrative boundary' or narrative zone" (Aylett *et al.*, 2006b, p.312), which means that a balance must be found between delimiting the boundaries of the episodes and allowing the characters to take charge (Louchart & Aylett, 2005; Aylett *et al.*, 2006b). A further complicating factor in the authoring process is that "the outcome of this process cannot be wholly assessed by inspection but requires simulation runs in order to develop adequate actions and goals or respond to specific needs for a scenario" (Aylett *et al.*, 2006b, pp.312-313).

So how might we achieve further insight into this authoring process? One way is to try and build emergent narrative instances; this approach is followed in chapter 6 and further, where the emergent narrative based story generator The Virtual Storyteller is discussed. Especially chapter 9 provides insight into the authoring process of two small story domains. Another route to gaining more insight into the authoring process is to attempt to further clarify what authoring means for emergent narrative. This is the route taken in this section as I attempt to better understand emergent narrative authoring as a process of creating meaning. This section resulted in part from collaboration with philosopher Moes Wagenaar, who performed a similar analysis for understanding how simulation and improvisation may be used to investigate philosophical concepts (Wagenaar, 2008).

3.3.1 Authoring for Emergence: a Paradox?

Let us start with the observation that at face value, the concept of 'emergent narrative' is somewhat paradoxical from an author's perspective. If we consider the notion of 'authoring' to be associated with creation, purpose and intention, and the notion of 'emergence' with the occurrence of complex behavior that is not obvious from the simple components that cause it, then the terms authoring and emergence seem to be in conflict with each other (Aylett *et al.*, 2006b; Spierling, 2007). This led Spierling (2007) to introduce the term *implicit creation*. In contrast to *explicit creation*, where authors explicitly write out every detail of a multiform plot, the notion of implicit creation refers to an authoring process in which authoring means specifying a dynamic model, so that this model "implies" the states, actions and events that emerge at runtime (Spierling, 2007).

For emergent narrative, there are at least two aspects of this dynamic model.

Character and storyworld modeling : Creating models of character behavior and the behavior of the storyworld to *enable* the emergence of an interesting course of events.

Modeling narrative control : Creating ways to guide, constrain and enable character behaviors at the right time so as to *facilitate* an interesting course of events.

In chapter 8, I discuss the issue of narrative control: the problems associated with guiding and constraining autonomous characters, and ways to enable particular character behaviors. In this chapter, I focus on better understanding the issue of modeling characters and the storyworld.

Content and Process Authoring

For character and storyworld modeling, we can make a distinction between two kinds of elements of the dynamic model:

(1) Content. Definitions of specific actions, emotions and goals for the characters, specific storyworld events that can occur, and the definition of the initial state of the storyworld, including its spatial representation and the objects in it. In FAtiMA, content is specified by means of XML files.

(2) Processes. An implementation of the cognitive processes of the character, such as event appraisal, goal management and action selection processes. In addition, the physics and other processes of the storyworld, such as the selection of storyworld events. In FAtiMA, processes are specified by means of Java methods and algorithms that form the implementation of the architecture.

Two points need to be taken into consideration here. First, content and processes are often deeply dependent on each other, shaped to work with each other (Wardrip-Fruin, 2006, p.102), and it should not be thought that making a distinction here is aimed at considering the meaning of each in isolation. Second, Crawford (2004) and the digital media model of Wardrip-Fruin (2006) make a distinction between *data* and processes. For Wardrip-Fruin, the term *data* suggests a certain static-ness, and refers mostly to the templates, text, sounds and images of a work. The content elements that are referred to here often also contain a process component. Take for instance the specification of a character action in FAtiMA. This specification contains preconditions and effects, determining when an action can occur, and how it changes the world. This is process-oriented knowledge. Therefore, the term *content* is used here for denoting authored elements such as the events, actions and goals that can occur in the emergent narrative, and the term *data* can be reserved for text, graphics and animations of the emergent narrative. In the remainder of this section, the focus will be on content and process authoring, and not on data authoring.

Authorship Is in the Rules

Although emergent narrative gives up the idea of having a predetermined plot specification guiding the experience, this does not mean that the author has to distance himself from *any* kind of authorship over the experience, as "there is a creative, inductive process of finding rules that attempt to model patterns of interest — a selection." (Spierling, 2007, p.22). For this claim, Spierling quotes John Holland:

> "Emergence must somehow be bound up in the selection of the rules (mechanics) that specify the model, be it game or physical science. . . . Knowing what details to ignore is not a matter of derivation or deduction; it is a matter of experience and discipline, as in any artistic or creative endeavor." (Spierling, 2007, p.22, quoting John Holland).

We here take 'rules' to mean the content and processes specifying behavior of the characters and of the storyworld. For instance, the FAtiMA architecture of section 2.2.2 is an example of a system of rules for character behavior, using procedures and algorithms that determine in which contexts the character takes which action. The *selection* of rules in the description of Holland can mean two things:

(1) The author determines which rules are included in, and which rules are excluded from the dynamic model.

(2) The author determines what the rules *are*.

Meaning (1) suggests that there are certain boundaries to the possible courses of events, in other words, authoring is creating microworlds with a specific focus. Meaning (2) suggests that the rules themselves are subject to authorial vision, in other words, authoring is modeling fictional worlds rather than real ones. Simply put, we can *make up rules*. Obvious examples of made-up rules can be extracted from classical fairy tales, for instance that dragons can spit fire, but many subtle ones can be found as well. For instance, 'Hollywood physics' has cars explode when trails of petrol leaking from their tanks are being lit. Such rules are limited by human imagination, rather than cognitive plausibility and realism.

In this light, character modeling is seen as a process of authoring, rather than as ongoing cognitive modeling research per se, since ". . . a system intended to simulate human behavior is inevitably an *authored* system. It cannot escape being ideological, because it cannot escape encoding a set of beliefs about human behavior." (Wardrip-Fruin, 2006, p.275). Although the two might inform each other, research in this direction will not lead to 'the' emergent narrative character model that can subsequently be 'filled in' with story-specific content. Both content and processes are part of the authoring process.

So the authorship to be had for modeling characters and the storyworld for emergent narrative must be found in the selection and creation of rules that form a dynamic model of their behavior. These rules are the result of both content and process authoring. We will now aim at better understanding the relationship between such rules and the resulting space of possible stories.

3.3.2 The Story Landscape

Chapter 2 discussed the branching narrative metaphor, which is often used to understand interactive narrative. This metaphor fits the needs of understanding the *explicit creation* of narrative, offering a representation of a multiform plot, but not those of understanding the *implicit creation* of a storyworld as with emergent narrative. The aim is to create meaningful dramatic interaction, which happens for instance when the actions of one character establish the context for emotions or goals of other characters, whose performed actions again might lead to emotions and goals for a third. There is no steering force on how this plays out exactly, nor can the author envision this exactly, and it is this property — the real-time translation of autonomous action at the character level to dramatic interaction at the story level — that is emergent in an emergent narrative system.

To understand the implicit creation of interactive narrative, we introduce the metaphor of a *story landscape* to indicate the space of possible stories that are 'implied' by the dynamic model. This metaphor appeared in Kriegel & Aylett (2008) and was further elaborated on in Louchart *et al.* (2008b). See figure 3.6.

The Story Landscape Metaphor

The story landscape visualizes the space of possible narrative developments as a three-dimensional version of the interactive "Flying Wedge of Possibilities" discussed in section 3.2.2. It utilizes the idea of creating narrative context; the right part of figure 3.4 can be seen as a contour map of such a landscape. Points on the landscape represent possible dramatic contexts of the simulation, and climbing hills represents a move towards more and more dramatic necessity, as in Laurel's Flying Wedge. In a "valley", there are many potential mountains to climb and many paths to do so. For instance, if Little Red Riding Hood takes on the goal to bring cookies to her grandma, this constrains her behavior and — in terms of the metaphor — sets her on the way to a peak, which is a different peak from that in which her mother had asked her to wash the dishes. Character interactions move the dramatic situation more and more uphill since they create dramatic context: they yield emotions and intentions for the characters that form a reason for further contextualized behavior.

The story landscape deliberately avoids representing the narrative as a series of discrete events, as with branching narrative, since there is narrative meaning to be found in processes that cannot be represented as events. For instance, the gradual buildup of a character's fear over time, or a delay in response time that may come to mean hesitation or lying.

As with any metaphor, it also has its limitations and mismatches. One mismatch is that since the narrative can potentially go on forever, some of the mountains have no 'peaks' but are infinitely high.

Practical Implications for Emergent Narrative Authoring

It is the author's task at design time to specify a dynamic model that yields a story landscape for the interactor to travel upon at run time. This is a process of implicit creation, as the landscape is an indirect result of the combinatorics of character states and the decisions they make. The story landscape metaphor provides no obvious authoring solutions because the author creates this story landscape only indirectly. It does, however, help identify certain practical authoring issues. We distill here three of these issues (boundaries, critical mass and dead ends) that follow from the metaphor, and provide some suggestions on how content can be structured and shaped to tackle such issues. The issue of creating a particular story landscape is addressed in sections 3.3.3 and further.

Boundaries. A boundary is what separates the story landscape from the rest of the universe (the 'sea' around the story landscape, if you will). For example, there is no need for submarines in an emergent narrative about cavemen, because they fall outside the boundaries of the envisioned landscape of possible stories.

An emergent narrative needs boundaries, not only because of the technical infeasibility of simulating an unconfined world, but also because the boundaries help define the topic, scenario and message of the emergent narrative. This notion of boundary is however quite abstract and can be realized in many different ways. For example, one might construct spatial boundaries (given by the locations where the story takes place), contextual boundaries (e.g. the bullying context in FearNot!) and interaction boundaries (limiting the ways of how the user can interact with the world). Boundaries are not explicitly authored, since they are implied in the authored content. Rather, for the author the key aspect to keep in mind is to find creative ways to justify the existing boundaries to the players. For example, Façade (Mateas & Stern, 2003) sets up a context (invitation for a dinner) that justifies the spatial boundary (all action takes place in one room) set by the authors. Related is the notion of a *negative behavior space* (Tomlinson, 2005): a set of behaviors for interactive characters that are explicitly and consciously excluded from its repertoire. Also related is the improv notion of a *circle of expectation*, as will be discussed in chapter 4.

Critical mass for emergence. Within well-defined boundaries, the authoring of content material is meant to 'cover' the story landscape with enough interconnected states and 'paths uphill'. As in any emergent system, a certain critical mass in terms of content is necessary for interesting narratives to emerge. This critical mass is not in absolute terms of quantity, but in relative terms of density, i.e., how well the authored

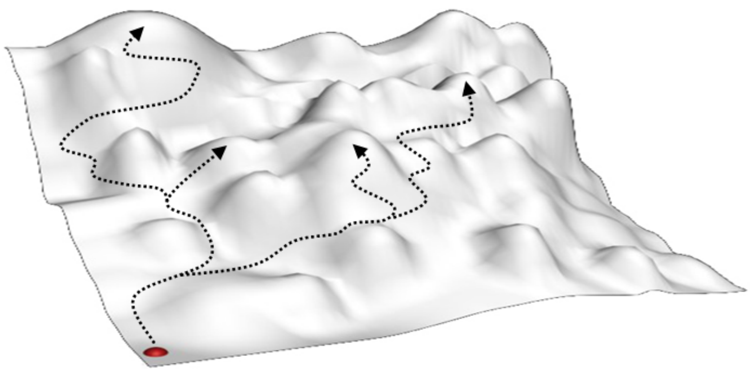

Figure 3.6: Visualization of a story landscape with some of its many possible paths drawn.

content serves to create different paths through the narrative landscape. It is difficult to find out whether the critical mass has been reached other than by playtesting and authoring. It is however important for the author when designing content to keep the density aspect in mind and not to view achieving the “critical mass” as a purely quantitative aspect. If a particular piece of added content adds new possibilities but also widens the boundaries of the story landscape, the density can go down rather than up; this is detrimental to the achievement of the critical mass.

Dead ends. We consider dead ends to be states in the story landscape where the emerging narrative ends, not because the story has reached *The End*, but because there is a lack of content. For instance, a goal was authored but the author did not specify actions to achieve it. If one character says: “What’s your name?” but the other character was not given a means to respond to it, this also creates a dead end. We suggest that authoring for emergent narrative is a continuing process involving finding dead ends and resolving them by authoring new content for that situation. An open issue for this process is the question how to *detect* such dead ends. A promising approach might lie in automated tools that run the emergent narrative many times and try to construct a representation of the story landscape similar to functionality in Crawford’s Storytron engine (Crawford, 2004, pp.280-282).

3.3.3 An Authorial Impasse

The task of constructing a story landscape presents the author with a certain impasse. Since event sequences are generated at run time as an effect of content and process authoring, there is no architectural support for explicit story lines. We can imagine two extreme mindsets: one in which an author has strong ideas about the different stories that should happen, and tries to implement those rules that have the desired stories as an ‘emergent’ effect, and one in which an author ‘lets go’ of this concern for specific story lines (Kriegel & Aylett, 2008), and focuses completely on ‘writing characters’: their roles, personality traits, goals, etc.

Neither extreme fits comfortably with the emergent narrative approach. On the one hand, having a strong concern for the emergence of specific story lines leads to an approach in which content and process authoring are done in such a way that the intended stories are produced. However, this is not only difficult, as it requires making predictions of the interaction of the behaviors of the character models and settings, but is also bound to result in a frustrating mismatch between what story lines one wants and what story lines emerge, as Meehan found out with his mis-spun TALE-SPIN tales (examples follow in section 3.3.5). On the other hand, we found that having *no* concern for desired story lines is also problematic, because it leads to a style of authoring in which arbitrary choices must be made in content and process authoring. For instance, in early development phases of The Virtual Storyteller, we attempted to build ‘a general purpose knowledge representation for storyworlds’. We found ourselves often justifying choices based on vague, general notions of authorial intent. For instance, we would include a character’s health in the knowledge representation, because in many stories, characters become sick. Without the context of a specific storyworld, such a choice is arbitrary. After the development of an *action oriented*

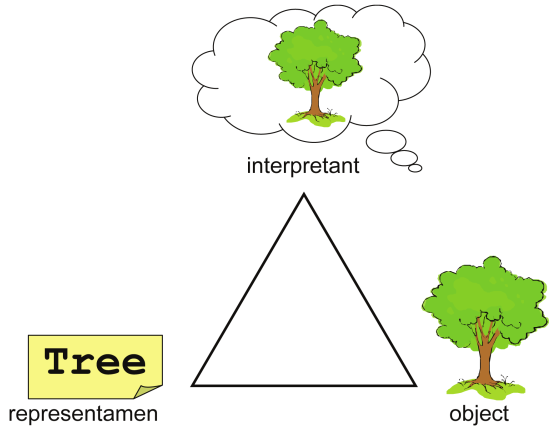

Figure 3.7: Triadic sign system of Peirce. A sign, in Peircean terms, is something that stands to somebody for something in some respect or capacity. For example, the word ‘tree’ might stand to a reader of the word for a certain real tree the reader has in mind.

ontology, in which the representation of storyworld knowledge was made dependent on how actions can change it (Uijlings, 2006), we realized this only replaces the problem; the next question becomes which actions to include in the domain, and again, choices are arbitrary.

The authorial impasse is that writing characters also means considering the role they play in the story lines that emerge. This leaves a bit of a chicken-and-egg problem in the sense that character definitions and the emergence of narrative mutually inform each other. In the following sections, I aim to come to grips with understanding and addressing this impasse.

3.3.4 Semiotics of Emergent Narrative Authoring

The authorial impasse is likely to occur in any work in which simulations are being authored, e.g., computer games. In this sense, it is related to the aim of Frasca (2001), who makes an analysis of video games as a medium for fostering critical thinking and debate, aiming to expose ways in which game designers can use and are using ideology in their design. To this end, he makes an analysis of simulation as a semiotic system. He employs the triadic sign system of C.S. Peirce (1932) for this. Peirce defines a sign as “something which stands to somebody for something in some respect or capacity.” (Peirce, 1932, §2.228). A sign is always a triadic relationship between the form that the sign takes (the *representamen*), the sense made of the sign by someone (the *interpretant*), and the thing that the sign represents (the *object*). See figure 3.7. The representamen ‘tree’ stands to its object (a tree) because someone interprets it as such. To Peirce, this triadic relation between a tree, the word ‘tree’ and the sense made of the word, is a sign.

Frasca’s definition of simulation follows directly from this semiotic model: “to simulate is to model a (source) system through a different system which maintains to somebody some of the behaviors of the original system.” (Frasca, 2003, p.223).

Emergent narrative fits Frasca’s definition of a simulation. For instance, FearNot!

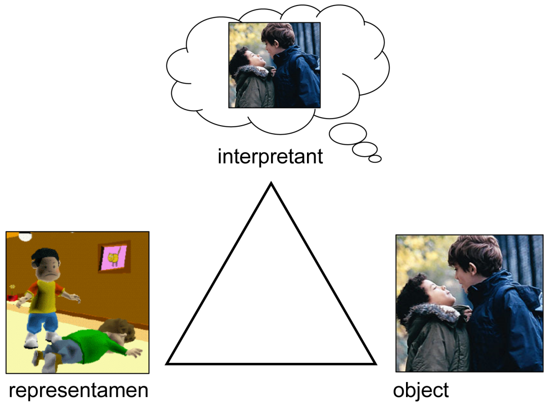

Figure 3.8: FearNot! is meant to stand to a child user for real bullying in some respect or capacity.

can be understood as a simulation, because it is a model of a (source) system (bullying in real life) through a different system (FearNot!) that maintains to somebody (the children that use FearNot!) some of the behaviors of the original system. See figure 3.8.

Mediation of a Simulation

With this definition, we can now return to Schärfe's last principle for narrativity, namely *mediation*. In what way can we see the simulation as conveying a 'point', referring to something outside the narrative experience?

Mediation relates to the interpretant. When presented with a story, a reader will make a mental model of the fictional reality of the story. This is more than an understanding of the fabula alone, but also includes a model of how this storyworld and its characters behave, and what this means, embedding the information actually presented within a larger frame of common sense and personal experiences. We come to 'know the characters'; it allows us to make predictions about what happens next, or to fill in details that are not (yet) stated.

Both a story and a simulation may be a vehicle for mediation. Again, we can use FearNot! as an example: both a story about a little boy being bullied at school and a simulation about bullying at school may convey the point of 'this is how bullying works'. In the absence of a narrating agent, this 'point' may not take on the form of a moral or message as for instance often seen in fairy tales, but nevertheless as an understanding of the general laws, cultural values or lessons to be learned about the object of representation.

Seen in this light, simulation and narrative are two different ways to represent an object of interest: "When systems are not very complex, it is usually better to use representation and narrative to describe its [*sic*] mechanics .... But as systems get more complex, simulations become a more attractive tool because they can model the rules that govern the system." (Frasca, 2001). It should be clear that in the case of emergent narrative, these are not the rules governing a story, but those governing a story *world*, salient with a potential for interesting courses of events that can be storified by the user.

Authoring as Semiosis

A large practical difference between writing a linear story and authoring an emergent narrative is that the former is concerned with exposing what happens, whereas the latter is concerned with determining the underlying rules of behavior of the storyworld and its characters. Writing a story allows for direct control, as the author can read and edit the text with relative ease to see if it appropriately conveys the point, using himself as a model of the reader. The author engages with the text in a process of making meaning, so that ultimately the text is to the satisfaction of the author. In writing, this is often an interaction between writer and text: the author creates the text as the text inspires the author. This is most obvious when authors speak of characters that 'run away with the plot' during the writing process, changing the initial story plan. In other creative tasks as well, this interaction between artist and artifact is known. It relates to what creativity researchers call a problem-finding style of creativity, in which the artist continually searches for his or her artistic problem, as opposed to a problem-solving style, which involves starting with a relatively detailed artistic plan and then executing this plan, the artistic problem being clear from the start (Sawyer, 2002b, pp.153-154).

In writing an emergent narrative, this reciprocal process between author and artifact is a bit more complicated than in writing texts, but nevertheless important to understand to be usable as a narrative medium. The difficulty arises because conveying a point using a simulation requires special consideration for the selection, construction and interaction of rules that govern the behavior of the simulation. The simulation model does not represent an actual world, but a constellation of *possible* worlds. According to C.S. Peirce, these relate to different 'modes of being':

> "My view is that there are three modes of being. I hold that we can observe them in elements of whatever is at any time before the mind in any way. They are the being of positive qualitative possibility, the being of actual fact, and the being of law that will govern facts in the future." (Peirce, 1932, §1.21-1.23).

Peirce calls these three modes Firstness (I), Secondness (II) and Thirdness (III), respectively. Simulation is a First, as it relates to the being of possibility, where the real world as we actually encounter it, is a Second. As a Third, we move into the domain of theory, of mentality, which for authorship we may relate to the vision of the author about a fictional storyworld, which forms a mediating connection between the simulation, and the actual world as we know it. The triadic relationship is shown in the diagram of figure 3.9.

The interesting thing here is that we may see the simulation itself again according to the three modes of being. The author does not create a story but defines the microscopic rules forming a dynamic model, which underlies a constellation of possible event sequences, i.e., the story landscape. As we saw, this story landscape is not directly obvious from the rules but rather an emergent property of it, which can only be observed in simulation runs. Still, this authoring process is not completely blind, as authors can make mimetic transformations of rules they imagine to underlie events in the real world, and make hypotheses about the effects and interactions of the rules

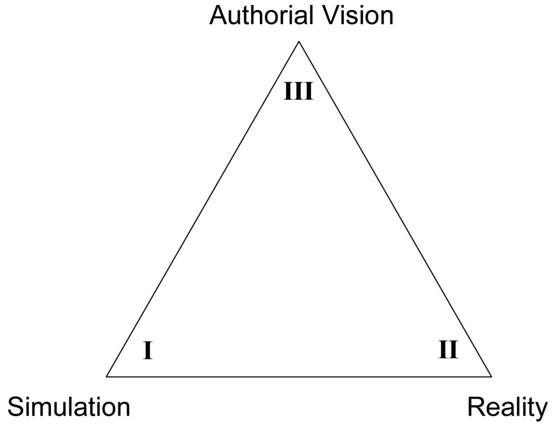

Figure 3.9: Triadic relationship for simulation in relationship to reality, and an authorial vision.

they create. For instance, in authoring an emergent narrative about bullying, authors might be able to come up with rules such as 'when people call him names, the victim's fear and sadness will increase' or 'when a child pushes another, there is a chance he falls'. Authors might also conceive of general laws or principles that may form the 'point' (for instance, 'fighting back is ineffective', or 'being bullied leads to a difficult dilemma for the victim'), and try to implement rules that have these laws as an effect (for instance, 'a bully has a high threshold for fear of being hurt' or 'if you push a bully, chances are he will not fall').

As the rules give rise to a constellation of possible event sequences, we may relate these rules to *possibility* (I:i), while the event sequences themselves relate to *actuality* (I:ii). Together, they give rise to certain emergent patterns or *laws* (I:iii). Perhaps a better way of describing this is as a mental model, allowing the player (or the author) to understand, on a macroscopic level, how the world behaves. The relationship between these three modes of being is shown in the diagram of figure 3.10. As a simulation, the emergent narrative system is defined in Firstness (by the creation of a set of explicit microscopic rules), explored in Secondness (seeing and 'trying out' what actually happens) and understood in Thirdness (forming a mental model).

As a medium, the ideas of the author (III) of course connect the simulation (I) to something outside the simulation, namely real life as a Second (II). This we can also see as a triadic relationship. The world as we actually witness and confront it (II:ii) is constantly theorized by mankind, not just in science but also in an attempt to understand it and relate to it. The world appears to be governed by macroscopic laws (II:iii), for instance, 'everybody dies eventually' or 'the earth circles the sun'. The real world does not contain explicit microscopic rules like a simulation, but here such microscopic rules are implicitly bound up in the world (II:i).

In his vision of the emergent narrative, an author will always either consciously or unconsciously take a relationship with the real world (II) into consideration. This relationship might bear a certain realism, for instance, the rules of FearNot! were based on empirical data about bullying situations, and the behaviors of the animated wolves in the interactive experience *AlphaWolf* (Tomlinson, 2005) were based on background research on real wolves. However, this relation might also be abstract

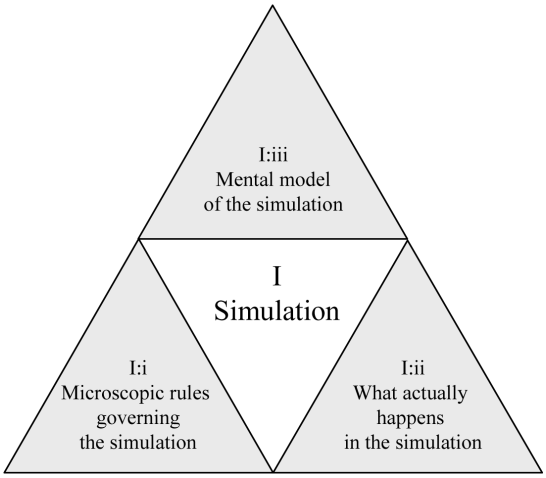

Figure 3.10: Triadic relationship for simulation.

or associative, as we also know from the traditional arts: the cartoon character Road Runner is not an exact replica of a real roadrunner, but rather an anthropomorphic version of it. Furthermore, Road Runner's behavior is abstracted to such an extent that about the only thing he does is run and say 'beep beep'. Abstractions are also found in the animation of his behavior: Road Runner's legs do not move naturally, but look more like spinning wheels, which makes us associate it with our understanding of the rapid movement of cars.

I propose that the process of authoring an emergent narrative can be seen as achieving reciprocal *attunement* between the three 'modes of being'. For creating an emergent narrative simulation, these modes of being are the explicit microscopic rules that govern the simulation in I:i, the actual event sequences that emerge from it and the possibilities this creates for interaction in I:ii, and finally the achievement of some kind of 'point' through storification, in I:iii. On a larger scale, emergent narrative authoring is a process of achieving reciprocal attunement between the simulation (I), an authorial vision of it (II) and the real world (III). See figure 3.11.

In comparison, the creation of linear narrative can be seen as authoring directly in I:ii; if it is used for interactive storytelling (e.g., the branching narrative model discussed in chapter 2), this creates a concern for giving the *illusion* of the existence of a I:i by hiding the existence of branch points.

During the authoring process of emergent narrative, ideas are formed in III, which we can now understand also in a triadic relationship: making mental models of what 'point' the author may want to convey (III:iii), which events may evoke this 'point' (III:ii), and what microscopic rules underlie these events (III:i). Each may change in the attunement; for instance, the authored rules may give rise to different event sequences than imagined or desired, the author might adapt his vision accordingly and implement new rules to match this changed vision. See figure 3.12. Authoring is finished when finally, the end product of the simulation building (I) corresponds to the final authorial vision (III).

The point that authorial intent may change based on what the system does, is important, as it deviates from the characterization of Iurgel (2007), who describes

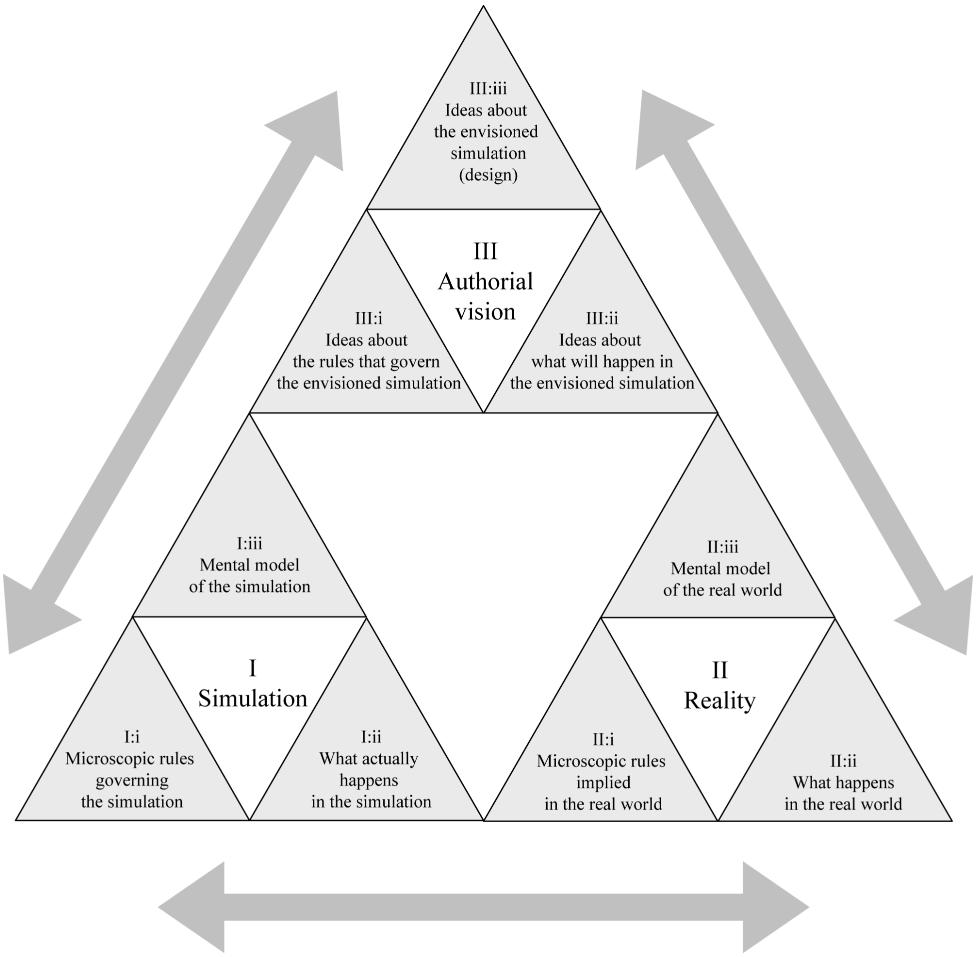

Figure 3.11: Triadic relationship for reciprocal attunement of simulation, authorial vision and reality. The arrows represent the attunement processes between these modes.

authoring for emergent narrative as an "approximation of a certain intended behavior". In this characterization, authorial intent remains unchanged:

> "The author has some specific behavior in mind, and then he needs to find out which 'screws' could possibly provoke the desired behavior. When one has to assume a large amount of parameters and of possible initial constellations, this can be very difficult, and eventually the desired result might turn out not to be feasible within the limits of the system." (Iurgel, 2007, p.39).

In this sense, using simulation for storytelling requires a deep reflection by the author on the storyworld. One needs to not only think of what the envisioned characters are supposed to do, but also explicitly consider the rules that determine *why* they do what they do. This may seem like a laborious and excessive endeavor from a design point of view, but it pays off in terms of mediation. Interactors can engage with these simulated characters and discover, through playing, the storyworld and the rules governing it that the author wants to mediate.

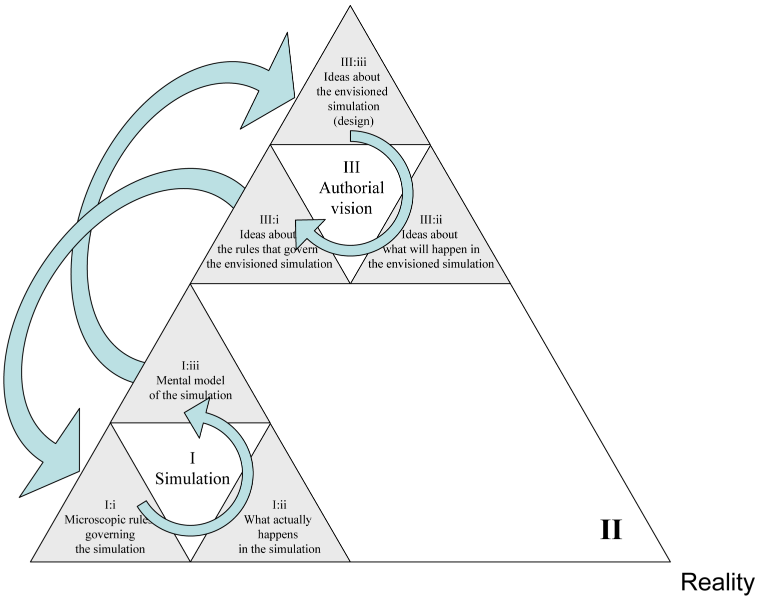

Figure 3.12: Attunement of the system and the author: the interaction between authorial vision and the actual system follows a kind of 'flow': the author envisions an emergent narrative, has ideas about possible event sequences, and develops ideas about the rules that should then govern the simulation, which after implementation yield results for the author to adapt his vision.

3.3.5 Implicit Creation: Debugging or Co-creation?

As discussed in section 3.3.3, the task of authoring an emergent narrative system provides an impasse because writing characters also means considering the role they play in the emergence of story lines. Based on the previous section, this impasse can now be reframed as part of the question of how to achieve attunement between the simulation — its rules, event sequences and resulting 'point' — and the author's vision or intent thereof. We found that authoring the story landscape in an iterative authoring cycle, as proposed by Louchart (2007, pp.154-157) and Louchart *et al.* (2008a) is a good way to achieve such attunement.

First, note that the authoring issue of purposeful implicit creation (Spierling, 2007) is shared by any approach in which story generation techniques are used within an interactive storytelling system. Using such techniques significantly changes the way that authors can craft their work (Spierling, 2007). It requires a reconception of what the system affords authors to author (which is now no longer the full branching narrative) and of how the content they author relates to the overall space of possible stories (the authorial and interpretive affordances of the system, (Mateas, 2001b)). Such an authoring process of implicit creation benefits from story generation feedback during authoring. This feedback is a tremendous help in examining to what extent attunement is achieved between the author's vision and the implemented story landscape so far. Several authoring tools explicitly provide support for such feedback (Spierling, 2007; Carbonaro, Cutumisu, McNaughton, Onuczko, Roy, Schaeffer, Szafron, Gillis, & Kratchmer, 2005; Thomas & Young, 2006; Pizzi & Cavazza, 2008;

Kriegel & Aylett, 2008; Si, Marsella, & Riedl, 2008).[2] For instance, the authoring toolset for the *Madame Bovary* system of Pizzi and Cavazza (Pizzi & Cavazza, 2008) provides step-by-step plan simulation to allow the author to visualize and modify the space of possible plans that the system generates. Si *et al.* (2008) explicitly see their framework as both a coach and a colleague to the author.

Such feedback may also affect the *creative* process of the author. In the field of modeling and simulation, feedback from the system is important to validate and verify the simulation model. Validation means assessing whether the model is indeed a representation of the source system (i.e., concerns building the *right* model), whereas verification means assessing whether the built model works as intended (i.e., concerns building the model *right*) (Balci, 1997). If we use these notions in the simulation of storyworlds, validation and verification mean that we check whether the simulation actually conforms to the author's vision, and whether there are no bugs in the simulation. This is a process that is often referred to as *debugging* (e.g., Medler & Magerko, 2006; Pizzi *et al.*, 2007): authors adapt the story content or the story generator in such a way that the resulting space of stories matches their authorial intent.

However, as noted by Thomas & Young (2006), the fictional nature of storyworlds allows for approaches in which authoring not only means constructing the domain representation but also the domain itself. As with linear story writing, attunement between author and artifact can be a two-way street: feedback from the system might inspire or otherwise cause the author to build a different model than perhaps originally intended. This enables a process that we may call *co-creation*: authors embrace the (sometimes unpredictable and surprising) output of the story generator as a contribution to the space of possible stories, being open for it to change their initial authorial intent and accepting that the possibilities and limits of these processes take a fundamental part in shaping and constraining the story space. In this case, we may ascribe creativity to the story generator, where it is expected or at least allowed to contribute novelty to the story domain. Such a co-creation process can be justified in many cases, especially in interactive narrative for entertainment. When the author attempts to create a "serious" interactive narrative, for instance for educational purposes as with FearNot!, authorial intent might be more constrained, especially when it is important that the model be based on empirical data.

Debugging and Co-creation Within TALE-SPIN

To illustrate attitudes of debugging and co-creation, let us revisit two tales generated by one of the first story generation systems, TALE-SPIN by James Meehan (Meehan, 1981). TALE-SPIN is relevant here because its character-centric approach has much in common with emergent narrative.

The two tales of figure 3.13 were classified by Meehan as 'mis-spun'. The first story was mis-spun because Bill did not see Henry Ant. To fix this domain underrepresentation, Meehan took the debugging approach by introducing 'noticing' inferences in TALE-SPIN. The second story had a different reason to be classified as 'mis-spun': the authorial intent was to reproduce the Aesop fable "The Fox and the Crow". Meehan

[2] For an overview of authoring tools and their relationship to story generation, see Pizzi & Cavazza (2008).

Story 1

HENRY ANT WAS THIRSTY. HE WALKED OVER TO THE RIVER BANK WHERE HIS GOOD FRIEND BILL WAS SITTING. HENRY SLIPPED AND FELL IN THE RIVER. HE WAS UNABLE TO CALL FOR HELP. HE DROWNED.

Story 2

ONCE UPON A TIME THERE WAS A DISHONEST FOX AND A VAIN CROW. ONE DAY THE CROW WAS SITTING IN HIS TREE HOLDING THE PIECE OF CHEESE. HE BECAME HUNGRY AND SWALLOWED THE CHEESE. THE FOX WALKED OVER TO THE CROW. THE END.

Figure 3.13: Two 'mis-spun' tales generated by Meehan's story generator TALE-SPIN.

wanted the fox to trick the vain crow into dropping the cheese. From this viewpoint, the hungry crow eating the cheese himself is not only unexpected but also unwanted, as it takes away the opportunity for a story about deception by the fox. Meehan again took the debugging approach: he changed the setup to match his authorial intent by making sure that the crow was not hungry, so that the intended Aesop fable emerged.

We can imagine though, that only taking the debugging approach is a rather brittle way to author content for a story generation concept such as that of TALE-SPIN. The more content is authored, the more likely it becomes that the emergence of the deception story is disrupted due to unexpected interactions. In contrast, taking the co-creation approach would mean that possible variations, resulting from a nondeterministic simulation of characters, are accepted as opportunities. Story content is authored for the continuation or improvement of these variations. Noticing that it is possible for the crow to eat the cheese because he is hungry, Meehan could have embraced this unexpected possibility, letting it inspire subsequent authoring. For instance, he might have made the cheese actually belong to the fox. He could then have authored the possibility for the fox to become angry with the crow eating his cheese, leading to a revenge plan.

An Iterative Authoring Cycle

Here we elaborate on the authoring cycle described in Louchart *et al.* by incorporating the notion of co-creation. See figure 3.14. An initial bootstrap design of a storyworld forms the start of an authoring process in which the author's intent for the storyworld is still vague, but becomes clearer as authoring progresses:

(1) Idea generation. The story landscape, laid out by the content and processes authored so far, inspires authorial ideas for how it can be extended. These ideas might be directly implementable as storyworld content (content authoring), or might require extending the cognitive processes of the characters (process authoring). The simulation may also have displayed undesired behavior (e.g., the lack of 'noticing' inferences in TALE-SPIN), which must be diagnosed (is it a domain underrepresentation? A flaw in the AI? Or simply an uninspiring development?) and treated.

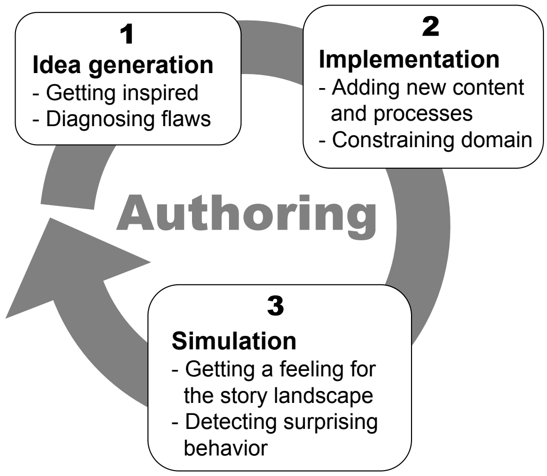

Figure 3.14: Iterative authoring cycle for emergent narrative. A story landscape is formed iteratively, each iteration consisting of three consecutive phases: (1) idea generation, (2) implementation and (3) simulation.

(2) Implementation. Based on the new ideas, story content is added to the system (content authoring), and new cognitive processes are implemented (process authoring). Based on the observation of undesired behavior of the simulation, flaws in the representation are repaired, or the domain is further constrained. The authored content and processes may expand and change the story landscape in several ways, some of which were not directly intended by the author or even surprising, due to the complex interaction of the authored material.

(3) Simulation. Running simulations of the storyworld under development gives the author a feel for the current shape of the story landscape, and a feel for what the system can do with the authored material so far. It also exposes unintended and surprising effects of the authored material, which may inspire the author in a subsequent cycle.

Within this authoring cycle, choices between debugging and co-creation must be made continuously. For example, we once modeled a goal for a pirate character to shoot an enemy ship, and two actions: to load a cannon and to fire at the ship. This had an unexpected effect on the story landscape: a pirate fired himself from the cannon to get to a nearby island. This was certainly not intended, but is it “wrong”? We should realize that this is an authorial choice. If we take the debugging approach (saying it does not match our authorial intent), then the action to fire something from a cannon must be further constrained to specify that only cannon balls can be fired. If we take the co-creation approach (adapting our authorial intent), then we incorporate this behavior into the story domain. We proceed, for instance, by modeling that shooting oneself from a cannon hurts, and that a pirate, as a consequence, will use the cannon only in emergency situations (e.g., to escape from a fight), and with reluctance.

At this point, it is important that the reader not see the co-creation approach as an alternative to narrative control. Co-creation does not mean submissively letting the system spin out of control. Co-creation simply means that both the author’s ideas and the system's generative processes affect the end result. In this process, nothing prevents the author from choosing for instance to constrain the possibility space using narrative control.

Improvised and Collaborative Authoring

The co-creation attitude builds on the idea in improvisational theater that there is no "wrong" direction to an improvised story per se; anything that is contributed by the actors could serve as a basis to further the story if properly incorporated. Improv actors start a scene with a trivial beginning, without knowing where it will take them, and then use association and knowledge of story progression to make authorial choices in context of what emerges. In the case of the proposed authoring cycle, the author also makes authorial choices 'in the moment', by simulating the system, deciding what might happen in the resulting narratives, and implementing such decisions.

The co-creation attitude also opens up possibilities for massively collaborative authoring, in which not one, but many authors work on the same storyworld (Kriegel & Aylett, 2008). In Kriegel & Aylett's ongoing work on rehearsal based authoring, the idea is to let the system learn goal and action representations, based on rehearsals that an author can do with the virtual characters in a scenario. In rehearsal mode, the characters play out a scenario just as they would when the final system is run. However, this time, the author can intervene in how the scenario plays out, telling characters what alternative choices they should make, and provide reasons for this behavior (Kriegel, Aylett, Dias, & Paiva, 2007). This translates into changes in the operators of the domain. Again, authorial choices are made in context of what actually happens.

3.3.6 Authoring the Initial State

I framed emergent narrative authoring as an iterative authoring process, in which the author gradually crafts out a story landscape. This process of attunement is reciprocal: authorial intent informs design decisions as simulation outcomes affect authorial intent. Authoring relates to Firstness, that is, the authored content and process define possibilities for event sequences. Rather than saying, 'this event happens' or 'a character has that goal', an author specifies the circumstances in which it is *possible* that the event happens or the goal is adopted.

However, we only considered the dynamics of the *events* of the emergent narrative, such as the goals, actions, cognitions and emotions of the characters. These can be distinguished from its *existents* (Chatman, 1980): the setting and characters of the story, such as the spatial representation of the storyworld, the objects in it, their locations and properties, as well as character traits and relationships.

Events bring an initial state of affairs of the narrative, to a final state of affairs. This initial state consists of existents, but also of backstory events. In contrast to the events, the initial state in emergent narrative systems is typically mostly static and predetermined. There are certain limitations to this. To better understand these limitations, let us first identify some of the factors that influence the creation of an initial state for an emergent narrative.

The Relationship Between the Initial State and Events

In part, creating the initial state can be seen as simply part of the creative process of world-building. The author creates a VE — settings, objects, characters — based on his creative vision, so that it will give the illusion of a world 'out there' for the audience to experience and act in. For example, for the FearNot! system, the settings of a class room and a playground, and the inclusion of a bully and victim character fit the dramatic frame of bullying scenarios.

However, the initial state of the VE also strongly affects the events taking place in it. For instance, in an example episode of FearNot!, the bully enters the classroom where the victim is doing his homework, and throws the victim's books off his desk. To enable this interaction, these books have to be 'placed' on the desk by the author. That there is a strong relationship between initial state and events can also be learned from the TALE-SPIN story generator. Different initial states result in radically different stories; with some configurations no story is even possible at all (Wardrip-Fruin, 2006, pp.245-254). The fact that the initial state affects the story landscape by determining and constraining the possible courses of events, makes consideration of this relationship an important factor for constructing the initial state. As part of the dramatic frame, defining the initial state can be considered "a good means of restricting choices while preserving the agents' autonomy" Klesen *et al.* (2001, p.193). Also in the *directed improvisation* work of Hayes-Roth & van Gent (1997), scenes are framed this way by providing the roles, character parameters and possible behaviors of characters in a scenario.

Here, the authorial impasse reasserts itself: without knowing how events will unfold, how to make informed decisions in setting up the initial state of the storyworld in which these events are to take place? If we follow the approach to authoring suggested in this chapter, constructing the initial state is included in the iterative authoring cycle discussed in section 3.3.5: as more and more of the characters' dynamic model is specified, the initial state is also gradually defined to accommodate the desired properties of the simulation. However, there are two limitations to this approach: (1) a varying degree of clarity in how particular aspects of the initial state affect the possible events, and (2) an overcommitment to one particular initial state.

Varying degrees of clarity. The clarity of the relationship between the initial state and the event sequences enabled or constrained by it varies from case to case. In some cases, properties of the initial state may depend directly on the events that are authored, e.g., adding an action `throw-books-from-table` requires a table with books on it for the action to be of use. In other cases, it does not follow directly from the events because the relationship between initial state and event is indirect: it is not immediately clear what threshold value for 'fear' to give the victim so that a dramatic internal conflict happens in which the victim sometimes ends up being 'too scared' to fight back. This conflict is possible because the victim considers possible plans in which getting hurt is a considerable risk, threatening his goal to avoid getting hurt and producing fear. If the fear threshold is too high, the victim will never be too scared; if it is too low, the victim will always be too scared. Finally, there is also a potential 'butterfly effect' in emergent narrative where there is *no* discernable relationship between the initial state and its events: properties of the initial state may propagate into the simulation in complex ways, enabling event sequences that would not happen with a slightly different setup.

For the initial state aspects that have a less clear rationale, authoring may take on the form of 'tweaking' so that a desired space of possible dramatic events is possible (Iurgel, 2007). As an alternative, part of these properties may be automatically derived based on given event sequences. This approach has been followed by Si *et al.* (2005). In their THESPIAN system, a *fitting* algorithm tries to automatically configure character personalities (in terms of initial goal weights), based on a set of author-defined story lines (scripts). The fitting procedure yields suggestions for the author to adapt the weights so that they are motivated to perform according to these scripts.

Overcommitment. Because of its influence on the course of events, creating a fixed initial state entails a considerable commitment, possibly ruling out alternative, equally valuable courses of events given the potential of the dynamic model.

As an example, consider an emergent narrative in which a husband comes home to his wife after a long day at work. As he hangs up his coat, he might find a wallet on the floor under the coat rack which does not belong to him. This proves his suspicion that his wife has been cheating on him. Alternatively, as the husband hangs up his coat, it may be his wife who confronts *him* with a female scarf that *she* had found on the floor, indicating that her husband has been cheating on her. Both rely on the same events: finding a strange item and confronting the partner. Both however have a different backstory of adultery, and different existents. Completely specifying the initial state in advance means committing to one of these possibilities; putting both a scarf and a wallet under the coat rack is no solution, as this creates yet a third course of events in which *both* have been cheating.

For story planning, Riedl & Young propose lessening the commitment an author has to make if the exact initial state of a story planner must be specified (Riedl & Young, 2005). Their arguments are similar to the two discussed here. An extra argument is that the author might simply not have a strong disposition to some of the properties of the initial state; the decision can be left to the system.

Towards a Dynamic Model of the Initial State

There is a difference in the way the story landscape is authored and the way the initial state is authored. The story landscape is 'implicit', created by means of a dynamic model that delimits the *possible* event sequences. The initial state is 'explicit', created as a static specification that forms the *actual* initial state of affairs for every possible event sequence.

As we are constraining possibilities in ways that are not always clear and intentional, and which are sometimes overcommitted, we should realize that there is an opportunity to specify a *dynamic* model of the initial state, just as a dynamic model of the events is specified. As authoring is always in Firstness, a fixed initial state corresponds to such rules as: *in every possible world, there is a scarf under the coat rack* and *in every possible world, the husband has been cheating on his wife*. Making this realization explicit means that we can also replace these rules with less committed and better contextualized versions: *there is either a scarf under the coat rack, or a wallet* and *if there is a scarf under the coat rack, the backstory is that the husband has been cheating on his wife.*

In fact, some dynamism on the global level is introduced if the initial state is cut into more or less independent episodic frames, as we saw in section 3.2.3. However, *within* each episode, the initial state is still predefined.

This discussion on authorship of the initial state prepares for section 4.3, which explains how in dramatic improvisation, the inferred initial state is gradually defined *during* a scene, and helps actors to for instance justify their actions. Section 8.4 makes first steps towards a computational model of this process.

3.4 Conclusion

Emergent narrative can be seen both as a theory of narrative in virtual environments, addressing the paradox between free-form interactivity from a first person perspective and narrative structure, and as a design approach. This chapter surveyed some core concepts of this theory: its constructivist and process-oriented definition of narrative, how narrative emerges through character interaction, how this emergent process can be facilitated, and the role of agency and human authorship within such a process.

This chapter made some first steps towards better understanding the authoring process of emergent narrative, as this has remained relatively anecdotal and technical in current discourse. Starting from the observation that authoring for emergence is a paradox, the metaphor of a story landscape was introduced to derive practical authoring issues. This metaphor clarifies the kind of impasse an author of emergent narrative faces: authorial intent cannot be placed at the plot level, as event sequences are an emergent property of character models, nor can it be placed solely at the level of character, as character exists by grace of what it does in a narrative context.

This chapter also investigated the process of constructing meaning for the author of an emergent narrative. Within this creative process, we have contrasted a mindset of co-creation, in which the story landscape implied by the system and the author's intent mutually inform each other, with a mindset of debugging, in which authorial intent does not change. This distinction was found useful in order to describe two different ways that story generation feedback during authoring may serve an author. The co-creation mindset is necessitated by the authorial impasse in emergent narrative, and requires an iterative authoring cycle, in which both the intent of the author and the simulation outcomes may change. In chapter 9 I will investigate how this iterative authoring cycle works in practice.

One important consequence of using the co-creation mindset for building interactive storytelling systems in general is that it moves away from the idea of having totally pre-meditated authorial control over the end result. The benefit is that the tension between authorial control and the sometimes unpredictable or uncontrollable story generation outcome is lessened. Another benefit of the co-creation view is that it is suitable for multi-party authoring approaches. A recent example is the massively collaborative authoring approach of Kriegel & Aylett (2008), in which intelligent story characters can be taught in a rehearsal mode how (not) to act and why.

Part II

Dramatic Improvisation

4

Poetics of Improvisational Theater

> "One way to understand 'action' is to attend performances that are in a language that you can't understand. Some will be baffling, but if the characters are altered by what was said, you'll remember them as though they were speaking in English. Good theatre is like tennis in that the spectators look to see how a statement is received, whereas in bad theatre it won't be received."
>
> **Keith Johnstone**
> (Johnstone, 1999, p.77)

This chapter focuses on improvisational theater as a drama theory and practice. As we will see, improvisational theater shares several key properties with the theory of emergent narrative discussed in chapter 3. By reviewing existing literature on the poetics of improvisational theater, the aim is to discuss what design directions can be distilled for emergent narrative. This chapter also serves as a basis for chapter 5, in which the improv model is used to better understand agency in emergent narrative environments.

4.1 Introduction

The term "poetics" derives from the Greek word *poiesis*, which means 'making' or 'creating'. According to Bordwell (1989), "the poetics of any medium studies the finished work as the result of a process of construction — a process which includes a craft component (e.g., rules of thumb), the more general principles according to which the work is composed, and its functions, effects, and uses. Any inquiry into the fundamental principles by which a work in any representational medium is constructed can fall within the domain of poetics." (Bordwell, 1989).

Findings in narratology often serve as a model for building interactive drama systems (Cavazza & Pizzi, 2006). However, as discussed in section 2.1.1, narratology studies stories as static artifacts rather than studying their (interactive) construction process, and does not provide a model for interaction. To better understand interactive story construction processes, it makes sense to study existing, real-life interactive narrative such as role playing games (RPGs) and improvisational theater, as also argued by others (Aylett, 2000; Louchart & Aylett, 2004b; Tanenbaum & Tanenbaum, 2008).

Louchart's theoretical investigation of the emergent narrative concept involved studying RPGs. Knowledge about narrative construction in RPGs was elicited based on interviews with role-players of pen-and paper RPGs and Live Action RPGs (LARP), providing insight into game-mastering and the subjective experience of narrative. We have similarly proposed that emergent narrative research can draw some valuable lessons from the story construction process of improvisational theater (Swartjes & Vromen, 2007). This is the focus of the discussion in this chapter.

4.2 Scope

Improvisational theater (sometimes abbreviated as improv or impro) is a form of theater in which the actors have not rehearsed a particular performance but make up the story and its characters as they go along, often based on suggestions from the audience. Let us first make two distinctions in order to limit the scope of the discussion in this chapter: (1) between improv comedy and drama and (2) between form and content.

4.2.1 Comedy Versus Drama

Improv is popularized as a form of comedy, by television programs such as the TV show *Whose line is it anyway?* which ran on American TV in the nineties (with similar programs being run in other countries, such as *De Lama's* on Dutch TV). Short comedic scenes are improvised using a game-based format and input from the audience. In the highly energetic and short-form setup of improv comedy, the improvisers make things difficult for each other, tap into recognizable stereotypes, and deliberately destroy narrative frames that arise. This last aspect is known in the improv world as *gagging*, or making jokes at the expense of the story. This has the effect that good drama is less likely to emerge and if a story develops, it remains somewhat flat and stereotypical. Then again, for improv comedy, the story is often subservient to comedy.

The aim of improvised *drama* is to have a compelling story unfold. Where any story development in improv comedy tends to stay superficial, dramatic scenes arise when the actors develop serious characters, and when these characters engage in dramatically meaningful interaction. This does not exclude comedy; still, many dramatic scenes contain comedic elements and when used in moderation, the construction of a serious dramatic scene is not prevented.

Improv is very suitable for comedy because it is by definition *spontaneous*, and hence more connected to the audience than a rehearsed performance, which gives it an inherent comedic edge. Sometimes, players cannot even help introducing comedy. In a recent improvised scene performed by a Dutch improv troupe called *De Jonge Woudlopers*, one player announced that the team would aim for a serious scene, after having played several comical ones. The player was given the role of a pizza delivery boy, having to deliver a pizza to the apartment of his ex-girlfriend. He looked very serious, concerned about the awkward confrontation with his ex, as he climbed the stairs of the apartment building. When he arrived, he could not help himself and gagged: “Oh, there’s also an elevator.” The audience laughed, seeing the obviousness of this observation and realizing how this destroyed his sincere attempt to be serious.

In this chapter, while realizing that comedy and spontaneity are inherent to improv, I focus not on these aspects but rather on the aspects that enable the collaborative construction of drama.

4.2.2 Form Versus Content

Within improvisational theater, a distinction can be made between the form of a particular improvised performance, and processes of narrative construction within the form. By form, I mean a predetermined structure or set of constraints that has a certain independence from the actual improvised story content.

A distinction can be made between short-form and long-form improv. Where short-form improv performances consist of collections of independent scenes of around 5 minutes each, long-form improv may involve full-length performances, sometimes with a succession of scenes, following a predetermined global narrative structure (e.g., in scene 1, the protagonist is introduced and we find out what he wants to achieve; in scene 2, the antagonist is introduced with a conflicting goal; in scene 3, the protagonist and antagonist meet each other, etc.) or with scenes that are only episodically or thematically connected, but share a predetermined theme.

For the past four years I have been a member of Pro Deo, a student group practicing Theatresports, an improv format originally developed by Keith Johnstone. In Theatresports, teams challenge each other to play short-form improvised scenes in order to earn points issued by a team of impartial judges. Each scene differs greatly in form and intent, some being played for comedy effect, whereas others create a more serious, sometimes tear-jerking dramatic performance. Theatresports has a large collection of *games*, that act as a form. Some examples:

- *One-word game.* During the whole scene, the actors are allowed to only use one specific word, usually given by the audience.
- *Typewriter.* One actor narrates a small introduction to a book, which the other actors continue by playing out some of the scenes in the book. The narrator fills up the space between the scenes by advancing the story, and provides a closing at the end.
- *Soap.* One episode of a fictional soap series is improvised, with several characters enacted in short scene snippets, being semi-randomly replaced by actors that take over the physical position of the previous actor as inspiration for a next snippet, focusing on such concepts as deception, betrayal and greed that often occur in real soaps.

Studying improv forms might inspire fruitful new design opportunities for interactive storytelling. For instance, FearNot! was based on the form of the Forum Theatre, developed by Augusto Boal (Aylett, Louchart, Dias, Paiva, & Vala, 2005). The scenario

"When the Master's Away" uses the *master-servant* form (Johnstone, 1979, pp.62-63), revolving around the reversal of extreme differences in *status* (Hayes-Roth, van Gent, & Huber, 1997). The *story-morphing* story generation paradigm of Elliott, Brzezinski, Sheth, & Salvatoriello (1998), in which the meaning of fixed plot sequences is changed by varying underlying emotions and affective dispositions, corresponds to several Theatresports forms, such as the *emotional replay* (Johnstone, 1999), in which the same scene is repeated several times, using different emotions given by the audience. While some forms might be more easily imagined as computer-based variants than others, an advantage they share is that they can be tested using improv actors, preceding and informing the design process.

In this chapter, I draw from the work of Garrett (2006), who studied Open Scene Additive Improvisation (OSAI), that is, scenes that are not based on a predetermined form. Like Garrett, I focus on the bare process of scene construction, rather than on the various forms or games that exist for improv.

I realize that there are limitations to making this distinction between form and content. First, one might object that in a more abstract sense, there may be a form even to OSAI. Garrett (2006) remarks — and I agree — that (experienced) actors are aware of the various features of a dramatic performance, and "seem to carry with them a notion of the well-made play, or rather, the 'well-made Scene' onto the stage." (Garrett, 2006, p.39). Furthermore, Theatresports games were originally designed as improvisation exercises, and elements of them are often incorporated even in open scene improvisation, where they act as scaffolds for the actors. Finally, sometimes strategies and methods of scene construction depend on the form, for instance in the *Soap* game, where actors focus on the dramatic highlights of soap clichés (e.g., one might suddenly say: "Actually, I am not your real mother") with less focus on the construction of a coherent plot. However, I do not believe that these limitations invalidate the focus on the bare process of scene construction taken in this chapter.

4.3 Poetics of Improvisational Theater

In this section I am mainly concerned with the question how drama is collaboratively constructed in improvisational theater. The question how stories can be improvised has been explored to a great extent by such people as Keith Johnstone, Del Close and Viola Spolin, but knows little scholarly work (Garrett, 2006). I focus here particularly on Johnstones work (Johnstone, 1979, 1999), which describes how actors collaborate and share responsibility for the emerging sequence of events and produce a compelling story. The outcome of the story cannot be controlled by any single participant; it emerges from the collective contributions of all actors.

4.3.1 Collaborative Emergence of Narrative

Improv fits the concept of *collaborative emergence* (Sawyer, 2001), meaning that there is no plan guiding the actors, there is no leader directing the actors' behavior, and none of the participants can control the outcome (Sawyer, 2001).

In an improvised performance, it is not just a sequence of events which emerges, but also the *dramatic frame* in which it takes place, in the form of a physical, social and emotional fictional reality. For instance, through their action and dialog turns, actors establish characters, relationships, objectives and the setting (the CROW model) (Harger, 2004). In this sense, a dramatic frame emerges incrementally and then constrains later actions of agents (Sawyer, 2001).

Actor turns in improvisation are subject to *retrospective interpretation*, where they often acquire meaning only *after* they are performed. For instance, actor A might start an improvised scene by saying "It is time." without knowing what it is time for. Actor B might say: "Yup, masks on!" At this point it is still not established what A and B are exactly going to do (e.g., are they going to rob a bank? Are they about to celebrate Halloween? Are they going to decontaminate a building?). The implication is that turns can be ambiguous, and that the dramatic frame cannot be reduced to the actors' individual intentions (Sawyer, 2002a).

4.3.2 Collaborative Pretend Play

Children's social pretend play displays a similar collaborative emergence of narrative within a continuously negotiated and re-interpreted fictional frame. There are clear similarities between this kind of play and narrative: both have fictional characters who operate in a temporarily created reality, both involve the production and comprehension of decontextualized language (i.e., abstracted from any context in which it might be uttered), and both have plot elements (motivating events, tensions, release) (Sawyer, 2002a). Here too, a retrospective interpretation of action takes place. A difference from dramatic improvisation is that where improv actors subtextually negotiate the dramatic frame, children often step out of character to explicitly propose contributions or modify those of their playmates through metacommunication (Sawyer, 2002a; Lederer, 2002). When playing house, they might for instance say, "Let's pretend I am the mother, OK?"

Both Lederer (2002) and Sawyer (2002a) mention the importance of script knowledge (e.g., the 'doctor' script or the 'house' script), that act as scaffolds for children's pretend play.

In addition to metacommunication and script knowledge, children use two basic rules in their pretend play (Lederer, 2002):

(1) The *pretend rule* means that players should not reveal that they are 'just playing' and should assume they are pretending at all times. Making references to reality (e.g., "This is not a baby, this is just a doll.") violates this rule.

(2) The *collaboration* rule means that players either incorporate contributions to the dramatic frame, or negotiate alternatives when differences arise. Refusing a contribution without an alternative (e.g., "No, you are not the mother.") violates this rule.

4.3.3 Strategies for Improvising Drama

Improvisational actors practice to further develop their innate skills for the collaborative construction of narrative. First of all, they learn to employ strategies for constructing and subtextually negotiating the dramatic frame, and second, they develop over time a feeling for 'what a story needs', so they can make fruitful contributions that help the story forward. For instance, they learn to create *platforms* (Johnstone, 1999, pp. 92-93) by establishing a specific who, what and where, and they learn to 'break the routine' (Johnstone, 1999, pp. 84-89), 'tilting' the balance between the characters.

Johnstone suggests that being creative in this context is different from trying to be original, as is often believed. It involves taking the ideas that are most obvious and staying within a *circle of expectation*. The spectators of an improvised performance create a 'shadow story' based on their expectations, and "...storytelling goes well when there is a close match between the improvisers' story and the spectators' shadow story." (Johnstone, 1999, p. 79). Paradoxically, according to Johnstone, the improvisers who stay within the circle of expectation seem the most original. This seems to be related to the notion of *boundaries* of an emergent narrative story landscape, and with the notion of dramatic probability, both discussed in chapter 3.

4.3.4 Johnstone's Poetics

The works of Johnstone is full of terminology pointing at collaborative strategies for story construction, including terms such as 'offer', 'accept' and 'block'. Although these terms have become part of a widely shared improv lexicon, they are often somewhat intuitive, ill-defined or ambiguous. This motivated Garrett (2006) to attempt to define these terms more formally. To our knowledge, this is the only scientific resource which explicitly attempts to formulate a poetics of additive improvisational theater.

Garrett conducted a case study analysis of seven OSAI scenes. The aim of Garrett's investigation was twofold: (1) to discover the ways in which student improvisers make use of Johnstone's poetics in order to arrive at coherent, engaging and dramatically well-made scenes, and (2) to suggest an overall 'working model' that could inter-relate elements of Johnstone's poetics organically, and be applicable to any OSAI scene (Garrett, 2006, pp.10-11). These elements are:

Offering. Every action by a player can be seen as an offer, as a constructive contribution to the scene.

Accepting. Actions by players that acknowledge, validate or extend upon offers of others. The opposite is called *blocking*: negating or refusing an offer, or undermining the basis of an offer without accepting any of its assumptions. Improv actors are taught to block as little as possible, because it disrupts the constructive building of a fictional reality.

Endowing. Naming or giving a quality to something not yet defined in the scene.

Justifying. Naming or giving a quality to something already defined in the scene because it needs explanation.

Extending. Stopping the narrative to focus, explore and extend upon one aspect of the scene, or to add detail to it.

Advancing. The opposite of extending: moving the narrative on to the next step.

Reincorporating. Bringing back narrative elements and offers that were established earlier on into the scene.

Yielding. Dropping one's own offer in order to maintain a single stage focus for the scene.

Note that these terms describe concepts on the level of actors collaborating to create a story and construct a dramatic frame through in-character dialog and action, and not on the level of characters 'living their lives' within an established dramatic frame, as with emergent narrative. Of these terms, *offering* and *accepting* may be seen as the most fundamental terms describing story construction and will be further explored in section 4.4. The terms *endowing* and *justifying* can be seen as instances of *offering*, *reincorporating* relates to creating narrative coherence, and *extending*, *advancing* and *yielding* relate to control of the pacing and the execution of the performance. A short sample scene might illustrate the operation of these concepts in scene improvisation:

A: Still up? *(offering)*

B: Yes dear *(accepting, endowing husband and wife roles)*, I couldn't sleep. I have an important meeting tomorrow with my boss. *(justifying being up still)*

A: You look *really* tense babe! *(extending, focusing on the problem)*

B: I know, it's just...I think my boss found out that I sometimes fall asleep at work. *(justifying)*

A: Yeah, admittedly not the best quality for a security guard. *(endowing a job, also justifying because it adds a reason why sleeping at work is so terrible)*

A: [*out-of-character*] The next day, at work... *(advancing to the confrontation)*

B: Hi, boss. [*big yawn*] *(reincorporating the tiredness)*

C: [*playing the boss*] Well well, Mr. Peters *(endowing a name)*, you look like you are about to fall asleep at work...again! *(accepting the tiredness, offering that the boss has indeed seen Mr. Peters sleep)*

B: You are not going to fire me, are you? *(offering)*

C: You handed me a letter of resignation yesterday, remember? *(blocking the offer)*

...

4.4 Comparison with Neo-Aristotelian Poetics for Interactive Drama

Here, I compare the poetics of dramatic improvisation as discussed so far with the neo-Aristotelian poetics for interactive drama as proposed by Mateas (2001a).

4.4.1 Neo-Aristotelian Poetics for Interactive Drama

While Aristotle's *Poetics* (Aristotle, 1907) still serves as a major resource within contemporary drama theory, it may come as no surprise that it has been used to formulate a poetics for interactive drama as well (Laurel, 1991; Mateas, 2001a; Tomaszewski & Binsted, 2006). The analysis of Greek tragedy led Aristotle to the identification of several layers of a play: Plot, Character, Thought, Diction, Song and Spectacle. The poetics of Aristotle was used and further developed by scholars such as Sam Smiley and Brenda Laurel, arriving at a neo-Aristotelian understanding of drama in which the layers of a play are seen as connected through chains of material and formal causation (Laurel, 1991, pp. 49-65). The *material cause* of something is the material out of which something is created or shaped. For instance, the material cause of a house is its bricks, woodwork and windows. The *formal cause* of something is the rationale for the existence and arrangement of material. For instance, the formal cause of a house is its blueprint. In this neo-Aristotelian model, moving away from Greek tragedy and toward contemporary (interactive) drama serving as a model for human-computer activity, Laurel (1991) proposes a few modifications to the original meaning by Aristotle. Spectacle is replaced by *Enactment*, meaning the raw sensory experience of the action being represented. Song is replaced by *Pattern*, meaning the pleasurable perception of pattern in sensory phenomena. Diction is replaced by *Language*, meaning the selection and arrangement of signs. *Thought* remains the same: inferred internal processes leading to choice (cognition, emotion and reason). Just so for *Character*: bundles of predispositions and traits, inferred from agents' patterns of choice. The *Action* is the plot of the play, the organic whole that adheres to principles of unity and totality (Aristotle, 1907).

In terms of a drama, the chain of material causation of the play determines how each level or part in Aristotle's model forms or shapes the level above it. From the lowest level up, we can understand Enactment to be the material for Pattern, which in turn forms Language that makes us infer the Thought of the characters involved. Character, finally, materializes the Action of the drama.

Analogously, the chain of formal causation determines what a certain layer forms in terms of the layer below it. Action is formed by Character, which is formed by Thought, and so on.

Mateas (2001a) incorporates user interaction into the neo-Aristotelian drama model in an attempt to formulate a model of interactive drama. The player is a character who can choose his or her own actions. For this, two more causal chains are added to the model: that of *material for action*, and that of *user intention*. See figure 4.1. The levels below Character constrain what the user can do (the *material constraints*) while the level above Character (i.e., the plot) determines a motivation to act (the *formal constraints*). The user is expected to reason along the line of authorial intent, to get a sense of the dramatic probability for action. For instance, thoughts of other characters (Thought), expressed through dialog or non-verbal behavior (Diction), form material constraints for the user as they allow the user to understand how he can affect their thoughts by taking action. Similarly, understanding the plot (Action) creates formal constraints as it gives the user an understanding for 'where the story is heading' and what action to take to act in line with this direction, in other words, what actions are dramatically probable. As discussed in chapter 2, the hypothesis of Mateas (2001a) is that the player will experience agency when there is a balance between these material and formal constraints.

Tomaszewski & Binsted (2006) presented a reconstructed version of this poetics, in order to alleviate some of the tensions that are present in Mateas' poetics. They do this mainly by reintroducing Aristotle's categorization of the parts of drama in the object, medium and manner of imitation. The general understanding of interactive drama remains the same: the primacy of Action as a formal cause for Character and for an interactor to have a reason to act.

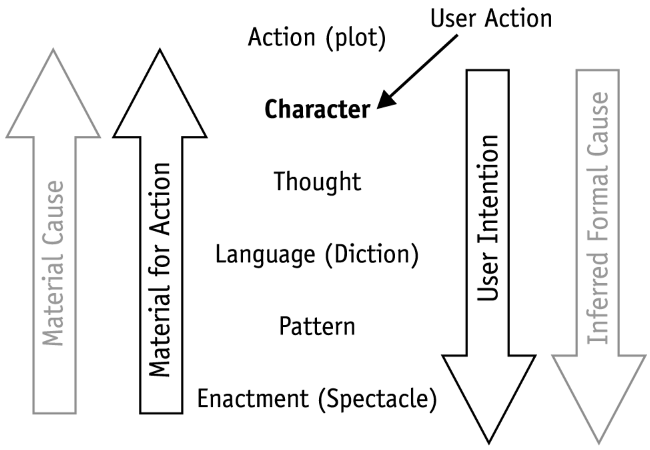

Figure 4.1: Mateas' Neo-Aristotelian poetics of interactive drama, incorporating user interaction at the Character level.

4.4.2 Negotiation of the Dramatic Frame

An audience that fully appreciates the fact that it is watching an improvised play knows what the actors also know: that there cannot be a preconceived plot, acting as a formal cause for the actors to act the way they do. The presence of such a plot is made impossible by the distribution of action decisions over each of the actors. This gives improvisational theater a unique quality in comparison to (neo-)Aristotelian drama. Instead, Johnstone defines 'dramatic action' as the product of 'interaction', where 'interaction' means 'a shift in the balance between two people' (Johnstone, 1999, p.77).

This key difference does not render the poetics as presented by Mateas useless for better understanding dramatic improvisation. Chains of material and formal causation still operate within an improvised play, in such a way that the different layers constrain each other. The absence of predetermined formal causes does not mean that there is no *perception* of formal cause. As Johnstone experienced, audience members sometimes do not believe that an improvised play was not rehearsed, thinking that some sort of trickery is involved (Johnstone, 1999, pp.25,193). This observation is relevant because it suggests that actors perceive formal cause in each other's acting as well, creating a tight loop of 'mutual inspiration' and a negotiation of formal constraints that drive the play.

However, in improvisational theater, different from the top-down formation of the whole Action as in the neo-Aristotelian poetics, there exists a strong interaction between all the layers. Actions or dialogs of fellow actors may travel up the hierarchy of meaning abstraction, impacting the whole Action which in turn starts providing formal constraints for the continuation at lower levels. An accidental cough might rapidly transform a player into a sick, old granny. The smallest delay in response by one player might be interpreted by another player to signify that 'there is something wrong' and might create a dramatic conflict that becomes central to the scene. This way, there is a continuous negotiation of formal and material constraints in an emergent process that Sawyer (2001) calls *bi-directional causation*: "actions of individual agents give rise to the incremental emergence of a dramatic frame; once it begins to emerge, the frame then constrains the later actions for agents." (Sawyer, 2001, p. 53).

One Theatresports exercise that is sometimes played at Pro Deo illustrates this clearly. Four players sit on four chairs next to each other on stage. The only thing they are allowed to do is mimic and exaggerate what the other players are doing. In the end, the scene should end by all four players standing up and leaving, for a common, clear reason. In the beginning, we see four players sitting and doing nothing. One might accidentally clear her throat. Suddenly, four players are clearing their throats, exaggerating up to the point where they are coughing like there is no tomorrow, as if their lungs are being filled with the most toxic air. The reason to leave has emerged: escape to fresh air. The initial throat clearing was not informed by formal cause, yet acted as such for the other actors.

4.4.3 Formal and Material Constraints Through Offers

Improvisational actors are trained to make good offers and accept those of others. The extremely broad definitions of 'offer' that we find on improv web pages or in improv literature are not immediately useful for deriving a computational model of these notions. Examples are: "each spoken word or action that defines some element of the reality of the scene",[1] "any dialog or action which advances the scene"[2] and even "anything an actor does" (Johnstone, 1979, p.97). In fact, there seem to be two senses in which the term 'offer' can be understood.

Meaning 1. *Action or dialog that communicates new aspects of the reality of the scene.*

In this sense, an offer is seen from the perspective of the information it contains for the scene, contributing to the *material cause* of the performance. This information is subtextually negotiated, and is explicit or implicit in dialog lines and actions. Sawyer (2001) proposes to model an improvisational action using an OFFER and a RESPONSE component. He defines an OFFER as "an incremental, creative addition to the emergent frame, such as a character, relationship, location, or joint activity" (Sawyer, 2001, p.62). The RESPONSE component can be used to (partially) accept or reject an OFFER, or even extend or modify it. As new information given by one agent might be inconsistent with the other agent's view, accepting an offer might

[1] `http://en.wikipedia.org/wiki/Improvisational_theatre`
[2] `http://www.improvcomedy.org/glossary.html`

require the agent to believably accommodate the information of the OFFER. For instance, the offer “Please don’t hit me again!” given by one actor implies that there is reason to believe that the other actor’s character would. Accepting this offer means creating this reason, for example by becoming someone who is violently angry.

Meaning 2. *Action or dialog with a certain intention to affect the direction of the scene.*

In this sense, an offer is seen from the perspective of the direction it gives to the dramatic development of the scene, contributing to the *formal cause* of the performance. For instance, the offer “the dog is dead” not only communicates this tragic information, but also communicates a possible direction for a scene of, let’s say, a mournful farewell ritual in the back garden. Strong offers may dictate direction (“Let’s go bury the dog in the garden.”), but weaker ones may only open up possibilities (“He deserves a respectful farewell.”). In the stronger sense, the definition is related to the interpretation of Hayes-Roth & van Gent (1997), who see ‘accepting an offer’ as changing one’s own plans “to accommodate the other’s apparent intentions” (Hayes-Roth & van Gent, 1997, p.3). In the weaker sense, improv actors expect their fellow actors to be able to accept the offer in interesting ways, but have no commitment to the specifics of this accept, relying on a retrospective interpretation of their offer. Nevertheless, both the offerer and the accepter carry responsibility for the dramatic construction: the offerer must make offers that create opportunities to be accepted, and the accepter must find ways to make good use of the offers.

4.5 Design Implications for Emergent Narrative

Building virtual characters that can improvise scenes in the same way as human improvisers means solving the AI problem, and although recent efforts aim for understanding the cognitive processes of actors in dramatic improvisation (Magerko, Manzoul, Riedl, Baumer, Fuller, Luther, & Pearce, 2009; Baumer & Magerko, 2009), we are far from a computational model of these cognitive processes. Still, the ideas and techniques employed within improvisational theater may inform the research agenda for emergent narrative.

4.5.1 Comparison with Emergent Narrative

There is much similarity between the concept of emergent narrative as described in chapter 3, and the practice of dramatic improvisation as discussed in this chapter:

- Both have an unscripted nature, making the resulting drama emergent.
- Both distribute the responsibility for the emergence of drama over its actors, making it impossible to ascribe authorship of the resulting piece to any single source.
- Both use local, in-the-moment decision-making to determine story progress whereby no single actor has the ultimate control over the emerging narrative at any point in time.

There are also differences between emergent narrative and improvisational theater in the way stories are constructed:

- Improv actors performing the role of a character also have an explicit concern for producing engaging drama. In emergent narrative, there is no explicit representation of this actor-level concern.
- Improv actors draw from a huge body of life experiences to inform their dramatic choices; this gives improv a certain limitless, open ended range of possible stories. In emergent narrative this range of possible stories needs to be authored and is therefore by definition limited.
- Improv is typically aimed at the production of a dramatic performance for an audience. In emergent narrative, users are envisioned to participate, and the drama is aimed at the users' storification process.
- In improv, as in children's pretend play, events often acquire meaning *after* they are performed (Sawyer, 2002a). Emergent narrative does not have this retrospective interpretation.
- In improv, the dramatic frame emerges *alongside* the course of events. Emergent narrative starts with a predetermined storyworld and uses simulation to produce an even sequence based on this storyworld.

4.5.2 Characters Become Actors

Aylett (2000) stated that narrative, in certain cases, may emerge directly from the interactions of its characters. The FearNot! application has demonstrated this to be true. A full reliance on emergence at the character level may be feasible for small-scale storyworlds, by making sure that characters and the storyworld are set up in such a way that dramatic interaction naturally emerges. However, the pure in-character perspective is likely to fall short when the amount of content is upscaled, and the pursuit of more sophisticated character models is not likely to solve this.

The division of narrative construction into episodes seems a fruitful approach to upscaling, but seems to ultimately suffer from the same problems as branching narrative: a lack of global agency because each episode presupposes specific conditions that must be met for it to finish. Moreover, it provides no way to account for the transformation in character state that supposedly happens *between* episodes. A more structural approach might be useful especially when the story domains grow and virtual characters might pursue their own interests at the cost of narrative coherence.

The poetics of improv may have something to offer here as it opens up an actor-level perspective on the story construction process that is currently absent in the emergent narrative approach. From the self-interested, character-level perspective that virtual characters currently have, they 'live their lives' in the virtual environment. From a collaborative, actor-level perspective, agents are cooperating and negotiating to establish a shared fictional reality, and aim to create opportunities for dramatic interaction. The course of events becomes a result not only of character-level motivations and emotions, but also of actor-level motivations to establish relationships between characters, to produce emotional responses, to create conflicts, etc.

At this point in the discussion, the distinction between the actor-level and character-level perspective is still conceptual. In chapter 8, the aim will be to examine this distinction from a computational perspective, by investigating to what extent this distinction can also be made architecturally.

One might object that opening up an actor-awareness for the virtual characters violates an important advantage of emergent narrative, namely that one of the characters can be replaced by a human player. This objection makes the assumption that the human player does not play by the same rules. However, as I try to show in chapter 5, human participants in such environments will start role playing without being instructed to do so, and make actor-level decisions that are similar in nature, albeit perhaps of less quality, to that of improv actors.

4.5.3 Offers and Accepts

The notions of offer and accept have implications both for authorship of emergent narratives and for the processes by which the emergence of narrative may be controlled.

Implications for Character and Storyworld Modeling

While improv actors can assume the other actors to be creative and employ their own associations in order to accept offers, for the virtual characters of emergent narrative a more formal pursuit of determining dramatically appropriate responses to action and dialogue is necessary. In part this was addressed in section 3.3: the corresponding idea is that for actions of one character, there must be interesting reactions defined for the other characters. This implements the requirement proposed by Louchart & Aylett (2004a) that characters are "designed in function of other characters" (Louchart & Aylett, 2004a, table 2). For instance, insults of the bully in FearNot! work because the victim is designed to avoid being hurt and accept the insult-offer by becoming distressed. The 'dead ends' of the story landscape discussed in section 3.3.2 can be seen as points in the simulation where offers are not matched by appropriate accepts.

Implications for Narrative Control

Seen from the actor-level perspective, a more proactive stance toward making and accepting offers might be developed. We might first of all define heuristics for the offering party to assess whether and how certain actions are going to have an impact on the scene, in order to assess which actions are good offers, and second, define mechanisms by which characters can meaningfully accept offers. An advantage of using computer characters is that they can communicate and negotiate out of character, 'behind the screens' as it were, opening possibilities for explicitly negotiating offers and accepts (as in children's pretend play) instead of subtextually (as in dramatic improvisation). I return to this issue in chapter 8, where a distributed approach to narrative control is discussed.

4.5.4 Framing the Storyworld

The first meaning of ‘offer’ described in section 4.4.3, i.e., an addition to the information of the scene, is worth exploring in more detail, as it provides a potential solution to the problem introduced in section 3.3.6. The problem was that committing to a fixed initial state of the characters and the story at authoring time considerably constrains opportunities for the emergence of narrative. Having a fixed initial storyworld reduces the flexibility that might be needed for an actor-level perspective on the emerging story.

As we saw, predetermining the initial state is not what happens in improvisational theater, where it emerges alongside the event sequence and is an important part of the creative process. An improvised story initially starts without such a frame[3] and takes place in one of many possible worlds which is gradually constrained by the individual contributions of the actors.

In chapter 8, a computational model for constructing these frames as *part of the story generation process* is proposed, so that the system can determine the properties of the dramatic frame based on requirements for the emerging story development. The technique of *late commitment*, described in section 8.4, models this process of gradually establishing the perceived initial state of the virtual storyworld rather than having it fixed from the start of the simulation. From the perspective of authoring emergent narrative, as discussed in section 3.3, this can be understood as a way to author the initial state in a way more in line with Firstness, i.e., in terms of specifying a set of possible worlds rather than one actual one.

4.6 Conclusion

This chapter investigated the poetics of improvisational theater, and proposed design implications for emergent narrative.

Emergent narrative has many similarities with improvisational theater. Perhaps the most important similarity is the lack of a prescripted plot; stories emerge based on local and opportune decisions that are not per se informed by a predetermined plot or plot structure.

A poetics for interactive drama based on improvisational theater contrasts with the more generally adopted neo-Aristotelian poetics for interactive drama, in which the aim is to provide global agency while at the same time “maintaining a tight, author given story structure” (Mateas, 2002, p.22) or working towards an author-determined destiny (Kelso *et al.*, 1993). This contrast is due to the following differences:

- Collaborative emergence of drama rather than an enactment of an author-given script

- Formal and material constraints are collaboratively negotiated through offers and accepts rather than determined by an author

[3]Input from the audience is often asked (e.g., a location for the scene or a profession of one of the characters), but a scene can also develop without such input.

- Real-time construction of the dramatic frame rather than a predetermined specification of the initial state

Following the improv poetics for interactive drama, the lessons we take for the design of emergent narrative are the following:

- Modeling actor-awareness for the virtual characters
- Organizing story content in terms of offers and accepts, by making sure that character behavior is matched by appropriate dramatic responses for other characters
- Defining heuristics for determining which actions are good offers at a certain moment in the emergent narrative
- Framing the storyworld, i.e., dynamically and retrospectively determining the initial state of the storyworld *during* the emerging narrative

In the next chapter, we investigate the aesthetics of dramatic improvisation as a model for interactive drama. To this end, we use human improv actors that collaboratively improvise a story, aimed at participants who have little improv experience, and do not know that the story is improvised.

5

Agency Within Improvised Stories

> "If you watch a movie, you become the hero - Gilgamesh, Indiana Jones, James Bond, whomever. The kid says, I want to be that. In a game, Mario isn't a hero. I don't want to be him; he's me. Mario is a cursor. Maybe you do want to be the Street Fighter guys - I don't know their names, Kung Wo, whatever - but I think they're more like your tennis racquet. When I play against you, I play me using the Kung Wo racquet."
>
> **Rob Fulop**
> Scott Rosenberg, *The Latest Action Heroes*, WIRED magazine 3.01, 1995

In this chapter, an experiment is described which contributes to the understanding of the process of interacting with stories from the first-person perspective of one of its characters. The experiment uses free-form improvisational theater as a model for story participation. This supports a particular conception of the notion of agency within interactive drama, which is useful for emergent narrative, because of its similarities with improvisational theater concerning authorial and participative roles. The results of this experiment appeared in Swartjes & Theune (2009a).

5.1 Introduction

The similarities between emergent narrative and improvisational theater make the latter a useful substitute for a fully-implemented emergent narrative system in order to explore issues of agency within such a system. Although the poetics of improvisational theater by its very nature incorporates interactivity, because of its real-time construction process, it is not immediately clear if and in which way this interactivity is also meaningful for a participant who might not aim to produce an engaging improvised scene per se. The question is what agency means for users that become involved in an improvised play. What drives their actions, if anything? Solutions like pre-briefing, as often used in role-playing for training scenarios, fall short because unless it is reinforced within the virtual environment via interaction, users that are not trained actors might not find 'staying in role' very important, and if they are willing to be cooperative, they might not know what behavior is appropriate at certain moments (Aylett, 2000).

As a solution, Aylett (2000) has proposed that the environment should create a sense of *social presence* for the user. The user is given a social role in the environment; the behavior required from the user is then communicated through social convention or social pressure, and this behavior has irreversible consequences for the environment and its characters (i.e., there are no save points or replay facilities).

In this chapter, we will first discuss related concepts of *dramatic presence* and *narrative presence* in section 5.2. This provides us with a general framework which we can use to assess the results of the experiment described in section 5.3, in which we give improv actors the task to create an enjoyable interactive drama experience for subjects participating in the experiment. From this experiment, section 5.4 will draw conclusions for the understanding of user agency in emergent narrative environments.

5.2 Being Present in Drama

The concept of *dramatic presence* refers to the experience of being present in a rich storyworld, with strong characters, aesthetic presentation, and long-term dramatic structure (Kelso *et al.*, 1993). Simply put, it is the experience of 'being in a story' as one of its characters (as in interactive drama). The notion of 'being in' a story subsumes the notion of taking meaningful action within that story. The experience of dramatic presence thus includes, but is broader than the experience of agency.

The live interactive drama experiment performed within the OZ project (Kelso *et al.*, 1993) pioneered the investigation of dramatic presence. In this experiment, actors played out a performance on a theater stage, not for an audience, but for an interactor participating in the drama. A director had a predetermined graph of desired scene sequences at his disposal, and gave directives to the actors and the interactor who were wearing headphones, in order to ensure that they followed a path through the scene graph. The graph was designed in such a way that each path through the graph would yield a meaningful story. The experiment was designed to investigate three basic questions: (1) how does it feel for an interactor to be immersed in a dramatic virtual world? (2) what is required of the actors in this world? (3) what are the requirements for the director to make an engaging interaction? Lessons learned from this experiment are that the experience of dramatic presence can be engrossing and powerful, that trying to direct the interactor breaks their willing suspension of disbelief, and that participating interactors experience the same performance very differently from outside spectators. One explanation for this difference is that the kind of deliberation that interactors go through when faced with choices and dilemmas is what makes them strongly engaged with the situation, whereas this process is very different from that of the audience for whom these choices are not personal. Interactors found interactive drama to easily cause immediate, personal emotions, not the emotions evoked by empathy as is the case in traditional drama (Zillmann, 1994).

Dramatic presence might be viewed and further characterized as part of the broader concept of *narrative presence*; the sense of being in or part of a story, be it as interactors playing a role in this story (as with dramatic presence), or simply as readers or spectators getting lost in the fictional world of a story being presented to them (Rowe *et al.*, 2007). Narrative presence can be seen as an affective-cognitive construct that characterizes an audience's perceived relationship with a story. It reflects experiences where readers of fiction, movie audiences or computer game players report feelings of being transported into a story. Different from physical presence (the sense of being physically located in a mediated space) and social presence (the sense of co-location and social interaction with a virtual or remote partner), both described by IJsselsteijn & Riva (2003), narrative presence does not necessarily aim for a perceived absence of mediation; more central are the perceived reality of the story and the experience of plausible cognitive and emotional reactions (Rowe *et al.*, 2007).

Narrative presence is a complex, multidimensional construct composed of a number of factors. Although not empirically validated, the factors that are argued to contribute to a sense of narrative presence can be divided into three categories: (1) narrative-centric factors, (2) user-centric factors and (3) interpersonal factors. These factors are summarized here; for more complete descriptions the reader is referred to Rowe *et al.* (2007).

Narrative-centric factors deal with the aspects concerning the story itself:

- *Consistency.* A disruption of consistency of the setting, plot and characters might disengage users from the experience.
- *Plot coherence.* It is important for narrative presence that the event sequence of the narrative has a logical, causal structure to it, and that the events bear relevance to the outcome of the story.
- *Drama.* Classical dramatic story structure, its well-formedness in terms of setup, conflict and resolution, potentially enhances narrative presence.
- *Predictability.* When characters, objects and events are predictable and mimic real world cause and effect, this is hypothesized to contribute to narrative presence by reinforcing audience expectations.

User-centric factors deal with the cognitive and affective elements of individual users (readers or interactors):

- *Affect.* Narratives that stimulate an audience's emotions may increase the sense of presence in the story.
- *Motivation.* The user should be intrinsically motivated to read on or keep participating. Four types of intrinsic motivation are mentioned: curiosity and fantasy (as a reader), and additionally challenge and control (as an interactor).
- *Efficacy.* When users are interacting with a storyworld and are faced with problems or challenges in this storyworld, their sense of efficacy (whether they believe themselves able to perform) impacts whether their sense of narrative presence stays or turns into feelings of boredom and frustration.

- *Control.* By offering control and freedom over a storyworld and its events, the audience transitions from passive observer to active participant, promoting a sense of being a part of the narrative.

Interpersonal factors deal with the relationship between the user and key story elements:

- *Identification.* Narrative contexts and characters that are relevant and identifiable to audiences are likely to provoke audience interest and enhance narrative presence.
- *Narrative Load.* Different narratives place different demands on the reader's or interactor's capacity to understand its events and make sense of the plot. Narrative load is a concept analogous to that of *cognitive load*.
- *Character Believability.* Believable characters (e.g., having plausible intentions and personality, being of sufficient complexity and depth) are important for a story to evoke a sense of narrative presence.
- *Empathy.* Empathic relationships between characters (including a human interactor), or audiences' feelings of empathy for a character in a story are hypothesized to affect narrative presence.
- *Involvement.* The feeling of actively participating in a story and seeking its conclusion promotes narrative presence.

5.3 Dramatic Presence Within Improvised Stories

In the experiment we conducted, we tried to achieve meaningful improvised interaction between two improv actors and a participant with no particular improv experience. Two improv actors from the local Theatresports group Pro Deo were found willing to participate. The actors each had more than five years of experience with improvisational theater, practicing on a weekly basis under the guidance of a professional Theatresports and drama teacher.

In such a setup, the improv actors can be expected to carry more responsibility for the success of an emerging story than a participant without improv experience. The improvisers know that the establishment of specific and strong social relationships is essential to the emergence of drama. The inexperienced participant might try to be clever and original, they might block offers brought in by others, they might not yield where necessary. However, the innate and early learned ability of people to engage in pretend and role play and the fact that 'taking the obvious' seems a good strategy for improvising stories, suggest that inexperienced participants should be able to participate in an improvised story in a natural way and experience a sense of dramatic presence.

We considered conducting the experiment on a theater stage, allowing real-time person-to-person interaction between the participants, as in the OZ project. However, we expected that issues of stage fright and performance anxiety might prevent the subjects from letting go of their reluctance and inhibitions and from opening up to the experience, especially when sharing responsibility for the story (unlike the interactors in the OZ project, whose choices affected the story but did not drive it). Therefore, we decided to do a text-based version of the experiment in which the participants would use a chat client to communicate. This is also closer to the way people interact with current interactive storytelling systems where typed dialog is often used as input modality, and is justified by the claim of Rowe *et al.* (2007) that the perceived reality of the story and the experience of plausible cognitive and emotional reactions is more important than the perceived absence of a medium.

We adapted a simple Java-based chat client (NFC chat) to support three modes of communication: (1) conversing, (2) emoting and (3) narrating (see figure 5.1). Conversing is the chat equivalent of stage dialogs. Emoting is standard in many chat applications (including IRC) and online RPGs, allowing chatters to make narrator-voice statements preceded by their name, enabling them to take non-dialog action, e.g., “Aaron looks around nervously.” or describe their physical or affective state. The third mode, narrating, allows the participants to use narrator-voice statements that are *not* tied to any particular character (as with emoting), e.g., “It was a stormy night.” The possibility for narrating is something we added; it was not available in any of the chat applications that we could find.

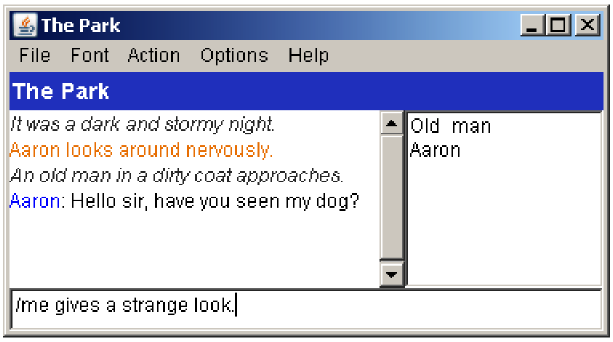

Figure 5.1: Screenshot of the chat client used in the experiment.

5.3.1 Pilot Experiment

Using a chat channel as a medium for improvised interaction is different from performing on stage. We presumed it might introduce unforeseen issues that affect the success of the experiment, especially with improv actors who are used to building stories on stage, where they express their character not only through dialog but also through non-verbal behavior. Therefore we first conducted a pilot experiment to investigate the existence of such issues. We gave the improv actors the task of experimenting with improvising scenes together using the chat client, which led to the following insights:

- The actors found that the medium shifted focus away from ‘doing’ and towards ‘talking’, in other words, they found dialogs to be more prevalent than on stage.
- Because communication of states and events switches from mimetic (showing)

to diegetic (telling) by using the modes of emoting and narrating, there was a tendency to choose dramatic language to describe states or events.

- Improvisation through chat loses some of the spontaneity that is displayed on stage; the chat allows much more time for reflection and revision and the actors regularly reconsidered their ideas by replacing a half-typed sentence by another.
- Offers became a lot more explicit than they would on stage, again because of the diegetic mode of communication which not only forces one to explicitly describe the offer, but also allows one to add an interpretation to the offer. An example from one of the scenes the actors performed is the emoting sentence "John seems unable to find a comfortable place and keeps moving around." On stage, it would be up to the other actors to interpret Johns behavior as an expression of his 'inability to find a comfortable place'. In this case, the actor introducing the offer also supplies part of its interpretation.

The experiments also led to improvements in the functionality of the chat client based on the input of the actors. There was a desire for using different colors for different modes of communication in order to be able to better distinguish between them, and for the ability to change the name of characters played, because the actors wanted the possibility to switch to another character in order to play more than one role per scene, which would normally be filled in by an extra player.

5.3.2 Main Experiment

We hypothesized that out-of-character communication between the improv actors would improve their ability to collaborate in engaging the interactor. There is evidence from studies of adult improvisation theater that professional acting ensembles create more complex plot structures if they are allowed to use out-of-character techniques (Sawyer, 2002a). We also hypothesized that having the actors communicate this way would provide more insight into the negotiation process of dramatic improvisation. Therefore, we placed the actors in the same room and instructed them to use out-of-character communication whenever they felt like it.

The two improv actors were placed in front of a computer in one room, and the subject in front of a computer in another room, so the actors would not see or hear the subject, and vice versa. Using a webcam we recorded the improv actors at play, in order to register any out-of-character communication going on. We did not record the subject, because at this time we were not looking for body language that would indicate feelings of presence, and we did not instruct the subject to think aloud. The logs of the chat were saved, including information about which of the participants introduced narrator voice sentences using the `\tell` command, which is not visible in the chat display. The setup of the experiment can be seen in figure 5.2.

We had three subjects, one male and two female, aged 21, 20 and 35 respectively, and asked them in advance whether they had experience with any kind of RPG, with chatting, with virtual communities such as Second Life, with improv theater (either as spectator or as participant) and whether they enjoyed role playing. Experience with chatting was a prerequisite for joining the experiment.

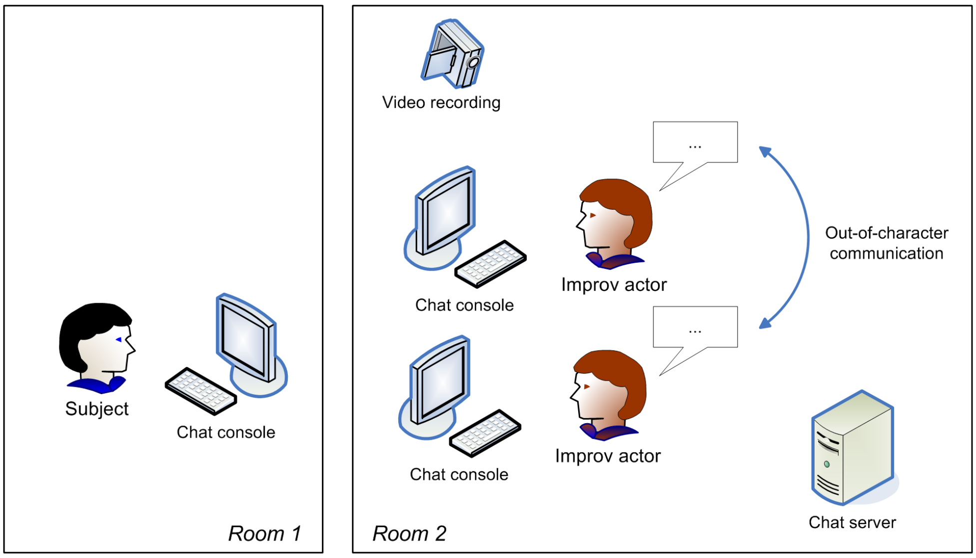

Figure 5.2: Experimental setup.

Each subject played a role in one improvised story. We did not pose a time limit on the participants; each session naturally took between 30 and 45 minutes. We kept the pre-briefing as minimal as possible; we made it clear that the subjects would be chatting with two other people (rather than with a computer program), and told them that they would be entering a storyworld, without giving them a task to achieve. We told them to relax and 'see what happens'. We wanted to avoid them feeling burdened with a task to create a story. The only information given in advance was the location of the starting scene of the story, the rest of the storyworld's reality and events was completely filled in by the participants (i.e., both the actors and the subject).

The experiment was purely exploratory; we did not look for quantitative measures of dramatic presence, nor did we aim for any empirical validation of the narrative presence factors used to assess it. Rather, we were interested in a qualitative analysis of the experience. The improvised nature of the stories made the experiment not only time-consuming (especially for the improv actors) but also highly non-repeatable.

Interview Questions

We were looking for insight into the experience of the participants and into the effort that improv actors had to make in order to turn the experience into an engaging dramatic experience. To this end, we interviewed the subjects after their individual experience. Based on the concept of narrative presence as discussed in section 5.2, we selected criteria for characterizing the experience of participants in the experiment, and used these criteria to establish interview questions. The interview was informal and loosely structured. The questions we used to guide the interview were themed around the following factors that were deemed relevant for this experiment:

- *Identification.* Did the subjects feel like they had to act, or could they 'be themselves'? Could they identify with the role they were playing?

- *Control.* Did the subjects feel guided, directed, forced to make certain choices? Did they feel like they had influence on the story? Could they steer the story in a certain direction? Did they have enough freedom of choice? Did they want more or less control?
- *Consistency.* Were there things that did not make sense?
- *Coherence.* Did events unfold in a logical fashion?
- *Efficacy.* Did they feel like there was an aim that they had to achieve?
- *Believability.* Were they able to understand the other characters' motivations and personality? Did they think the other characters understood what their own character was doing?
- *Curiosity.* Were they curious to see what would happen next, or how the story would end?
- *Affect.* Did they find the experience enjoyable, exciting, boring perhaps?
- *Narrative load.* Was the story understandable? Or was it too complicated, or did too many things happen?

Based on the suggestion of Aylett *et al.* (2006b) to use debriefing for emergent narrative, as a way to reach closure, we expected that the interview would also function as a debriefing. Therefore, we included the improv actors in the interviews as well, hoping that important information about their thought processes would be revealed while they were achieving closure in discussion. We considered this to weigh stronger than the risk that including the actors in the interviews might result in the subjects giving socially desirable answers, reflecting favorably on the actors.

We held a separate interview with the improv actors after all three sessions. We wanted to know more about their perceived task of giving the subject a feeling of dramatic presence:

- Did they have an idea what to do in order to give the subject a feeling of being a character in a story?
- Did they feel like they were able to do this?
- Did the player accept the offers they were giving? How did they deal with the player blocking offers?
- Did they have to use many offers? More than usually perhaps?
- Did they think the subject enjoyed the experience, and why?
- Did stories indeed emerge from the interactions (even though the subject might not have 'worked' to achieve these stories)?
- How much initiative did the players take?

Because the actors were familiar with the terminology of the improv poetics as discussed in section 4.3, we could ask them about the story construction process directly in these terms.

We also analyzed the chat transcripts and the video material, annotating any out-of-character communication between the actors.

5.3.3 Results

This section describes the results of the experiment, by summarizing the stories that were played out, and highlighting particularities that were interesting. It also discusses results from the interviews and other analyses. Names of characters (originally often identical to the names of participants) have been changed to protect the participants' privacy.

First Story

The first story's given location was a forest. The subject was a 21 year old male. He indicated that he had ample experience with RPGs, online chatting, multiplayer online computer games and that he really liked playing a role. He had a little bit of experience with virtual communities and with improvisational theater, both as a participant and as a spectator.

Story description. The subject hides in the shrubbery when a knight in a red cape rides past on a horse. He then encounters a group of angry peasants who turn out to be bald. The peasants explain that the knight in the red cape has shorn off all their hair in an act of revenge because one of the peasants has defeated the knight in a tournament at the castle. The subject agrees to help out the peasants to pursue the knight and take revenge. After the pursuit, the subject and peasants are confronted with the knight. The peasants want revenge but the subject is noble and proposes a peaceful solution where the knight buys each of them a hairpiece.

Observation. The subject seemed a bit rebellious, making out-of-character remarks about inconsistencies ("Weren't you already standing still?"), making jokes ("`\me` laughs like a fat old lady."), challenging and testing the characters' reactions ("I don't want to provoke, but [one of the bald peasants] really deserved it.").

Interview. The subject's main point was that he found very confusing what his influence on the story was supposed to be. He found it a problem that the location "forest" gave him no support to know what kind of forest it was, what kind of storyworld he would be in. He had a feeling that he could do anything, that any problem could be resolved by further endowment of the situation (the subject gave the example that if he were to encounter a locked door, he could blow on a whistle to have a battering-ram appear). He felt that he was playing a game more than experiencing a story, where he would try out things and see what the reactions of the other characters would be (e.g., laughing at the baldness of the peasants). He clearly indicated a need for rules that constrained what he could do. He found it remarkable and perhaps annoying that the actors would sometimes further endow his own character's actions:

> "First I wanted to say 'John wards off the attack but it fails and he gets a sword between his ribs' but that was no longer possible because somebody else already said 'John raises his sword' and I thought, hey, that's not what I'm doing at all!"

> "When I said that my men came out of the shrubbery it was not my intention for them to be the peasants. One of the actors filled that in. Maybe good for the consistency or something, but I thought I had my own band of robbers."

He indicated that the story should be interesting or new enough to go along with it, otherwise it could have gone in a completely different direction. He described his own role to be that of a 'dungeon master within his own dungeon'. He felt like he stood above his role, immune to the consequences he would feel if it were reality. He did however enjoy the creative side of the experience, wondering what he could create and how the other characters would react to his actions.

Second Story

The second story's given location was a bar. The subject was a 20 year old female. She indicated that she had ample experience with online chatting, a little bit of experience with multiplayer online computer games and that she likes playing a role a little bit. She had very little experience with role playing, with virtual communities or with improv theater as a spectator. She had never participated in improv theater.

Story description. The subject and Richard, a detective, are old friends and meet in a bar. The subject tells Richard and the bartender that after her studies, she moved to the Dominican Republic where she met the man of her dreams. This man turned out to be involved in drug deals, and had put 30 kg of coke in her suitcase, causing her imprisonment for the past 15 years. Richard knows this man and the fake names he uses (John, Thomas) from previous investigations and proposes setting up a meeting with him as a trap. Thomas, however, plans a liquidation instead of another coke deal and attempts to shoot the subject before Richard heroically intervenes, engaging in a fight with Thomas and arresting him. In a dramatic ending the subject expresses her anger with Thomas for causing her all this misery.

Observation. Contrary to the advice given by the first subject, it seemed that the actors took *less* control over the story line. After a bit of chit-chat, Richard asks the subject what she's doing nowadays. From this point on, the whole backstory of the Dominican Republic and what happened there, was the subjects' contribution. The subject did not seem short of inspiration and was really dominating the input.

Interview. Unlike the first subject, this subject indicated that she really played out the story as if she were there. She found it an enjoyable story that she could visualize. She felt that she had a lot of influence on the story, that if her answer would be different than expected, it would change the whole course of the story. She was satisfied with the amount of control she had. She didn't feel that at times there was something she was supposed to do. In order to investigate this issue of control further, we asked her what she thought a possible instruction could be that we had given the actors. We intended to find out which aspects of the experience (if any) felt forced or coerced. She indicated it might be that one of them was instructed to be a detective, because it inspired her cocaine story and maybe the role of detective was intended to bring the story in this kind of genre.

The actors commented that they had the feeling that the subject was making the story, and they were going along with it, rather than the other way around. They were struggling for control at times, because it did not automatically become a story (it started as a conversation about places, events and people elsewhere, introducing a massive amount of backstory without anything happening in the scene). Only when the actor playing Richard decided to show the subject photos of Thomas with many different women, proposing to set up a trap for Thomas, did the story return to the 'here and now'.

Third Story

The third story's given location was a beach. The subject was a 35 year old female. She indicated that she had ample experience with online chatting, a little bit of experience with role playing and improv theater as a participant, and has some affinity with role playing. She indicated she has no experience with virtual communities, multiplayer online games, or with improv theater as a spectator.

Story description. The subject's character Annie and her husband Bert are on the beach, happily playing, whereas their son Steven is bored and decides to go into town. Annie and Bert decide to go swimming despite a red flag waving on the beach. The coast guard tries to warn them but is inaudible and some moments of suspense occur when the subject's husband Bert disappears and reappears a few times in the waves and Annie panics. An upcoming storm and Bert's cramp add to the uncomfortable feeling that swimming was a wrong idea. The coast guard comes to the rescue, but then disappears in the waves, replaced by a lot of blood. In a moment of intense helplessness and panic, Steven reappears on the beach and is asked to get help. They are rescued by a boat and then find out that there have indeed been shark reports. Whether they were indeed attacked by a shark or perhaps some other kind of monster was never confirmed.

Observation. This story was a bit different from the other stories in the sense that the perspective of the story became very subjective when the horror increased. After an intensely horrific experience in bad weather where a strange monster kills the coast guard, the actors describe that "...something is roaring in the distance, coming closer rapidly" and that "...a dark shape is moving through the waves." This turns out to be a life-saving rescue boat but this is not known to the subject until the very last moment (she thought it was a shark). This is an experience that would be difficult to achieve on stage. The subject seemed really immersed, expressing in-character panic and staying in character during the whole experiment. Steven dives into the water, delaying his reappearance, causing the subject to fear that he drowned or was attacked by a shark. This suspense device was used several times in the story.

The whole horror theme sprung from the major offer given by the subject that she saw a red flag on the beach. Interestingly, the characters' relationship to each other (Annie and Bert as parents of Steven) was not endowed until the last ten minutes of the story. Up till that point, they could just as well have been a group of friends visiting the beach for a day.

Interview. The subject felt like she was both playing out a role, and immersed in the story. She observed that the actors kept changing roles and considered doing this too, but then decided it was not necessary. She really felt as if she was there in the water and she could really imagine it. The 'shark' (indicated by a chat name consisting of a few vertical lines) really frightened her. She also felt that she had influence on the story, for instance, she was the one starting the story by playing Frisbee. She had a feeling that things were happening continuously and she had to keep on providing input. Just like the second subject, she did not feel like she needed any more or less guidance; the location was enough for the feeling that "something would happen." She found the story logical and understandable and could visualize it well. She said the story could have easily become ten times as long as it did. A little expectation of constraints was implied when the subject mentioned she was not sure whether the characters were allowed to die.

Again we asked the subject what she thought could have been an instruction to the actors. The subject was not sure what this instruction could have been. She did have the feeling that the story was moving in a certain direction (an adventure in dangerous waters) but then realized that this could not have been instructed to the actors as it was *she* who had made the offer that caused this direction (mentioning the red flag on the beach).

She had a lot of fun playing the story. She said she would also have enjoyed it had the story been different. With three people, the story could go in all kinds of directions and she had not thought in advance where it could go. She said she thought to 'plant' a red flag and see if the others would take up the idea and interpret it as a shark theme.

The subject indicated that there were occasional moments where the immersion diminished, for instance when she collapsed after her rescue and it took a while before anyone picked her up. It gave her the feeling that maybe she had to do something to advance the story.

One point of observation was that the subject felt a bit strange about being able to see when an actor changes roles (role changes were announced in the chat). At one point in the story, the actor playing Bert changed roles to play out the "shark", and then switched back. But it was fun from the perspective of creating the story and filling in the details of the roles together:

Bert (B) and Annie (A, the subject) are helplessly floating about in a sea with a scary monster, presumably a shark (indicated by |||||)

B: Ahhh! There it swam again!
[*Actor 1 is now called:* |||||]

|||||: GROWL!

A: [*Annie tries to keep on swimming*]

. . .

[*Actor 1 is now called: Bert*]

A: aaargh

A: Bert, keep on swimming

At the same time the actors indicated they were struggling to decide where the story should go. They had introduced a problem (the dangerous water) but had difficulty deciding how to resolve the problem, since they had at a certain point endowed the beach to be deserted. The subject also felt this: how are we going to save ourselves from this situation? She was however confident that they would be saved eventually, mentioning she thought this to be the actors' responsibility. At a certain point the actors found the story becoming a bit boring because they were in the water all the time and nothing really happened.

The Actors

Observation. In all three stories, the improv actors conferred with each other by (1) discussing story control issues, (2) discussing possible advancing offers, (3) establishing common ground in the interpretation of the participants' intent and (4) expressing out-of-character experience.

Story control discussion took on the form of questions such as "Where is this heading?" and "How does this end?", intertwined with remarks such as "The problem of the story lies outside of the scene now", "Now she's just talking, it has to become a story somehow!" (story 2) and "There is still no relationship between you and Annie" (story 3).

Discussion of advancing offers negotiated a common direction for the story. An example is the remark "We can go in two directions, either go into the coke business or catch Thomas" (story 2). Sometimes more specific advancing offers were proposed, such as: "Shall we see if we can make her transport our drugs?" (story 2).

Examples of establishing common ground: "I had given her a name of that guy." (story 2), "Huh, she thinks I have money?" (story 2), "Haha, she still loves him — now we are going along in *her* story!" (story 2), "I'm waiting for her response...oh, she *wants* to die!" (story 2), "She doesn't dare to go into the water." (story 3).

Examples of expressing out-of-character experience: "Ah damnit, *I* was going to do that!" (story 1), "Yaay, she's doing it!" (story 2), "Haha, she's going to play her own extra character...great!" (story 2), "Alright, there we go! Monster time!" (story 3), "GROWL, haha." (story 3).

Interview. At the end of the experiment, there was a discussion with the actors where they could indicate their experiences with the three stories.

The actors commented on the surprising observation that as a response to the first subject's wish for more constraints, they reacted in subsequent runs by providing *fewer* constraints. They left the initiative more to the subjects, and this seemed to have the effect that participants realized that it was *their* story they were acting out, and that the actors went along in the storyworld of the subject, rather than the other way around. They mentioned this as a possible explanation for the fact that the second and third subjects had no feeling of needing more guidance and reported that it was 'just right'.

They reported that the subjects indeed blocked their offers at times, but they were always able to work their way around it by reinterpreting them as offers. One example from the second story is illustrated here:

> *Richard (*R*) the detective talks with Cindy (*C*, the subject) about her lover who supposedly planted drugs on her, causing her to end up in jail*
>
> R: so be honest with me, I read that investigation about the 30kg coke. Come on, that coke was not your man's, Cindy.
>
> C: excuse me?
>
> . . .
>
> R: [*to barman*] what? I know John. He would never be so stupid to plant coke!
>
> C: That man's name wasn't even John.
>
> R: It wasn't?
>
> C: His name is Thomas. I thought you were doing detective work.
>
> . . .
>
> R: John, Thomas, I lost track of all his names.

Here, Cindy's blocking "excuse me?" and "That man's name wasn't even John" might have been caused by unwillingness to be framed as the villain of the story.

The actors were very aware of their task as managers of the story, and of the offers they were giving to the subject and to each other. They mentioned that this task was not very dissimilar to improv acting, and that they were looking for ways to introduce and resolve conflict. There were times during the experiments that this process went rather effortlessly, whereas at other times they were heavily deliberating and discussing their options, which they mention is different from normal improv acting, where there is typically no time for such deliberation.

Their greatest fun was in seeing how the subjects responded to their offers, especially when it went as predicted, to see that 'it worked'. They had much more difficulty 'predicting' the first subject than the second and third.

5.3.4 Discussion

The experiment described attempted to apply an improvisational theater model to interactive storytelling, having the actors 'aim' the story at a participating interactor rather than at a passive audience, trying to achieve a sense of dramatic presence for the interactor.

The results indicate that there are at least two aspects that made participating in the experiment enjoyable for the subjects: (1) getting a feeling of being in a story, experiencing its events first-hand (i.e., dramatic presence) and (2) being collaborative, creative and explorative, building a story together by providing input to the fictive reality of the story and finding out its consequences.

Unlike in the OZ project, the interactors received a high level of global control over the construction of the story (although they might not have fully realized the extent of their control). The experiment results suggest that despite their lack of experience with improv and with building stories, interactors with this kind of control can still have a highly engaging experience, feeling present in a drama that is unfolding. In this sense, our findings are consistent with that of Kelso *et al.* (1993).

The enjoyment of collaboration and creativity was something that the actors and subjects shared. The actors clearly and explicitly expressed this through their out-of-character reactions to the story unfolding, but this enjoyment is hardly surprising given the fact that they had been pursuing their interest in improv for years. The subjects were less explicit about this, but demonstrated highly collaborative behavior, rarely blocking and proactively and regularly providing input to the story, not only by reacting in-character to the storyworld events, but also by offering, endowing and justifying aspects of the fictive reality. It is possible that their cooperation was partially caused by a desire to be polite, towards both the experimenter and the actors. However, this does not sufficiently explain their proactive attitude. The amount of story input the subjects spontaneously provided suggests that they were intrinsically motivated to co-construct the story.

Because we had given the subjects little to no briefing to base their expectations on, we did not expect the collaborative and proactive in-character behavior that the subjects displayed, and had anticipated a tough job for the actors. From the players' comments about their creative process, we conclude that this is mostly a process of expressing details of their imagination of the reality of the story so far and the associations it evoked, staying within their own 'circle of expectation' in a way that seemed quite natural. This was most explicitly expressed by the first subject (even though he was the least immersed in the fictive reality): "...I was thinking about introducing a bazooka, but then thought I'd better stick to the theme." It is likely that the first subject had strong expectations of play, based on his RPG experience. He was clearly looking for constraints, indicating he expected to play a game offered to him, rather than perform and create a story in collaboration. His remark that he was the 'dungeon master of his own dungeon' was indicative of these expectations. The actors not meeting these expectations might be an explanation for his limited sense of dramatic presence compared to the second and third subject.

A collaborative attitude might indeed be important for this kind of interactive drama; the second and third subjects mentioned without being asked that they imagined that a setup such as used in this experiment only works if the interactor is talkative and responsive. The actors commented that "...the story really becomes better when the players also introduce things; then you're working on the plot together and [this works better than] when you have to drag the player along by yourself."

When the actors went along with the story of the interactor, rather than the other way around, this appeared to cause a heightened sense of dramatic presence (as also hypothesized by the actors). An obvious explanation is that the more initiative is given to the subject, the more the storyworld will reflect the circle of expectation of the subject. If the actors do take the initiative, they should clearly communicate their associations with the given location so as to allow the subjects to easily adapt their expectations. When the actors left the initiative to the interactor, there were no issues of control or constraints as prevalent in the view of agency that relies on the system to provide formal constraints to balance the freedom of the interactor. However, the hypothesis that interactors should be given the initiative needs further exploration. Other factors for the heightened sense of dramatic presence of the second and third subjects might have been the gender differences or the aforementioned RPG expectations.

5.4 Agency in Emergent Narrative

In chapter 4, we discussed the poetics of improvisational theater and made a comparison with the theory of emergent narrative. Based on the experiment described in this chapter, we can now give a somewhat clearer picture of what agency might mean within an emergent narrative environment.

5.4.1 Playing Versus Performing

A panel discussion at the ICIDS 2008 conference considered the notion of agency within storyworlds, partly fueled by the keynote talk by Andrew Stern, who identified a problem with the term "interactive storytelling". If the focus of research in the field is to provide agency, "telling" implies a preconceived notion of something to tell, which is "antithetical to the notion of giving primary control to players to direct the interactive story as they play." (Stern, 2008).

Borrowing terminology from older or related media can cause much confusion indeed. This was also noted by Tanenbaum & Tanenbaum (2008), who argue that the notion of the interactor as *player*, as borrowed from ludology, comes with similar connotations that are problematic for interactive storytelling. Tanenbaum & Tanenbaum (2008) discuss how the role of author and interactor are conceived of when this notion of player is borrowed. There is an assumption that most players in games want unrestricted agency (within the physical and interface constraints offered by the game), and are willing to sacrifice narrative coherence in order to get it. Indeed, "many games are even designed to reinforce this notion, by rewarding actions such as breaking open every crate or destructible object in a room to get power-ups and other ludic incentives." (Tanenbaum & Tanenbaum, 2008).

In the experiment described in section 5.3, we saw that the first subject showed this kind of player mentality, expecting constraints against which he could "win" (for example, he found it problematic that if he were to encounter a locked door, he could blow on a whistle to have a battering-ram appear). In a user experience study of the interactive drama Façade, participants were also facing a mismatch between their expectations, based on games that were familiar to them, and what they were able or supposed to do while playing (Millam, El-Nasr, & Wakkary, 2008).

Seeing and approaching the interactive storytelling system as a computer-mediated *performance*, as Tanenbaum & Tanenbaum (2008) suggest, casts the interactor in a rather different role of *performer*. Interactor(s) and the system engage in a process of co-creation, in which each is collaborative and proactive. Our experiment supports this idea. An active collaboration was evident in the actions of the second and third subjects, who were rather willing to continue on a path of narrative coherence, and did not derive pleasure as much from "winning" or from the unrestricted freedom they were given, as they did from the imagery and fictional world that the story provided and their meaningful interaction with this storyworld.

5.4.2 Consequences for Agency in Emergent Narrative

What is suggested here is a conception of agency that defines meaningful action in terms of how action relates to dramatic performance, caused by it and in itself influencing the course of the subsequent drama. The improvisation experiment showed that such meaningful action can be afforded purely by the formal constraints of role play: by offering appropriate dramatic contexts, and in the absence of expectations of game play, interactors almost automatically started collaborating and cooperating in order to achieve a meaningful drama.

There are three practical consequences of this notion of agency for affording user interaction within emergent narrative. First, there does not have to be a predetermined goal for the interactor (e.g., "go into the water and try to escape from the shark") in order to make actions meaningful. The experiment gave no such goal to the participants. In interactive drama, actions also acquire meaning in retrospect, in relation to consequences of these actions. If the interactor trusts this to happen, then understanding how particular actions affect the story line can be meaningful even if this understanding comes much later. The system does not continuously have to communicate clear formal constraints (i.e., what should you do now to advance the story?). Rather, the system can also strive to make actions meaningful in retrospect.

A second point is that the notion of performance implies that there is a separation of player and character played, rather than the interactor living the fictional world from the perspective of life (Ryan, 2001, p.320). For interactive drama, a direct identification between player and character (i.e., I *am* this character) creates a tension between play and performance: the player that plays an interactive Macbeth does not want to die in a dramatic ending, because from the perspective of life, which sane person *would* want to die? A separation between player and character as in RPGs (i.e., I *play the role of* this character) takes away this problem: the performer's character dying might be the appropriate ending to a beautiful dramatic performance from the performer's point of view. This implies that the interactions of an emergent narrative do not need to be tailored such that the interactor can 'be themselves'. Rather, the expectation of them playing a dramatic role should be enforced; for interesting drama to emerge, they should not only have to, but also *want* to make the dramatically bolder choices.

The third point is that an interactive dramatic performance is closely tied to collaboration and cooperation. Participating in an emergent narrative requires a certain willingness to play within the formal constraints of a role. These formal constraints might be partially defined at the start of an emergent narrative but also establish themselves further during play in the form of *offers*. Through such offers, an emergent narrative establishes a certain cooperative contract with the interactor (Young, 2002b). For instance, if an interactive Little Red Riding Hood character starts at home and mother calls the interactor into the kitchen, this offer intends for the interactor to go over and speak to her. They would not be going along with the offer if they ignored the call and went on their own little exploration. The system should encourage and reinforce cooperation, but I agree with Crawford (2004, pp.209-212) that the system does not have to be able to cater to all kinds of ways in which the story might continue if the interactor does *not* go along (i.e., blocks). If the interactor blocks, the resulting emergent narrative experience might simply be less satisfying, as user involvement is part of the fundamental basis of the concept.

5.4.3 Whose Story Is It Anyway?

As we end the theoretical and conceptual part of this thesis, and prepare to move to the technical part, it is perhaps a good moment to recapitulate what we have learned so far with respect to the title of this thesis: *whose story is it anyway?*

For emergent narrative authoring, we discussed in chapter 3 a co-creation view, where system generativity and authorial intent both are determinants of the end result. Generativity means giving away some of the full control that an author can have over the experience, in ways that might not always be understandable or predictable. Furthermore, with the co-creation view there might not even be *one*, but *many* authors.

For participation in an emergent narrative, we considered the subjective notion of *storification*, where in a VE there is no such thing as 'the story' that the system 'tells'. What the story is depends on whose storification process we consider. In this chapter, we discussed the notions of collaboration and performance, which fit the improvisation model for interactive drama. In light of the terminology discussion, it is perhaps not so much that the interactor becomes the 'author' of his or her own story, but rather that the whole author versus audience or character versus plot distinction disappears. In the decision moments of the play, the participant simultaneously becomes (1) the author, making a 'creative' decision, (2) the performer, acting out this decision and (3) the spectator, wanting to see this decision play out. Or, as Spolin notes, "for both players and audience the gap between watching and participating closes up as subjectivity gives way to communication and becomes objectivity." (Spolin, 1999, p.24). This collapse of author, performer and spectator roles takes away the 'narrative paradox'.

Part III

The Virtual Storyteller

6 The Virtual Storyteller: Story Generation by Simulation

> "There are many other little refinements too, Mr Bohlen. You'll see them all when you study the plans carefully. For example, there's a trick that nearly every writer uses, of inserting at least one long, obscure word into each story. This makes the reader think that the man is very wise and clever. So I have the machine do the same thing. There'll be a whole stack of long words stored away just for this purpose." "Where?" "In the 'word-memory' section," he said, epexegetically.
>
> **Roald Dahl**
> The Great Automatic Grammatizator (1997)

In this chapter, we present *The Virtual Storyteller*, a computer program that generates simple stories using the emergent narrative approach.[1] The Virtual Storyteller was first described in Theune *et al.* (2003); ongoing development was described in Theune, Rensen, op den Akker, Heylen, & Nijholt (2004) and in Swartjes & Theune (2008).

6.1 Introduction

The research aim of The Virtual Storyteller was to gain more insight into the conditions under which stories emerge through character interactions, and into the authoring process of emergent narrative storyworlds. I was interested in the following questions:

(1) To what extent is it possible to develop storyworlds according to the emergent

[1]The Virtual Storyteller is released under the GPL license and can be downloaded from `http://virtstoryteller.sourceforge.net`

narrative approach, whilst going beyond some of the problems associated with its pure character-centric view on narrative?

(2) To what extent can improvisational theater techniques be formalized and put to use to improve the emergent narrative approach?

(3) What are some of the authoring issues of developing such storyworlds? In particular, how does the iterative authoring cycle discussed in chapter 3 hold up in practice?

These questions were explored by building concrete virtual characters and storyworlds. The stories that can reasonably be expected with the emergent narrative approach at this point are likely to be rather limited in scale and complexity.

6.2 Architecture of The Virtual Storyteller

The design of The Virtual Storyteller is based on a classical narratological distinction: that between the events as they really happen in a story and how they are related to the reader. The Russian formalists (e.g., Propp, 1968) called these two perspectives, or layers, the *fabula* and *sjužet*, the French structuralists spoke of *histoire* and *récit*. The decomposition made by Bal (1997) includes a third layer:

Fabula layer. The sequence of events taking place in the storyworld. It consists of the actual events of the story. It is the essential base from which narrative arises and the layer in which concepts such as causality between events exist. Chapter 7 will elaborate on a more formal definition of the fabula as it is used in The Virtual Storyteller.

Story layer. A filtering of the fabula in which only certain parts of the fabula are exposed, using different viewpoints (focalization). The story layer constitutes a narrative structure by organizing the fabula into episodes and relevance of actions. It also encompasses the order in which the events of the fabula are told, making it similar to the meaning of the term *sjužet*.

Text layer. A finite, structured whole in which an agent relates ('tells') a story in a particular medium. Although Bal focuses on *language texts* and therefore considers mainly linguistic signs (i.e. the specific wording and phraseology chosen to tell the story with), the definition of text is sometimes — for instance in the view of Schärfe (2004, pp.19-20), and also in this thesis — extended to encompass non-linguistic signs such as visual images, sound or a combination of these. A story is told by the author to the audience, and the way this is done constitutes a discourse structure. It also reflects the norms and values of the author, saying or suggesting which actions are good and bad, which is a very important part of a story.

Story generation in The Virtual Storyteller happens in two phases. First, a fabula layer is produced in the *simulation phase*, where agents play out their roles of characters in a storyworld. Then, this fabula layer forms the basis for the *presentation phase*, where

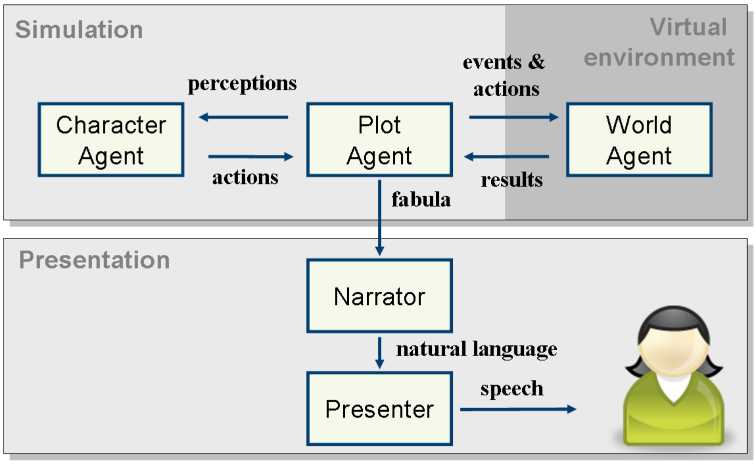

Figure 6.1: Global architecture of The Virtual Storyteller

a story layer is created based on the fabula layer, which is subsequently presented in the form of a narrative text. The primary medium for presentation within The Virtual Storyteller has been natural language, both written (Theune, Hielkema, & Hendriks, 2007a) and spoken (Theune, Meijs, Heylen, & Ordelman, 2006). Figure 6.1 shows the story generation process where the presentation phase has been instantiated with natural language text production using the *Narrator* (Theune, Slabbers, & Hielkema, 2007b) and a *Presenter* that uses text-to-speech and facial animation to create the illusion of an embodied storyteller.

6.2.1 The Simulation Layer

Here, I discuss the simulation layer of The Virtual Storyteller from an architectural perspective. The goal of the simulation subsystem of The Virtual Storyteller is to simulate a virtual world with virtual characters in order to produce interesting fabulae. I will call this a *storyworld simulation*. The relevant design choices for the implementation of the agents for a storyworld simulation will be discussed in chapter 8.

The simulation layer of The Virtual Storyteller is comprised of a Multi-Agent System (MAS) based on the Java Agent Development Environment (JADE). JADE provides a platform for implementing Java-based agents, and handles all inter-agent communication in the form of FIPA Agent Communication Language (ACL) messages. Each JADE agent runs in a separate Java process. The agents in the simulation layer use SWI-Prolog for some of their knowledge representation and reasoning processes, such as action planning.

The Plot Agent takes the lead in setting up the storyworld simulation, similar to the Story Facilitator used in FearNot! and I-Shadows (see chapter 3). The Plot Agent contracts a World Agent to act as a bookkeeper of the storyworld representation. The World Agent manages a knowledge representation of the current state of the storyworld, and performs scheduling and execution of actions and events that change this state. In setting up the storyworld simulation, the Plot Agent also recruits Character Agents to play a role in the storyworld simulation.

From this point on, the simulation happens in rounds, again coordinated by the

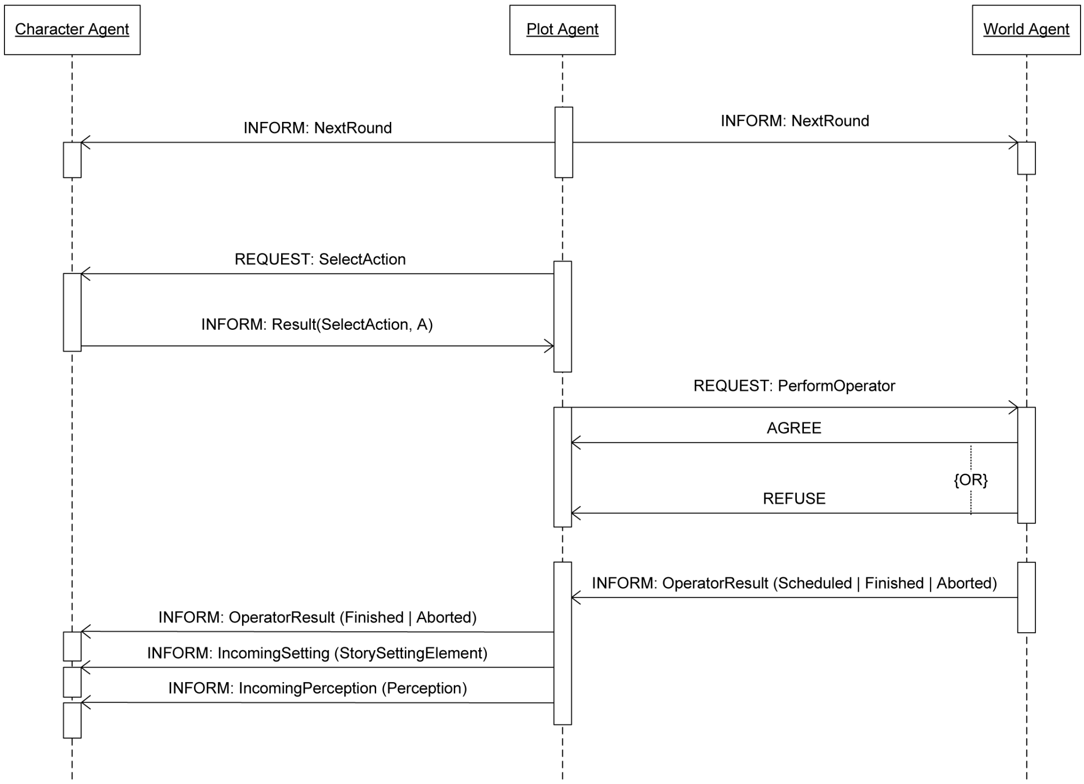

Figure 6.2: Sequence diagram for one round of the simulation.

Plot Agent. Each round, the Plot Agent requests all Character Agents to select an action they want to perform, and sends back perceptions based on changes in the virtual world. The choice for a round-based setup takes away some of the autonomy of the Character Agents, but not in any fundamental way; the reason is that it allows for easy step-through of the simulation, and reduces the number of deliberation cycles for the Character Agents to one per round. See figure 6.2 for the sequence diagram of one simulation round, showing the message flow between agents.

The Character Agents are implemented based on the FAtiMA agent architecture used in the FearNot! system.[2]. As in FAtiMA, a Character Agent uses appraisal and coping to deal with its environment, both on a quick and direct reactive level, and on a slower but more planful deliberative level. The most notable difference from FAtiMA is that in addition to this character-level cognitive processing, the Character Agents also have an actor-level perspective on the storyworld simulation to affect its course of events. This aspect will be treated in chapter 8.

6.2.2 The Fabula

The result of running a storyworld simulation is the production of a fabula, a sequence of events that is temporally and logically ordered. As the system logs what happened and why, it creates an 'understanding' of the story. This places an extra requirement on

[2]Currently, the FAtiMA architecture has been released under the GPL license and can be downloaded from `http://www.e-circus.org/` At the time of developing The Virtual Storyteller, the source code of FAtiMA was not yet released.

the agent architecture, namely that it is able to explain the causality of its decisions. This is the challenge of *Explainable AI* (Johnson, 1994; Core, Lane, van Lent, Gomboc, Solomon, & Rosenberg, 2006). What these events are, and in what way they are temporally and causally ordered, will be elaborated on in chapter 7.

6.2.3 The Presentation Layer

The fabula forms the basis for the presentation of a story in some sort of narrative text. Where the primary focus within The Virtual Storyteller project has been on presentation by means of natural language generation, using a piece of software called the Narrator (Theune *et al.*, 2007a,b), there have also been experiments with dramatized speech synthesis for oral storytelling (Theune *et al.*, 2006), with producing simple animations based on the fabula, and with generating cartoons. An overview of these experiments will be given in section 7.4.

6.2.4 Knowledge Representation in The Virtual Storyteller

To prepare for examples given in chapters 7 and 8, we here briefly discuss how facts about the storyworld and fabula knowledge are represented in The Virtual Storyteller.

As a knowledge representation formalism, we use the Resource Description Framework (RDF) (Beckett, 2004) and the Web Ontology Language (OWL), specifically its OWL-DL dialect, which is based on Description Logics (McGuinness & van Harmelen, 2004). RDF and OWL, both W3C standards, are often used in the context of the Semantic Web. They provide clear formal semantics and are well-supported in terms of authoring tools (e.g., the *Protégé* ontology editor) and reasoning engines (both in Java, e.g., Jena and in Prolog, e.g., SWI-Prolog). We found these concerns advantageous for authoring the complex knowledge required for The Virtual Storyteller. For similar reasons, Peinado & Gervás (2006) used RDF and OWL for a re-implementation of the MINSTREL story generator, which was originally developed in Lisp.

In RDF, knowledge is expressed in triples of the form $< S, P, O >$, where P is a predicate that relates a subject S to an object O. Each of the elements S, P and O is represented by a Uniform Resource Identifier (URI) (O may also be a literal), or its shorthand using an XML namespace notation. For example, the triple <`ps:anne_bonney`, `rdf:type`, `ps:Pirate`> represents the fact that Anne Bonney is a pirate. In this triple, the predicate `rdf:type` is shorthand for the URI `http://www.w3.org/1999/02/22-rdf-syntax-ns#type`.

OWL is an ontology language, giving formal semantics to resources and properties defined in RDF. We use OWL to specify an ontology of *Classes*, which can be distinguished from *Individuals*, which are instances of one or more Classes. For instance, `ps:anne_bonney` is an Individual belonging to the `ps:Pirate` Class.

The Virtual Storyteller makes use of a number of OWL ontologies:

- The *Storyworld Core* upper ontology for the storyworld simulation knowledge (prefix: `swc`) which contains the classes, properties and relationships that are relatively independent of the particular story domain, such as the `swc:Object` and `swc:Role` classes and the `at` relationship.

- The *Fabula* upper ontology for the fabula knowledge (prefix: `fabula`) that has the top-level classes of fabula elements, such as Actions (`fabula:Action`), and properties that define causal relationships, such as `fabula:motivates`. The elements of this ontology will be discussed in chapter 7.
- One or more domain-specific ontologies that determine further subclasses of the *Storyworld Core* or *fabula* ontologies. For instance, the *Pirates Setting* ontology (prefix: `ps`) used in the example setting of figure 8.1 in chapter 8 contains the class `ps:Pirate`, which is a subclass of `swc:Role`, and the specific goal `ps:DrinkRum`, which is a subclass of `fabula:AttainGoal`.
- Presentation-specific ontologies, containing for instance classes and properties for specifying a lexicon and common sense rules for natural language generation (e.g., the information that ships typically have one deck is used by the Narrator to refer to *the* deck of the ship, instead of *a* deck of the ship).

6.2.5 Limitations and Assumptions

In the design of The Virtual Storyteller, a couple of assumptions were made in order to limit the scope of problems to be addressed.

Story Generation

The Virtual Storyteller is a story generator based on the emergent narrative approach. The reason for adopting the emergent narrative approach for The Virtual Storyteller is not that it is considered the best one for generating stories. Indeed, if the goal is to make a good story generator, it is important to also include author-centric knowledge, and search algorithms which can operate in a nonlinear fashion and without search time constraints, as was the case in systems like MINSTREL (Turner, 1994), UNIVERSE (Lebowitz, 1985) and FABULIST (Riedl, 2004). TALE-SPIN is often criticized for a lack of such author-centric knowledge (Wardrip-Fruin, 2006, p.273). Rather, the choice for emergent narrative was made to investigate possibilities and limits of the approach, keeping in mind the potential for an interactive application in virtual environments.

User Interaction

Because the Virtual Storyteller is currently not interactive, the scope of the research issues was limited to a setup with virtual characters only. Research challenges associated with providing an interface for a human participant to enter the virtual world, such as natural language understanding and behavior recognition, were excluded. The emergent narrative approach to interactive storytelling remains methodologically relatively free from the question whether it is dealing with virtual characters or human participants. Although the virtual characters might have a different role in emergent narrative from that of human interactors, who might not employ the same story creation techniques or even share a level of responsibility for the story equal to that of the virtual characters, both at least retain their autonomy. Chapter 8 will further treat the argument that this autonomy necessitates forms of drama management that do not rely on directives and coerced cooperation of the characters. As such, The Virtual Storyteller is *compatible* with interactive drama, but is not considered to *be* an interactive drama system.

Visualization

Most AI-based interactive drama systems use a 3D graphical environment for the dramatic representation. Many have used existing game engines for simulation and visualization purposes (e.g., Young, 2002a; Cavazza *et al.*, 2002; Mott & Lester, 2006); some have built a custom visualization engine (e.g., Fairclough, 2004; Aylett *et al.*, 2006c). Unlike these projects, I do not use a 3D graphical environment (e.g., a game engine). Instead, the emergence of stories is investigated based on two forms of presentations: (1) the output from the presentation layer, a narrative text retelling the emerged event sequence *after* the simulation, and (2) run-time feedback from the system, including a direct textual representation of the events as they occur, as in the example of figure 6.3.

This limitation allows for refraining from certain design considerations that arise when a graphical virtual environment is used. Examples are the timing of actions, positioning of characters and other mimetic concerns such as facial expressions, body language and action animations. These considerations may interfere with some of the chosen design solutions, but the assumption is that these will not be fundamental. It has been demonstrated that — at least to a certain extent — a separation of concerns can be made between the minds of the agents (their cognitive representation of the virtual world), and their embodiment in the virtual world (representing the level at which visualization issues occur). This distinction between mind and body has also been made in other projects (e.g., Hayes-Roth & van Gent, 1997; Prada *et al.*, 2000; Klesen *et al.*, 2001). If a game engine is being used, this requires an integration of the differences in world state representations of the engine and of the AI, which can be accomplished using a translation interface (Riedl, 2005).

6.3 Earlier Work on The Virtual Storyteller

The work on The Virtual Storyteller presented in this and the following chapters builds on the approach taken within the Human Media Interaction group of the University of Twente. From the initial version onward, one of the main goals has been to explore automatic plot generation using characters as intelligent agents (Theune *et al.*, 2003). These intelligent agents were implemented first as simple goal-directed agents that used backward chaining of rules in order to find ways to achieve these goals, and were later extended with emotions (Theune *et al.*, 2004), based on the OCC model of event appraisal (Ortony *et al.*, 1988). The emotions sometimes led characters to behave irrationally; for instance, a cowardly hero with the episodic goal of killing the villain could be equally likely to adopt the goal of running away from the villain because of its fear.

A sample scenario of the emotion-based version of The Virtual Storyteller can be seen in figure 6.3. It features two characters that hate each other: Amalia, a fearful princess and Brutus, an aggressive villain. These characters are given episodic goals:

(...) Amalia walked to the forest. Brutus walked to the plains. Amalia picked up the sword. Brutus walked to the desert. Amalia walked to the desert. Brutus was afraid of Amalia because Brutus saw that Amalia had the sword. Brutus hit Amalia. Amalia was afraid of Brutus because Amalia saw Brutus. Amalia walked to the forest. Brutus was afraid of Amalia because Brutus saw that Amalia had the sword. Brutus walked to the forest. Amalia stabbed the villain. And she lived happily ever after!!!

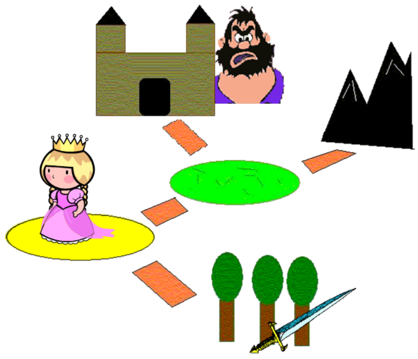

Figure 6.3: Topology of the Brutus and Amalia storyworld, and a sample story output. A variation of the story is possible, in which Amalia does *not* stab Brutus, either because she never took the sword or because she is too afraid. In this variation, Brutus captures and imprisons Amalia in his castle.

Brutus wants to capture Amalia while Amalia wants to kill Brutus. In most simulation runs, the characters immediately start pursuing their episodic goals: Brutus starts walking towards Amalia to capture her, while she sets out to get the sword needed to kill Brutus. In addition to these episodic goals, the characters have emotionally motivated goals such as singing out of joy, or screaming out of fear, that they sometimes adopt when the respective emotions are high enough.

To achieve well-formed plots, a director agent (which we later termed the plot agent) was used to take on this responsibility. To achieve this, it used proscriptive control: characters had to get permission from the director to perform selected actions.

We learned three lessons from this version:

(1) Proscriptive control violates character autonomy and can threaten the believability of the characters. A character action that is not carried out despite being obvious (for instance, Amalia running away from Brutus), should have a reason for not being carried out. For instance, the action fails (Brutus stops her before she can escape) or there is an alternative, more or less equally salient action (stabbing Brutus, or being paralyzed with fear). The issue of controlling autonomous characters will be further explored in section 8.3.

(2) The stories produced depend to a large extent on the setup of the storyworld. Most notably, the outcome of the sample story depended on whether Amalia obtained the sword in time, and this depended strongly on where the sword was initially placed. Furthermore, the topology of the storyworld had to be defined in such a way that Amalia and Brutus had a high likelihood of meeting. Section 8.4 presents a technique where the initial state of the storyworld can be determined dynamically, as an alternative way to influence autonomous character behavior for plot-centric considerations.

(3) The expression of the story in natural language remains limited when the events are being told as they occur, reducing the story to a chronological list of actions. It misses at least proper expression of the inner motivations of characters (e.g., Amalia walked to the forest *to look for the sword*) and the ability to determine which events are relevant and interesting to tell, and in which order. The narrator could benefit from a model of the fabula that is more sophisticated than a simple list of events. Such a model is presented in chapter 7.

6.4 Overview of the Following Chapters

The following chapters focus on specific parts of The Virtual Storyteller. First, chapter 7 presents a formal model of the fabula layer, based on the causal network theory of Trabasso *et al.* (1989), and illustrates how the fabula layer is used as a basis for the creation of a text in the presentation phase. Then, chapter 8 focuses on the simulation layer, in particular on the design of the Character Agents. An argument is made for the integration of actor-level and character-level concerns within one agent to support narrative control, as proposed in chapter 4. Finally, chapter 9 discusses the authoring process for two small sample storyworlds, and illustrates in detail how the system operates by means of sample event traces of storyworld simulations within these domains.

7

The Fabula Model and the Presentation Layer

> "You see there is only one constant. One universal. It is the only real truth. Causality. Action, reaction. Cause and effect. We are all victims of causality. I drank too much wine, I must take a piss. Cause and effect. Au revoir."
>
> **Merovingian**
> The Matrix Reloaded (2003)

In chapter 6, a distinction was made between three layers in the consideration of narrative: the *fabula* layer, the *story* layer and the *text* layer. This chapter presents a formal model for the representation of the fabula layer. The fabula layer is generated by The Virtual Storyteller in the simulation phase and serves as an intermediary representation for the presentation phase, in which the fabula is used to produce a narrative text. Parts of this work were published in Swartjes & Theune (2006, 2008).

7.1 Introduction

The first step in the method of story generation used in The Virtual Storyteller is the production of an interesting fabula. A fabula is the result of a storyworld simulation, and contains the entire set of events that occur in the simulation, generated by recording these events and their relations during the simulation.

The aim of this chapter is to arrive at a formulation of a formal model of the fabula of an emergent narrative simulation. As a starting point, Bal's definition of *fabula* as "a series of logically and chronologically related events" is used. Events, in this definition, form "the transition from one state to another state, caused or experienced by actors." (Bal, 1997, p.182).

7.1.1 Reasons for Modeling the Fabula

There are several reasons why having an explicit fabula model is considered desirable for The Virtual Storyteller. The first reason concerns the presentation layer, aiming to produce a narrative text from the events. In order to do this, one should be afforded the opportunity to reason about the events that occur, in a way similar to an author or reader who is given the task to retell the events of the storyworld simulation. A simple enumeration of events is not enough, as becomes clear from the example of figure 6.3 and from the output of TALE-SPIN's natural language generation component MUMBLE (see figure 2.8 in chapter 2 and figure 3.13 in chapter 3). An explicit temporal and logical ordering of events forms a first step towards better narrative text generation; this way, the fabula can be considered as a whole and this moves away from telling the events as they occur. The fabula model serves as an intermediary representation so the simulation phase can be decoupled from the presentation phase.

A second reason concerns the simulation layer, aiming to produce an *interesting* fabula. The hypothesis is that if The Virtual Storyteller can model its own understanding of the emerging fabula, it can make more informed decisions on how it can develop further in the simulation phase. The model can serve as a long-term context for character behavior. As characters can know parts of the fabula, they can use this as an *autobiographical memory* (Dias, Ho, Vogt, Beeckman, Paiva, & André, 2007), giving long-term narrative context to the dramatic choices at hand. The model can also serve as a basis for 'interestingness' heuristics that influence story progression, for instance, increasing causal coherence. By making the logical and temporal relationships between fabula elements explicit, the system is afforded to analyze the fabula for 'storiness'.

A third reason also concerns the simulation layer and is a practical one: a taxonomy of types of events and logical relations can serve as a constraint on the aspects that must be modeled for virtual characters that should 'produce' these events and relations.

7.1.2 Story Comprehension and the Causal Network Theory

For further defining the fabula, I draw from story comprehension research in order to make a characterization of 'events' and their logical ordering. Story comprehension theory provides a human cognitive focus on narrative and clarifies how narratives will be *understood*. If an articulation of the events and their logical ordering is based on a story comprehension model, it forms a model of what Mateas (2001b) calls the *interpretive affordances* of the system, and can inform decisions for both the simulation and presentation layers.

Story comprehension research aims at understanding how people understand stories, and which factors contribute to this understanding. Theory formation is usually supported by using memory-based measures, such as importance of events, summarization, recall and question answering (Trabasso *et al.*, 1982; Trabasso & van den Broek, 1985). Importance of events assumes that people can judge the importance of certain events in comparison to others; the difference in indicated importance says something about the understanding of these events. Recall makes use of memory as a measure for understanding (Mandler & Johnson, 1977; Trabasso & van den Broek, 1985); the assumption underlying this measure is that more important story events are more likely to be recalled. Summarization tells us something about the importance of events as well; events that end up in the summary are likely to be more important. The answering of questions about the why, how and when of events directly addresses story understanding structures based on causality and temporality (Graesser, Lang, & Roberts, 1991).

An influential theory has been the *causal network theory* of story comprehension, in which the general idea is that people connect story events in a causal network, and that an event's causal connections to other events can be used as the main predictor of its importance in the story (Trabasso *et al.*, 1982; Trabasso & van den Broek, 1985; Trabasso *et al.*, 1989; Trabasso & Nickels, 1992). This theory was applied to experiments in the narration of picture stories (Trabasso & Nickels, 1992). Children and adults were asked to narrate the events that they inferred to be happening in a sequence of pictures, and the clauses that these children used were categorized using clause category types to expose the underlying narrative structure. This revealed three stages in the development of story comprehension. Very young children comprehend a story as a sequence of isolated states and actions, whereas at a later age, they can identify a temporal ordering. This can be witnessed when children tell about their experiences: "And then this happened and then that happened and then...". Eventually, children learn to identify and express causal relationships between goals, actions and outcomes, developing into a full hierarchical ordering of episodes that comprises coherent stories.

That causality plays an important role is also evident in MAKEBELIEVE (Liu & Singh, 2002), a story generator based solely on common sense knowledge. Part of this knowledge is causal, for instance, the knowledge that if one commits a crime, one goes to prison. In MAKEBELIEVE, this kind of knowledge is used to generate causal chains that resemble narratives, such as the following:

> *John became very lazy at work. John lost his job. John decided to get drunk. He started to commit crimes. John went to prison. He experienced bruises. John cried. He looked at himself differently.*

With the little semantic knowledge of the individual events that MAKEBELIEVE possesses, it is interesting to see the important role of causality in the construction and comprehension of narrative.

The causal network model of Trabasso and his colleagues is a transition model in which nodes represent the narrative clauses of a story, categorized according to one of six types (Setting, Event, Internal Response, Goal, Attempt and Outcome), and the arcs represent causal relationships between these clauses: physical (ϕ) and psychological (ψ) causality, motivation (m) and enablement (e) (Trabasso *et al.*, 1989). These story elements and their causal relationships form implicit hierarchical episodic structures of the story. The basis for each episode is formed by a causally related Goal, Attempt, and Outcome. Goals set expectations, Outcomes affirm or deny them.

7.2 The Fabula Model

In Bal's definition, the fabula contains the entire set of events that actually occurred, organized by a certain temporal and logical ordering. The causal network theory of Trabasso and his colleagues provides a useful definition of 'logical ordering': events

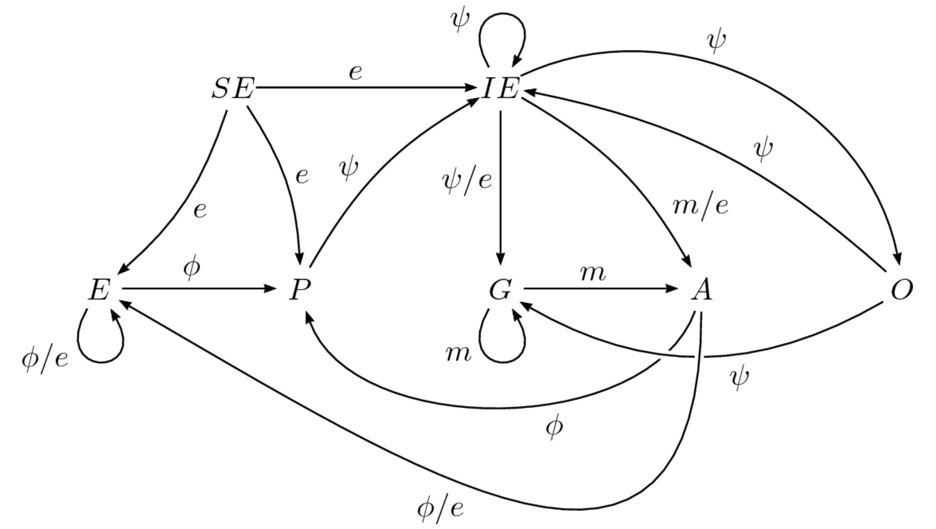

Figure 7.1: Fabula model for story generation. The arrows represent *possible* causal relationships between the elements of the fabula.

appear to the reader as causally related. The conceptual framework established by Trabasso & van den Broek assumes, like a number of related frameworks, that people employ world knowledge about cause and effect in order to understand an event in a narrative, and in particular that they employ naive theories of physical and psychological causation, that is, folk psychology and physics, in order to construct a coherent interpretation of the events as they unfold in the story (Trabasso & van den Broek, 1985). It comes as no surprise then, that the classification of clauses they propose has a strong correspondence with the BDI paradigm in AI research, which is itself based on folk psychology.

The formalization of a fabula proposed here is based on Trabasso's model:

Definition 7.1 (fabula). *A fabula is a quadruple $< \mathcal{F}, \mathcal{C}, \mathcal{T}, \mathcal{D} >$. $\mathcal{F}$ is a set of fabula elements, each of a type $\tau \in \{SE, E, P, IE, G, A, O\}$. $\mathcal{C}$ is a set of causal relationships between fabula elements of the form $f_1 \stackrel{c}{\rightarrow} f_2$, where $f_1, f_2 \in \mathcal{F}; c \in \{\phi, \psi, m, e\}$. $\mathcal{T}$ is a set of temporal annotations to elements of $\mathcal{F}$. $\mathcal{D}$ is a set of descriptive annotations to elements of $\mathcal{F}$ that describe their contents, and may recursively contain fabulae.*

Appending this definition, there are restrictions on how fabula elements are causally connected. These restrictions are graphically represented in figure 7.1. It shows all *possible* causal relations between fabula elements. The meaning of the different fabula elements and their causal relations will be explained further on.

The fabula model differs in some aspects from Trabasso's model. One of the main differences is that the fabula model we propose attempts to capture the fabula in a single (objective) network, so we can speak of *the* fabula, or *the* actual course of events. In Trabasso's model, a separate network is constructed from the (subjective) viewpoint of each character in the story. For instance, something that is an Action for one character can be an Event for another. This points to an important difference from the subjective, first-person perspective in emergent narrative as discussed in chapter 3. For our story generation purposes, we take a global, omniscient perspective, modeling as it were the storification of an external observer. Perspective taking (focalization) is considered to be a concern for the presentation layer.

7.2.1 Fabula Element Types

Our fabula model defines causal relationships between seven types of elements: Setting Elements, Goals, Actions, Outcomes, Events, Perceptions and Internal Elements. Before we discuss these causal relationships, let us first take a look at the elements themselves, and discuss their differences from Trabasso's model.

Setting Element (SE) A Setting Element describes a part of the setting of a story, the state of the storyworld as it was before the course of events of the fabula occurred.

Goal (G). A Goal is the main drive for a character to act. We adopt the definition used in Trabasso's model; a Goal in this context describes a desire to attain, maintain, leave or avoid certain states, activities or objects (Trabasso *et al.*, 1989).

Action (A). The term Action is used to indicate a goal-driven, intentional world change brought about by a character. Trabasso's model uses the term Attempt, which from a planning perspective can be seen as a series of Actions that constitute a plan. We use Actions directly since the individual Actions in an Attempt can have separate effects (e.g., an Action can be perceived or cause an Event).

Outcome (O). Trabasso's model categorizes clauses as Outcomes when they indicate goal attainment. In our fabula model, Outcomes are always a subjective, mental property: when a character believes that its Goal is fulfilled, the Goal has a positive Outcome, but if the character believes that the performed Actions did not succeed in fulfilling the Goal, the Outcome is negative. The Outcome thus relates to the world as the character believes it to be, not necessarily to the world as it actually is. This makes interesting dramatic situations possible. For instance, in the story of Romeo and Juliet, Juliet pretends to be dead. Romeo however thinks Juliet is *really* dead, which is a very negative Outcome for his Goal to be together with her.

Event (E). From the subjective character perspective in Trabasso's model, an Event is anything that evokes a response from a character, and in this sense an Action of one character can be an Event for another. From the global perspective of our fabula model, however, an Event is defined as anything that happens in the world that is not directly and intentionally performed by a character, e.g., a tree that falls down, or a twig that breaks when a character steps on it.

Perception (P). Perceptions are understandably lacking in Trabasso's model since the presence of an element in the character's personal network implies that it has been perceived by that character. However, when adopting a global fabula perspective, the explicit notion of Perception is important because the Character Agents do not necessarily perceive everything that happens in the storyworld.

Internal Element (IE). Anything that happens within the mind of a character, such as cognitions, emotions, feelings and beliefs, is considered to be an Internal Element. We use the term 'Internal Element' instead of 'Internal Response' as used in Trabasso's model, because the word 'response' suggests a cause even though there isn't always one, at least not at the level of abstraction we intend to use.

The model has been implemented as an OWL ontology; the aforementioned elements are only the top elements of a more extensive subsumption hierarchy. For instance, Goal subsumes AttainGoal and AvoidGoal, Internal Element subsumes BeliefElement and Emotion, and Perception subsumes See and Hear. Furthermore, properties are available for each element that allow for the expression of knowledge about which Character Agent originated or experienced the fabula element, and the time at which the element occurred (in terms of discrete time steps in the storyworld). This enables a temporal ordering of the elements.

7.2.2 Causal Connection Types

Following Trabasso *et al.* (1989), we distinguish four types of causality that are used to connect the fabula elements: physical causality (ϕ), psychological causality (ψ), motivation (m) and enablement (e). These types differ in causal strength (Tapiero, Van den Broek, & Quintana, 2002), physical causality being the strongest, followed by motivation, psychological causation and enablement. This difference in causal strength can be reflected in the presentation generated, i.e., stronger causal relationships might need less explicit wording.

Physical Causality (ϕ)

When an Event or Action causes something else in the storyworld to happen, this causality is physical. This is the strongest form of causality and might not need to be made explicit in the presentation of the story. In fact, this causality is often so strong that it is difficult for a reader *not* to infer it, even when unstated. Take for instance the two Actions *John fired his gun* and *Peter died*. Most readers presented with these successive events would infer that John shot Peter, but this is not stated explicitly and other explanations are very well possible. There are three cases where physical causality applies:

(1) Actions physically cause Events. For instance, when a knight stabs a dragon with a sword, this can physically cause the dragon to die. This can also be used as a way to model the occurrence of non-standard results: when the knight crosses a small bridge, it can cause the bridge to collapse.

(2) Events physically cause other Events. For instance, a tree that falls on a bridge causes the bridge to collapse. Or Sleeping Beauty pricking herself on the spinning wheel (an unintended action, thus an Event) causes her to fall asleep.

(3) Events and Actions physically cause Perceptions. When a character perceives either the Events or Actions themselves, or their results, such Perceptions are physically caused by the Events and Actions.

Motivation (m)

Motivation (m) is an intentional causality, originating within the Character Agents' minds. Wanting to kill the monster can motivate the knight to stab it with a sword. Motivation relates to Riedl's definition of character believability (Riedl, 2004), i.e., that the events in a story are reasonably motivated by the beliefs, desires and goals of the characters that participate in the events. Again, there are three cases:

(1) Goals motivate other Goals. A Goal G_1 motivates another Goal G_2 when G_2 is a subgoal of G_1. For instance, a knight's Goal to kill a dragon could motivate a subgoal of finding the dragon.

(2) Goals motivate Actions. Using a planning algorithm ensures that the planned Actions are driven by one or more (motivating) Goals. Each Action from the generated plan will be motivated by the Goal for which the plan was made.

(3) Internal Elements motivate Actions. Actions that are causally connected to Internal Elements are 'reflex-like' reactive Actions like crying and screaming, that are directly caused by an Internal Element and not by a strategic attempt to fulfill a Goal.

Psychological Causality (ψ)

Psychological causality (ψ) takes place within the mind of the characters. For instance, if a knight believes that a dragon is going to kill him, this psychologically causes fear. Psychological causality represents causality on the level of the cognitive processes of the character. The difference from motivation is that psychological causality is not intentional. A causal chain of event appraisal can be identified where perceptions lead to Goals: (1) Perceptions psychologically cause Internal Elements, e.g., beliefs; (2) Internal Elements (beliefs) psychologically cause other Internal Elements (e.g., emotions, or further beliefs); (3) Internal Elements psychologically cause Goals. This implies that the Character Agent needs a way to determine Goals based on its beliefs and emotions.

Psychological causality also applies to Outcomes, since the Outcome is a mental concept. Internal Elements psychologically cause Outcomes when a Character Agent believes that a Goal failed or succeeded: a positive Outcome when a Goal is considered attained and a negative one when achievement of the Goal is considered to have failed. When a character no longer wants to achieve the Goal, this will lead to a neutral Outcome. Outcomes can in turn psychologically cause Goals or Internal Elements. Positive Outcomes may lead to positive emotions; negative Outcomes may lead to negative emotions and possibly the reinstatement of the failed Goal.

Enablement (e)

Enablement (e) is the weakest form of causality. If a fabula element A enables another fabula element B, this means that A is necessary for B, but not sufficient to explain the occurrence of B. An obvious formalization of enablement is that the effects of A satisfy preconditions of B. In the case of an Internal Element enabling an Action, the requirement would be that the Internal Element is a belief and the contents of that belief satisfy preconditions of the Action.

Note that the model does not include Actions enabling other Actions. Because Actions are consciously planned by the characters (except if they are directly caused by emotions, without any deliberation) they can only be enabled by beliefs. For instance, killing a rabbit does not enable eating the rabbit until the character sees and believes that the rabbit is indeed dead. This restriction does not apply to Events enabling other Events. Note also that as a consequence, Events can only occur if their preconditions are truly met within the storyworld, whereas a character may be mistaken about the preconditions of an Action being met, and may try to pursue it anyway.

Our model subsumes the fabula model used by the Liquid Narrative group of Michael Young, who use the representation of a partial-order, causal link (POCL) plan as a fabula model (Riedl, 2004, pp.48-49). Such a plan consists of a set of operators, a set of temporal orderings between these operators, and a set of causal links between them. If the operators represent story events, a POCL plan adheres to Bal's definition of a fabula. However, it should be noted that causal links in a POCL plan typically only represent enablement (e) relationships. The IPOCL planner created for FABULIST (Riedl, 2004, p.73) produces a more expressive fabula representation: IPOCL plans extend POCL plans with *frames of commitment*, which are essentially character goal representations. The IPOCL representation links such frames of commitment to sets of actions that are purported to be motivated by this goal by means of an *interval of intentionality*. These links can be seen as motivation (m) relationships.

7.3 Recording the Fabula of a Storyworld Simulation

During the storyworld simulation, The Virtual Storyteller gradually constructs a fabula by recording what happens in the simulation. This recording is done by both the Plot Agent and the Character Agents, and the knowledge is stored centrally by the Plot Agent. At any time during the simulation, the user can request the Plot Agent to save the fabula generated so far in a file. This file contains a knowledge representation of the fabula in the form of a set of RDF Named Graphs (Carroll, Bizer, Hayes, & Stickler, 2005). An RDF Named Graph is identified by an RDF resource URI, and contains a collection of RDF triples. The main graph contains triples that describe the fabula elements and causal relations between them. All other Named Graphs describe the contents of fabula elements that they are linked to by means of the predicate `fabula:hasContent`. See figure 7.3 for a small fragment of a fabula generated by The Virtual Storyteller in a story domain about pirates. This fabula is graphically shown in figure 7.2; a sample narration of the fabula can be seen in figure 7.4

7.3.1 Recording Fabula Elements

During the storyworld simulation, the task of generating fabula elements is shared between the Plot Agent and the Character Agents. Each fabula element is an instance of one of the seven element types described in section 7.2.1, and identified by an RDF resource. For instance, in figure 7.3, the RDF resource `<#iAction_billyBones_28>` represents an instance of `ps:OpenDoor`, a subclass of Action (A).

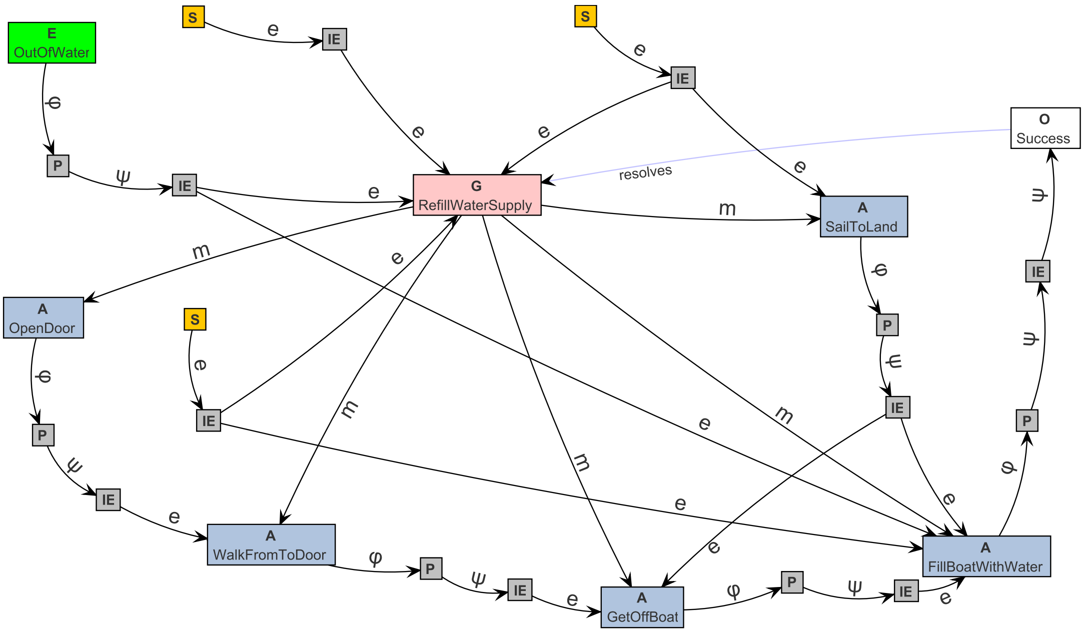

Figure 7.2: Sample fabula produced by The Virtual Storyteller in the Pirates domain.

For four of the fabula element types (IE, G, A and O), instances are created by the Character Agent as a result of the character's internal processing. For example, when a new belief is asserted in the agent's memory, a *Belief Element* (BE, a subclass of IE) instance is also created and sent to the Plot Agent. Similarly, when an agent adopts goals and selects actions, these are recorded as fabula elements and sent to the Plot Agent. For the other three types (SE, E and P), instances are created by the Plot Agent.

7.3.2 Recording Causal Connections Between Fabula Elements

The task of generating causal connections between the fabula elements is also shared between the Plot Agent and the Character Agents. It necessitates the agent having a certain extent of introspective capabilities. In some cases this is trivial, for instance an action selected based on a goal plan is the basis for an instance of a $G \xrightarrow{m} A$ causal connection, represented as an RDF triple. An example from figure 7.3:

```
<#iGoal_billyBones_27> fabula:motivates <#iAction_billyBones_28>
```

In some cases however, the required introspection of the agent becomes somewhat more complex. For example, to see which IE instances enable an Action that the agent selects based on a goal plan, the agent has to consider the preconditions of the action and match these with IE instances stored earlier.

This introspection, although theoretically unlimited, will in practice ultimately be limited by the discrete, structural representation of the fabula model, which flattens out some of the interesting process-based narrative aspects. For instance, the deliberation over possible plans for a goal cannot be represented in the fabula model, as it

```
<#iBelief_billyBones_22>
    a                 fabula:BeliefElement ;
    fabula:character  ps:billyBones ;
    fabula:enables    <#iGoal_billyBones_27> ,
                      <#iAction_billyBones_32> ;
    fabula:hasContent <#iBelief_billyBones_22_contents> ;
    fabula:time       "9"^^xsd:int .

<#iGoal_billyBones_27>
    a                 fabula:RefillWaterSupply ;
    fabula:character  ps:billyBones ;
    fabula:agens      ps:billyBones ;
    fabula:patiens    fabula:oWaterSupply_1 ;
    fabula:motivates  <#iAction_billyBones_28> ,
                      <#iAction_billyBones_32> ,
                      <#iAction_billyBones_35> ,
                      <#iAction_billyBones_39> ,
                      <#iAction_billyBones_43> ;
    fabula:time       "10"^^xsd:int .

<#iAction_billyBones_28>
    a                  ps:OpenDoor ;
    fabula:character   ps:billyBones ;
    fabula:agens       ps:billyBones ;
    fabula:patiens     ps:oHatch_1 ;
    fabula:phi_causes  <#iPerception_billyBones_20> ,
                       <#iPerception_billyBones_21> ,
                       <#iPerception_billyBones_22> ;
    fabula:time        "10"^^xsd:int ;
    fabula:starttime   "11"^^xsd:int ;
    fabula:endtime     "12"^^xsd:int .
```

Figure 7.3: Fragment of the sample fabula of figure 7.2, represented using the RDF Named Graphs serialization language TriG.

represents only the outcomes of this deliberation (i.e., the selected actions). Another example occurs when an emotional model is used: the moment-to-moment increase and decrease of emotional intensity has to be made into discrete events with narrative meaning, and connected to the events that cause them (Dias *et al.*, 2007). The agent has to be able to say: “I hit my friend because I was angry that he broke my trophy.” Sawyer (2002a) makes similar arguments to point out the limitations of Trabasso’s model for understanding narrative in improvisation.

7.4 Presentation

By making the fabula explicit, we have an objective account of events at our disposal which is independent of stylistic concerns such as viewpoints, author opinions, time lapses and couleur locale, and therefore has the potential to be shaped into different forms of presentation. This also makes it possible to tell different stories based on the same fabula. Where the following chapter focuses on the production of interesting fabulae, here we assume the existence of such a fabula and focus on the generation

Once upon a time there was a pirate, who was called Billy Bones. He was in the hold of his ship. The water supply was depleted and he wanted to replenish it. Therefore he opened the hatch. With a ladder the pirate walked to the deck. With the ship he sailed to an island. After he had gone ashore at the island, he replenished the water supply with water from a pond.

Figure 7.4: Narrative text generated by The Narrator of the sample fabula of figure 7.2 (manually translated from Dutch to English).

and presentation of a narrative text based on the fabula. Again, we consider the word 'text' here to be media-independent. In addition to natural language texts, we have also focused on generating cartoons.

Although a theoretical distinction between the story and text layer was useful, in practice we found that several story-level choices were not independent of the choices to be made for the actual text production. Although it is likely that different presentation forms benefit from a common library of tools for story-level operations, they will be defined and discussed here as part of the process of text generation.

7.4.1 The Narrator: Natural Language Generation

In The Virtual Storyteller, natural language is used as the primary medium for presenting the story to the user. Within the Virtual Storyteller project, a Natural Language Generation (NLG) architecture called the Narrator was developed (Theune *et al.*, 2007a,b). The Narrator uses a fabula file, together with lexicon information, as input for generating a narrative text. Optionally, the text can be presented by an embodied agent using text-to-speech. To explain how the Narrator operates, I use a small sample fabula produced by The Virtual Storyteller, based on a simple simulation with one character. Figure 7.4 shows the narrative text that was generated by the Narrator.[1]

From Fabula to Document Plan

The first step carried out by the Narrator is to determine the content and the global structure of the text to be generated. This is done by converting the input fabula to a *document plan*: a binary branching tree containing selected elements from the fabula, connected by rhetorical relations (relations between the parts of a text). Constructing the document plan involves removing those fabula elements that will not be explicitly expressed in the story. These include positive outcomes and beliefs caused by perceptions, which are considered to be inferable by the reader (e.g., the italicized sentences in the following sequence will not end up in the final text: Billy picked up the bottle of rum. *He saw that he had picked up the bottle of rum. He believed that he had picked up the rum.*). Document planning also involves adding new elements that represent

[1] Actually, the Narrator produces Dutch text. The original text is: *Er was eens een piraat, die Billy Bones heette. Hij was in het ruim van zijn schip. De watervoorraad was op en hij wilde hem vullen. Daarom opende hij het luik. Met een ladder liep de piraat naar het dek. Met het schip voer hij naar een eiland. Nadat hij bij het eiland aan land was gegaan, vulde hij de watervoorraad met water uit een vijver.*

background information about the storyworld or properties of the characters, such as their names and locations.

When mapping the fabula to a document plan, the causal connections between the selected fabula elements are replaced with corresponding rhetorical relations. Consecutive actions motivated by the same goal are connected using a Temporal relation, which can be signaled using cue phrases such as *then* and *after*. Motivation and psychological cause links are mapped to Volitional Cause, which implies a certain extent of intentionality on the character's part. Cue phrases signaling this relation include *because* and *therefore*. Enablement and physical cause links are mapped to Non-volitional Cause, signaled by cue phrases such as *so that* and *thereby*. To introduce characters from the Setting Elements, the storytelling-specific Temporal-once relation is used, cued by *Once upon a time*. The Elaboration relation is used for background information, which is often expressed in a relative clause (e.g., *who was called Billy Bones*). The most general rhetorical relation is Additive (cue phrase: *and*); it is used if two fabula elements together cause another fabula element, and in general to connect two fabula elements if no other relation applies to them.

Next, the fabula elements in the document plan are replaced with abstract sentence structures called Dependency Trees. For each type of fabula element, a template is available specifying how its arguments should appear in the corresponding Dependency Tree. For example, the agens and patiens of an Action are normally given the grammatical roles of subject and object, while instruments are expressed by a prepositional argument. An example from figure 7.4 is *He replenished the water supply with the water from a pond*. To express Internal Elements, there are templates for standard sentences such as *The pirate was angry* but also for storytelling-style constructions such as *He had never been so angry!*, to be used for emotions with a high intensity.

To achieve coherent output texts that are more than a sequence of simple sentences, the Narrator may combine some Dependency Trees to form complex sentences. Whether it is possible to combine two Dependency Trees depends on the cue phrase selected to express their rhetorical relation. The cue word also determines which syntactic construction is used to combine the trees. For example, in the last sentence of the sample story, the cue phrase *after* introduces a subordinate clause. When Dependency Trees are combined, recurring elements may be deleted. For example, a construction such as *Billy Bones cursed and Billy Bones screamed* will be reduced to *Billy Bones cursed and screamed*.

Generating Referring Expressions

An important step in generating a fluent story is the generation of appropriate references to characters and objects. To do this, the Narrator checks (among other things) if the entity being referred to (the referent r) has been recently mentioned, and if there are no other entities of the same gender that have been mentioned equally recently. If both conditions hold, r can be referred to using a pronoun such as *he* or *it*. However, stylistic considerations also play a role: after a pronoun has been used several times in a row, a definite description is preferred to achieve some variation. This is illustrated by the fifth sentence of the example story, which uses *a pirate* where *he* would also have been allowed.

If a regular noun phrase is used, first a noun expressing the type of r is selected (e.g., *pirate* or *ship*). Then the Narrator checks if any adjectives need to be added to the noun, for example to distinguish r from another entity of the same type. Finally, it is decided whether the noun phrase should include a definite or an indefinite article (*the* or *a*). The Narrator generally chooses an indefinite article when r is mentioned for the first time, and a definite article when r has been mentioned before. However, in some cases a definite article can be used at first mention. This is the case with so-called 'bridging descriptions', which refer to an entity that has already been evoked by the mention of another object it is related to. The story in figure 7.4 contains several examples of this, such as *the hold of his ship*, *the water supply*, and *the deck*. To be able to generate such descriptions, we have defined a number of rules stating that, for example, every entity of type 'ship' has a deck. If r (e.g., a deck) is related to another entity r' (e.g., a ship), the Narrator checks if there is a rule specifying that an entity of the type of r' usually has an entity of the type of r. If there is such a rule, r may be introduced using *the*. In addition, if r' has been mentioned before, and there is no other entity which may stand in the same relation to r (in the example: if there is no other ship the deck could belong to), then the relation between r and r' can be easily inferred and does not need to be mentioned explicitly. For this reason, the sample story simply mentions *the deck* and not *the deck of the ship*, since the ship has already been introduced in the second sentence.

Text and Speech

As the last text generation step, the Dependency Trees are converted into actual sentences. Using language-specific knowledge about syntax and morphology, the words in the Dependency Trees are put into the correct order, and nouns, adjectives and verbs are inflected (i.e., suffixes indicating number, tense etc. are added to the word stems in the Dependency Trees). Finally, punctuation is added.

The finished story can be presented to the user in text format, but it can also be presented by a talking face using text-to-speech. Recently, the Narrator has been coupled to DEIRA, a framework for generating spoken reports by an embodied agent (Knoppel, Tigelaar, Oude Bos, Alofs, & Ruttkay, 2008). See figure 7.5. The embodied storyteller can currently produce high-quality speech and lip synchronization; however the generation of appropriate facial expressions is still work in progress. Other work in progress is the synthesis of more expressive speech, based on the analysis of speech data from human storytellers (Theune *et al.*, 2006).

Related Work

The Narrator is a system for story text generation and can in that sense be compared to the narrative prose generator STORYBOOK (Callaway & Lester, 2002) and *nn*, a system originally designed for narrative generation in interactive fiction, and recently combined with the MEXICA plot generator (Montfort & Pérez y Pérez, 2008). While our work on the Narrator has mainly focused on the levels of micro planning and surface realization, document planning in the Narrator is not as advanced as that of others, who have explored the generation of suspense (Cheong & Young, 2006)

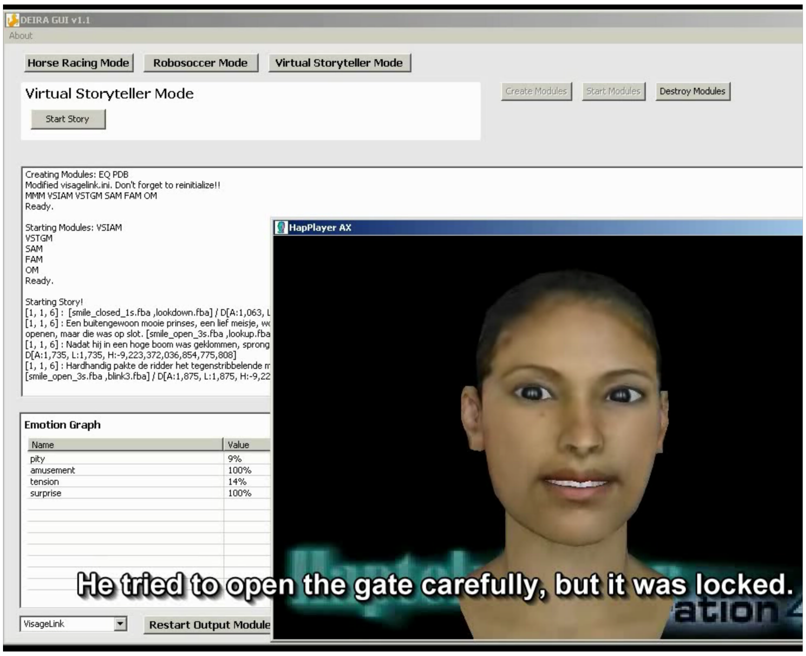

Figure 7.5: DEIRA telling a story.

and more recently, flashback and foreshadowing (Bae & Young, 2008) in creating a document plan. Our goal to present the story by means of an embodied agent makes it comparable to the goal of the *Papous* system (Silva, Vala, & Paiva, 2001).

7.4.2 COMICS: Comic Generation

As an alternative to natural language generation, we have recently started exploring comics generation as a relatively easy way to visually present a story in comparison to (3D) animation. The work described in this section is in the very early stages. The system we are developing is called COMICS[2] (Zeeders, 2010).

For generating comics, we use the *automatic composition* method, in which panels are composed of pre-drawn images and elements (Alves, McMichael, Simões, Vala, Paiva, & Aylett, 2007). This method can be contrasted to the *automatic transformation of dynamic graphics* method, in which the system uses screenshots of an already existing visualization (e.g., a game engine) and enriches these screenshots with comics content (e.g., speech balloons).

An authoring tool called *ActionMaker* was developed for creating representations of Actions and Events using stick figures that can be manipulated to create desired poses of the objects and characters involved (figure 7.6). The stick figures form the basis for creating visual representation of characters with a variety of graphical features.

[2]Creative Ontology-based Machine Illustrating Comic Stories

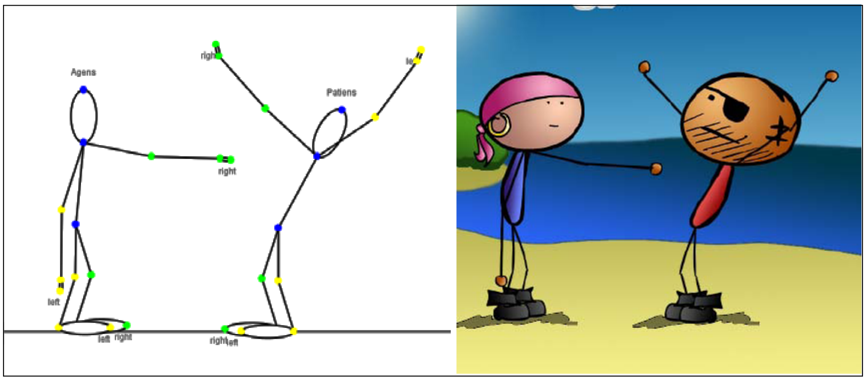

Figure 7.6: Creating action poses for the comic in the ActionMaker **(left)**, and the resulting final panel generated by COMICS **(right)** (Zeeders, 2010).

From Fabula to ComicsDL

As in the Narrator, the Comics system first determines the parts of the fabula that are to be shown. It selects a connected subgraph of the fabula, filters out elements that are irrelevant for presentation, for instance, 'trivial' Perceptions and Beliefs following from Actions and Events (as in the Narrator) and combines elements that should be grouped on one panel, for instance, a goal and the first action motivated by this goal. The result is transformed into the comics-specific, XML-based description language *ComicsDL*, based on the Comic Strip Description Language (CSDL) of Alves *et al.* (2007). This intermediate representation describes the panels of the comic, and the objects and actions for each panel.

From ComicsDL to Comic

The next step for COMICS is to create panels based on the ComicsDL representation, poses for Actions and Events, and libraries of graphics (e.g., objects, backgrounds and body parts). In this early stage of development, there are still many issues to be solved. Some issues we encountered can be noticed in figure 7.7: (1) a lack of continuity in the visualization of objects and states, e.g., the *PickUp* action on the first panel features a cannonball, which appears to be gone on the second panel; (2) lack of semantics of how objects interact, e.g., in the last panel, a cannon is fired in the hold of a ship, but as the hold of the ship forms the background of the panel, it appears as if the cannon is fired *inside* the ship.

7.5 Conclusions

In this chapter, a formal model of the fabula of simple stories was presented that is usable to capture the fabula of an emergent narrative. We have described the fundamental elements of the model and four types of causal relationships between these elements, based on Trabasso's causal network theory of story comprehension. Furthermore, we have shown how these elements and their causal relationships can be generated during emergent narrative simulation, and how the fabula forms the basis for a presentation using natural language and cartoon generation.

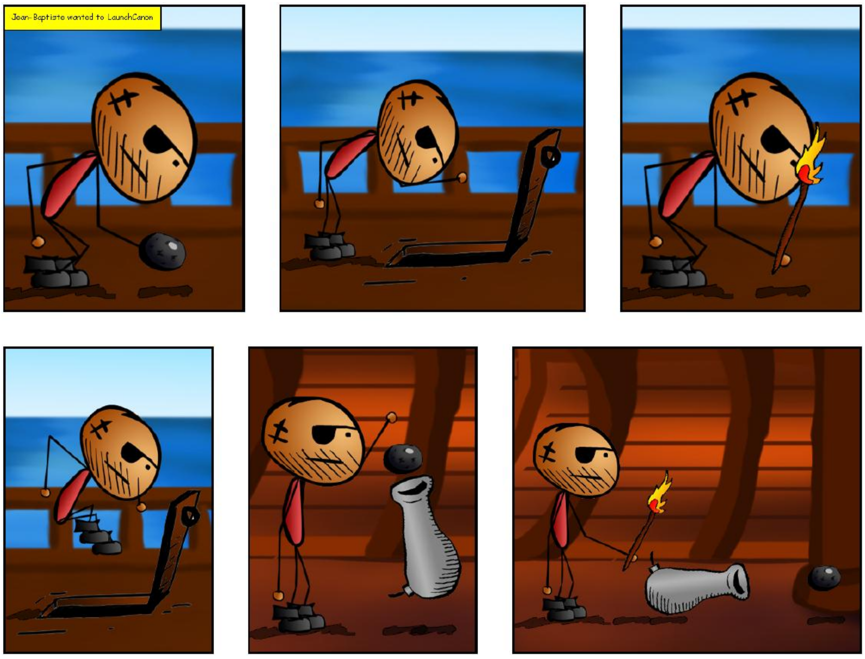

Figure 7.7: Comics generated for a small story fragment in the Pirates domain. Jean-Baptiste's goal is to fire a cannon. He picks up a cannonball located on the deck, opens the hatch to the hold, picks up a torch located on the deck, goes to the hold, loads the cannon and fires it.

Due to our use of the formal fabula model, it was possible to build a sophisticated Narrator component that can make the most of the information specified in the fabula. The result is that we can generate stories that are more coherent than those generated by previous versions of the Virtual Storyteller (compare the Brutus and Amalia story of figure 6.3 with the pirate story of figure 7.4), although still by no means of the quality achievable by a human author. In contrast to systems that only produce a list or plan sequence of actions or events, expressed by means of simple sentences (e.g., Riedl, 2004; Cheong & Young, 2006; Meehan, 1981), the Virtual Storyteller uses the fabula to also mention the underlying emotions and goals, and expresses them in fluent text using complex sentences connected by suitable cue words.

Future work on the Narrator should focus on document planning, employing story-level reasoning about the fabula to create suspense and surprise. Furthermore, the Narrator currently lacks the possibility to generate natural language for dialog acts. Finally, from the viewpoint of Expressive AI, we found that the Narrator does not provide enough authorial affordances for controlling the sentence structures produced. For instance, Actions are narrated using standard verb phrases, whereas an author may often want to create richer ones. For example, an Action such as `SetSail`, occurring in the pirates domain we used as an example in this chapter, currently leads to a sentence such as *With the ship he sailed to an island* in figure 7.4. There is currently very limited support to influence such expressions beyond specifying their nouns and verbs. For instance, if one likes the Action to be expressed as *"Off we go," he said and gave the command to set sail to an island*, there is no way to achieve this. To improve the authorial affordances of the Narrator, perhaps a combination of templates (providing excellent authorial affordances) and natural language generation (making it possible to still take micro planning and surface realization concerns into account) might be useful. A way to do this would be to allow the author to explicitly provide dependency trees for fabula elements using a graphical authoring tool.

Our ultimate goal is to use the Narrator within COMICS to provide comics enriched with natural language. For instance, character dialog can be expressed in text balloons, Internal Elements and Goals in thought balloons or in text boxes above the panel, as in the top left corner of the first panel in figure 7.7.

8

The Simulation Layer

> "Everything is connected in intricate webworks of cause and effect, and your goal in life is to understand as much of that webwork as you can. To do so, you must concentrate on causal relationships, on the precise nature of causality. You need a language that allows you to express with clarity and precision the exact nature of each causal relationship you discover. I have good news and bad news for you. The good news is that this language has already been developed; the bad news is that it's mathematics."
>
> **Chris Crawford**
> (Crawford, 2004)

This chapter describes the architecture of the simulation subsystem of The Virtual Storyteller. Drawing on the conception of emergent narrative as a simulation, as presented in chapter 3, and the lessons learned from improvisational theater, as presented in chapter 4, this chapter presents a further, technical investigation of the emergent narrative approach and focuses on novel techniques that further the emergent narrative design practice. Parts of this chapter were published in Swartjes & Theune (2008), Swartjes, Kruizinga, Theune, & Heylen (2008b) and Swartjes, Kruizinga, & Theune (2008a).

8.1 Introduction

The goal of the simulation subsystem of The Virtual Storyteller is to simulate a virtual world with virtual characters in order to produce interesting fabulae. My research aim in creating the simulation layer was twofold:

(1) To investigate possibilities and limits of opening up an actor-level perspective for autonomous story characters, and in particular how they might be allowed to use late commitment to gradually fill in an emergent dramatic frame.

(2) To investigate the authoring process by which one may develop a coherent set of story material for emergent narrative.

This chapter specifically focuses on aim (1), presenting mainly an architectural view on the storyworld simulation. It discusses the design choices that were made, but not the actual authoring process by which one can create specific storyworlds. This subject will be treated in chapter 9, which presents two authored storyworlds and discusses the authoring process in relation to the iterative authoring cycle presented in chapter 3.

In this chapter, I first discuss how a storyworld simulation is modeled in The Virtual Storyteller. Then, I focus on drama management within such a simulation and argue that a form of drama management compatible with the idea of emergent narrative is to distribute it over the characters, as in improv. To this end, a distinction is made between an actor-level and a character-level role of the agent. I introduce a novel technique with which agents, from an actor-level perspective, can become much more flexible in shaping their character-level behavior.

8.2 Modeling a Storyworld Simulation

In this section, I discuss the implementation choices made for modeling a storyworld simulation in The Virtual Storyteller from a character-level perspective. This consists of:

- Modeling the initial state of the simulation, including its setting.
- Modeling the characters that will be featured in the simulation.
- Modeling the storyworld in which these characters 'live', including the occurrence of external Events.

Several points should be taken into consideration. First, the simulation should produce a fabula, containing the fabula elements described in chapter 7. The fabula elements and their causal connections must be generated at simulation time and collected into one causal network. This entails processes being in place for all the fabula elements and causal connections. It also entails that the event sequence of the simulation be a result of explicit physical and psychological causality, so that this can be captured, and that this causality can also be perceived by an audience. As discussed in chapter 7, this implies a focus on *folk physics* and *folk psychology*. These are issues of character and storyworld modeling.

Second, the fabula should reflect a certain degree of causal coherence between its events, meaning that the fabula elements become connected within a larger causal network. Ideally, this network contains a long causal chain, contains fabula elements about multiple characters, and has a high degree of interconnectedness. The assumption, based on the causal network theory discussed in chapter 7, is that the more fabula elements are causally connected to and within the causal chain, the more coherent the fabula is. This is not just an issue of character and storyworld modeling,

```
# A ship
ps:oShip_1
    a                   ps:Ship ;
    ps:hasWaterSupply   ps:oWaterSupply_1 ;
    ps:mooredAt         ps:oTreasureIsland_1 .

# A bottle of rum
ps:oRumBottle
    a               ps:Bottle ;
    swc:contains    ps:oRum_1 ;
    swc:at          ps:oHold_1 .

# A pirate: Anne Bonney
ps:anne_bonney
    rdfs:label   "Anne Bonney" ;
    a            ps:Pirate ;
    a            fabula:Character ;
    swc:at       ps:oDeck_1 ;
    a            ps:Captain ;
    ps:owns      ps:oShip_1 .
```

Figure 8.1: Fragment of the setting of a Pirates domain in the RDF serialization language Turtle. The predicate `a` is Turtle shorthand for `rdf:type`.

but also partially an issue of narrative control and of authoring story content and the processes that support it.

Third, the system should provide clear authorial affordances to the author; that is, authors should be afforded the opportunity to think and work with the architectural entities of the system. As argued in section 3.3.5, feedback is important for the iterative authoring process of emergent narrative, not just as a way of debugging but also for *co-creation* purposes. The agents partaking in the storyworld simulation should afford authors the opportunity to understand the choices that they make during the simulation, and reflect the intermediate results of the simulation.

8.2.1 Initial State

Stories have a setting within which they operate. See figure 8.1 for an example. The setting contains facts about the storyworld that are true at the beginning of the storyworld simulation. This includes such things as the topology of the storyworld, the location of objects, and knowledge about characters and their properties. The setting knowledge is expressed in the Turtle language, which is a well-readable serialization of RDF.

Besides the setting knowledge, there needs to be information as to which characters should be featured in the simulation. This information forms part of the story facilitation knowledge of the Plot Agent, and will be discussed in section 8.2.4. This information acts, together with the setting information, as the starting condition for the simulation.

This way, the author can provide a *static* representation of the exact initial state of the simulation, as opposed to a *dynamic* representation of parts of the initial state as proposed in chapter 3, so that decisions as to the exact initial state can be made *during* the simulation. A step towards this approach is described in section 8.4.

8.2.2 Characters

The Plot Agent casts the necessary characters by requesting Character Agents to participate in the storyworld simulation. If there are not enough Character Agents, the Plot Agent can start up new ones. When a Character Agent agrees to participate, it gets assigned a role, identified by an RDF resource identifier (e.g., `ps:anne_bonney`).

Following FAtiMA, the Character Agent architecture consists of two layers: (1) the deliberative layer, handling the deliberative and goal-directed aspects of the agent, and (2) the reactive layer, handling quick, immediate reactive responses to changes in the environment.

Deliberative Layer: Goals and Outcomes

As discussed in chapter 7, character goals are important ingredients of simple stories. Goals, attempts to attain them, and their outcomes anchor episodic structures in so-called GAO (Goal-Attempt-Outcome) episodes (Trabasso & van den Broek, 1985; Trabasso *et al.*, 1989). Therefore, goal-directedness has been made a central component of the Character Agent.

Goals. The representation of goals in The Virtual Storyteller is based on the representation of *active-pursuit goals* in the FAtiMA architecture, which causes the agent to try to attain a certain goal state. These can be contrasted with *interest goals*, which represent states the agent wants to maintain or avoid, but are not actively pursued. Where active-pursuit goals have preconditions that specify when the goal becomes active for the agent, in The Virtual Storyteller a distinction is made between conditions that *enable* goal adoption, and conditions that *motivate* or *cause* goal adoption. This is achieved by representing goals using goal schemas and goal selection rules.

A *goal schema* is a data structure that represents a character's active-pursuit goal. It consists of preconditions, success conditions and failure conditions. The preconditions determine whether it is *possible* to adopt the goal, relating to the causal connection $IE \xrightarrow{e} G$ of the fabula. The success conditions specify the partial state of the world that must be true for the goal to be successful. The failure conditions specify when goal attainment should be considered failed.

A *goal selection rule* is a data structure with preconditions that determine whether the agent is caused to adopt the goal. The preconditions may test both knowledge about the state of the storyworld (that is, the agent's current beliefs), and knowledge about the fabula so far (e.g., knowledge about what beliefs, goals or actions may have occurred in the past and why). Depending on what kind of knowledge the preconditions are testing, goal selection rules determine the causal connections $IE \xrightarrow{\psi} G$, $O \xrightarrow{\psi} G$ and $G \xrightarrow{m} G$ of the fabula.

Agents adopt a goal when it was selected by a goal selection rule, and when the preconditions of the goal schema hold. Once adopted, the goal competes with other adopted goals to become the active intention. If it does, the planner will attempt to create a plan to achieve the success conditions of the goal, and the agent will proceed to execute this plan.

Actions. To achieve its goals, the Character Agent has access to a set of actions in its domain. An action is represented using an *action operator*, following a STRIPS-like notation (Fikes & Nilsson, 1971). An action operator has a set of preconditions that determine whether the action is possible in the current state of the world, and a set of effects, determining which facts should be added to the state of the world, and which should be deleted, after the action has been carried out. Actions have a duration, expressed in the number of rounds that the action is 'in execution'. In contrast to for instance the work of Coddington (2002), the expressivity of actions is equal to that of instantaneous actions, i.e., there are no invariant conditions that specify the state of the world *during* execution of an action.

Goal plans of action. Following the FAtiMA architecture, the Character Agents make use of an adapted version of a partial-order, causal link (POCL) planner that can generate a plan for the character to achieve its goal based on the action operators in the domain. Actions selected by the planner yield $G \xrightarrow{m} A$ causal connections for the fabula. A detailed description of the planner will follow in section 8.4.3.

The planner continuously updates its plan of action whenever the environment changes. An important difference from many other planning domains is that in stories, plan failure is not an undesired side effect of a changing environment, but a potential source of dramatic emotional response, suspense, and conflict. To this end, the possibility to deal with plan failure should be taken into account. Continuous planners are particularly suitable for a changing environment in which plans may fail and the agent needs to reconsider its plans and goals regularly (Avradinis, Aylett, & Panayiotopoulos, 2003).

Outcomes of goals. Goals in stories lead to a certain outcome, affirming or denying the expectations set by the goal (Trabasso *et al.*, 1989). This outcome can be positive (e.g., Hansel and Gretel find their way back home) or negative (e.g., Hansel and Gretel get lost). So when does re-planning stop and does a Goal get an Outcome? We can identify several cases:

- The success conditions of the goal hold. The goal has been attained and gets a positive outcome (O+).
- The failure conditions of the goal hold. The goal has failed and gets a negative outcome (O-).
- It is no longer possible to create a plan given the current state of the world. The goal gets assigned a negative outcome (O-).

The last solution is naive, as a character in stories will typically not abandon its goal in such a case. For instance, when Hansel and Gretel cannot find their way back home because the birds have eaten their bread crumbs, this does not cause them to abandon their goal of finding their way back. A more sophisticated solution would be to add emotion-focused coping mechanisms of decaying hope for a solution ("Don't worry Gretel, we will find a way."). Such emotion-focused coping is included in the FAtiMA agent (Aylett, Dias, & Paiva, 2006a), whereas the implementation of the Character Agents of The Virtual Storyteller only considers problem-focused coping. The choice to create a negative outcome in our case is motivated by the desire to keep the agent from being stuck, because it is waiting for the possibility to create a plan for its goal.

Reactive Layer: Quick Responsiveness to Environment

Besides using goals and a planner to achieve its goals, the agent may also select actions directly based on the state of the environment. An *action selection rule* determines when an action should be chosen as a direct effect of the current state of the environment and the agent. Actions selected this way always have priority over actions selected by the deliberative layer. The idea behind this is that reactive actions are *more urgent*: they are typically actions that should be performed immediately. An example is an action to greet someone, triggered by an action selection rule that specifies that this character will greet anyone it encounters, if it hasn't done so already. The preconditions of the action in this case yield the causal connection $IE \xrightarrow{e} A$, whereas the preconditions of the action selection rule yield the causal connection $IE \xrightarrow{m} A$.

Social Planning

A problem that one faces when using autonomous characters for emergent narrative is that whereas dramatic action is the product of interaction, there is usually not much in the agent that considers this interaction, for instance the effects of its actions on other characters. However, in stories, even apparently simple ones, there are often surprisingly complex interacting plans (Bruce & Newman, 1978). One only has to think of deception to realize that characters in stories often *do* consider and even manipulate the mental state, including motivations, of other characters to achieve their plans (Bruce & Newman, 1978; Bruce, 1980). This suggests that *social planning* (Gratch, 2000; Chang & Soo, 2009) is important for character-centric narrative generation. For instance, Chang & Soo (2008) show how social planning enables the character-based simulation of a simplified version of Shakespeare's *Othello*, in which one of the characters, Iago, can formulate a plan to make Othello kill his wife Desdemona. Constructing such a plan requires reasoning about the motivations of other characters. In Chang & Soo's example story domain, Iago can reason that if he deliberately drops a handkerchief, stolen from Desdemona, at lieutenant Cassio's residence, Othello might think his wife is cheating on him.

One possibility to achieve this kind of reasoning is to implement some sort of Theory of Mind (ToM) that allows the agents to reason about or simulate the minds of others (e.g., Bosse, Memon, & Treur, 2007; Chang & Soo, 2009; Sindlar, Dastani, Dignum, & Meyer, 2010). It should be kept in mind that such work typically aims at forming an accurate estimation of the mental state of other agents, whereas in stories it is often the case that authors deliberately let characters make wrong estimations (or, on the contrary, overly clever ones), in order to achieve interesting dramatic developments. The classic example is perhaps another Shakespeare plays, *Romeo and*

Juliet, in which Juliet feigns her death, causing Romeo to incorrectly infer that she really is dead, eventually leading to the tragic suicide of both of them.

This suggests that a certain degree of authorial control over such social reasoning is desirable. To this end, The Virtual Storyteller uses a simple solution for representing the effects of actions on other characters, in which direct authorial control is afforded over the kind of social inferences a character can make. The solution is to create operators that can be used to capture aspects of what a character can reasonably believe about and expect from its social environment in given contexts. These operators are *belief operators* and *expectation operators*.

Belief operators allow a character to draw personal inferences based on the current state of the world. For instance, if a pirate finds that his ship is suddenly gone, he can reasonably believe that it was stolen.

Expectation operators allow a character to make believable plans in a largely unknown world. For instance, if the pirate wants to find a new ship to go on a treasure hunt, he can reasonably expect to find one in the harbor. This allows him to make a plan to go to the harbor, and when he arrives, he might find an actual ship.

This approach utilizes the fact that the agent is situated in a microworld that is known by the authors who built it. An example of the use of expectations within plans of the agent can be seen in figure 8.2. In the RED story domain (described in chapter 9), based on the classic Little Red Riding Hood story, it can occur that the mean wolf steals the birthday cake from Little Red Riding Hood, who was on her way to give this cake to Grandma. To avenge her granddaughter, Grandma adopts the goal to kill the wolf. Figure 8.2 illustrates her plan: to bake and poison a cake, to go to the wolf and give it to him, expecting that he will eat it and die.

Again, both belief operators and expectation operators can be authored to be deliberately wrong or overly simplistic. In addition to the tragic example of Romeo and Juliet, another reason for this might be to create comic situations. For instance, Olsen & Mateas (2009) aim at using planning formalisms to generate Road Runner scenarios with the kind of physical humor typical for this domain. The humor often resides in a mismatch between the reasonable beliefs and expectations of Wiley E. Coyote and the antagonistic force of the environment, with its unrealistic physics and selective failure of ACME products. Coyote expects that Road Runner will crash against his rock painting of a tunnel, but the physics make it a *real* tunnel. Then, when Coyote believes it *is* a real tunnel because Road runner just went through it, Coyote painfully finds out that it is fake after all.

Emotions

An aspect not investigated in this research is the generation, representation and expression of character emotions, considered fundamental to generating an empathic response to drama (Zillmann, 1994), and playing a critical role in creating engaging believable agents (Gratch & Marsella, 2001).

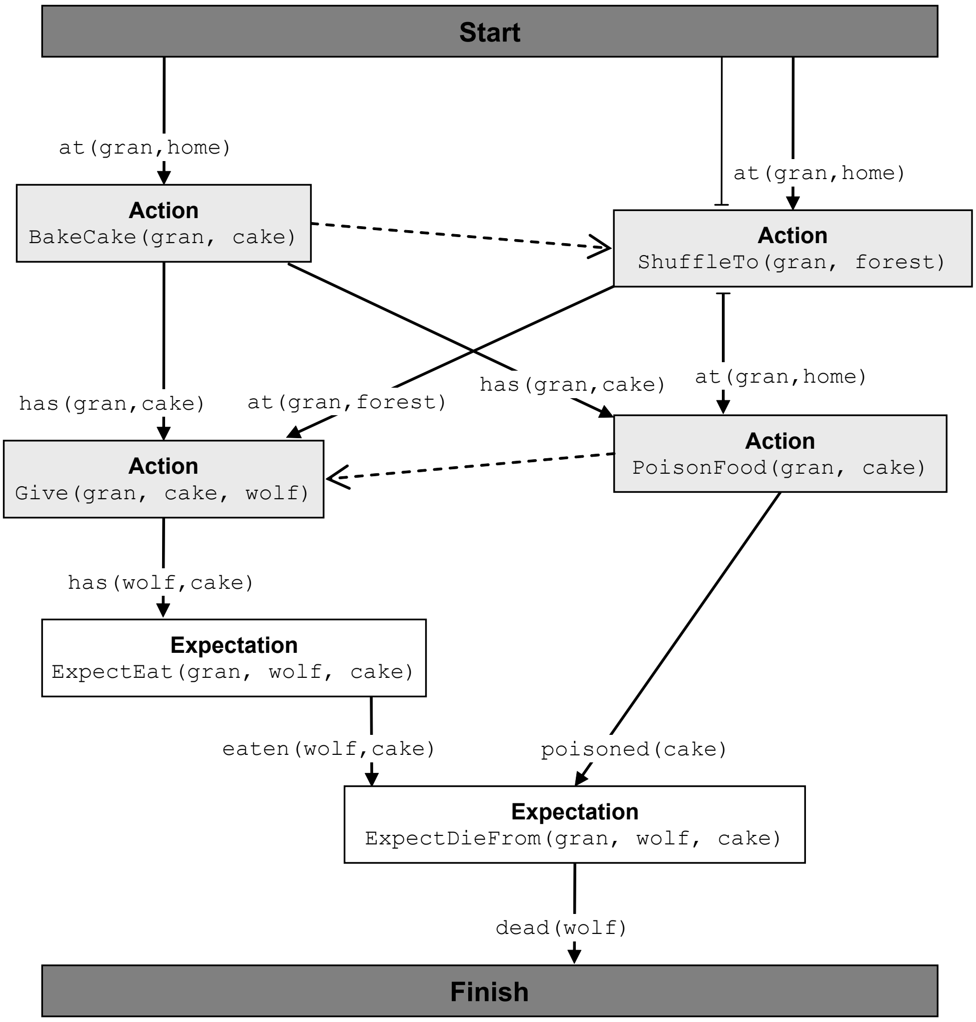

Figure 8.2: Example of a partial-order plan in the RED story domain, in which Grandma's goal goal is that the wolf is dead. The plan contains two expectations: (1) if you give someone a cake, they will eat it, and (2) if someone eats a poisoned cake, they will die. The dotted arrows represent additional ordering constraints generated by the planner to resolve causal threats: (1) `ShuffleTo` threatens the causal link `at(gran,home)` of the `BakeCake` operator, and (2) `Give` threatens the causal link `has(gran,cake)` of the `PoisonFood` operator.

In The Virtual Storyteller, it is possible to achieve a limited form of emotional *expression* by means of the emotional charge that actions inherently carry. For instance, in the Little Red Riding Hood domain described in chapter 9, the action *Cry*, reactively selected as a response for little girls to something being taken away from them without their consent, might communicate the fear, sadness and powerlessness that Little Red Riding Hood 'feels'. Skipping, another thing that little girls do in this domain, might communicate happiness. However, without an explicit representation of these underlying emotions, there is no persistence of emotions to guide future behavior or emotion-specific handling, such as dealing with the fact that emotions decay over time.

A more sophisticated representation of both reactive and prospect-based emo-

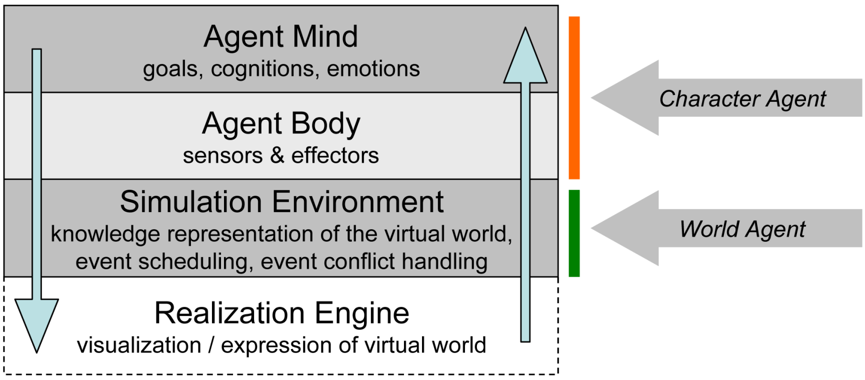

Figure 8.3: Representation layers of a character and its virtual environment.

tions, was used in other interactive drama work, for instance the FAtiMA architecture (Aylett *et al.*, 2006a), the MRE system (Gratch & Marsella, 2001) and EmoEmma (Pizzi *et al.*, 2007). As discussed in section 6.3, an earlier version of The Virtual Storyteller also contained a model of prospect-based emotional appraisal. These emotion models, however, typically consider general emotions based on the OCC model: joy, distress, hope, fear, etc. The work of Pizzi *et al.* (2007) is a notable exception; they consider the kind of more specific, complex emotions that occur in literature, such as 'pride of having a lover' or feelings of guilt and regret, emotions that Pizzi *et al.* (2007) call *literary feelings*. Furthermore, they show how pushing the representation of feelings into the planning domain (i.e., making them operators) holds promise for narrative generation.

8.2.3 Virtual Environment

A Character Agent cannot be seen in isolation from its environment. The agent senses, reasons and acts within the environment. Therefore, cognitive agent architectures usually consist of components that handle the sense-reason-act cycle (the agent *mind*) and components that handle the embodiment of the agent within its environment (the agent *body*) (Vala, Raimundo, Sequeira, Cuba, Prada, Martinho, & Paiva, 2009). A third layer of representation is the *realization engine*: the actual graphics and physics engines that make up the virtual world in which the agent operates. Vala *et al.* (2009) suggest further separating the realization engine from the *simulation environment*, managing a representation of the state of the simulation relatively independent of the specific way the virtual environment is realized. See figure 8.3.

A similar separation is made in The Virtual Storyteller, which does not have a realization engine, but runs storyworld simulations at the simulation environment level. The role of simulation environment is taken up by the World Agent. If The Virtual Storyteller is to be integrated with a realization engine, then we only need to interface with the World Agent: an appropriate mapping must be made to reconcile the more abstract knowledge representation of the simulation environment of the World Agent with the more specific representation required by the realization engine, such as the mapping described in Riedl (2005).

The Occurrence of Events

In the absence of a realization engine, which also typically contains a physics engine, we need an alternative way to determine the occurrence of Events, which are unintentional at the character level. Examples are dying, becoming thirsty, a thunderstorm occurring or a seagull landing on the railing of a ship. Such Events are represented using *event operators*.

One might wonder whether the World Agent is a good place for selecting these event operators. This would certainly be true if these operators should be selected based only on rules of physics (at a certain level of abstraction). For instance, the selection of an event operator `Die` might be based on a rule specifying that someone dies when he is over 80 years old. However, there are other causal factors that might determine the selection of event operators, such as the dramatic appropriateness of an event for a given situation. For instance, in a drama about the hardship of motherhood, it may be dramatically interesting if a teenager dies just at a point in the story when the mother is regaining trust in her ability to deal with the teenager's rebellious character. In the fairy tale Sleeping Beauty, it is not a mere function of physical laws that causes Sleeping Beauty to accidentally prick herself on a spindle, resulting in her sleeping for 100 years. The enchantment of the wicked fairy might have had something to do with this accident.

Lugrin & Cavazza (2006) go so far as to make the environment into an actor as well, bypassing the native physics engine of the Unreal Tournament game engine they use with an AI-based alternative in order to create "Death Kitchen": a virtual kitchen environment that acts as a malevolent entity, creating dangers for the user in the style of the *Final Destination* movie series. We however give the Character Agent and Plot Agent the responsibility to select event operators, keeping the World Agent — as a simulation environment — objective and free of dramatic concerns. In section 8.4, we will see in which cases Character Agents select such event operators and why.

Scheduling and Execution of Operators

As a simulation environment, the World Agent performs tasks similar to the ION framework (Vala *et al.*, 2009) used in FearNot! and ORIENT. It is responsible for maintaining a knowledge representation of the state of the storyworld at any given point in the simulation. It handles scheduling and execution of operators that change this state, and sends back the outcome of these operators (finished, aborted) to the Plot Agent. First, the Plot Agent requests the World Agent to perform certain operators. Then, the World Agent will check if the operators can be performed, and schedules them for execution. Actions and Events have a duration, expressed in number of rounds (default: 1 round). When the specified number of rounds has passed, the operator is executed and the outcome is sent back to the Plot Agent.

One of the tasks of the World Agent is to resolve conflicts between operators. By separating requests for operator execution from their actual execution, it is possible to consider how several concurrent operators (that is, the set of scheduled operators plus new operators requested to be scheduled within a given round) will be handled.

The World Agent adheres to a number of heuristics that are useful for a consistent

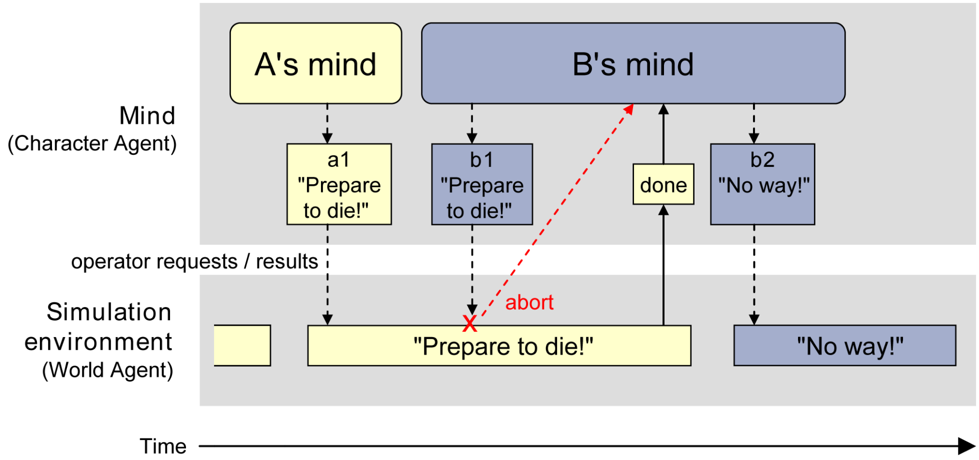

Figure 8.4: Conflict resolution by the World Agent. Actions that require a resource that is already in use are aborted. In this example, Action a1 requires agent A (as speaker) and B (as hearer), causing Action b1 to be aborted because it also requires agent A and B.

simulation. First, the World Agent always executes event operators before action operators. For instance, if an action to cross a bridge leads in the same round to the selection of an event operator specifying that the bridge collapses, we want the event operator to be executed *before* the action operator, which then fails.

Second, new actions by an agent always interrupt already scheduled actions by the same agent. The World Agent assumes that the Character Agent will not select a new action if it wants to wait for the result of its current one; so if it does, the intention is to cancel the previous action.

Third, if newly requested action operators conflict with already scheduled ones, only one of them will be executed. Conflicts arise when several agents select action operators for which the order of execution yields a different story state (and thus may matter) or which should not happen simultaneously. An example is two pirates about to engage in a sword fight. Say we implemented a dialog interaction, in which one pirate says “Prepare to die!” and the other pirate responds “No way!” before they start fighting. See figure 8.4. Both agents may be initiating this interaction at the same time, if they simultaneously say “Prepare to die!” In this case, we want only one to succeed so that the other can formulate the response instead. This is essentially a turn taking issue, but one which is not just limited to speech acts: a similar undesirable situation arises if one pirate tries to stab the other while the other simultaneously decides to walk away. We have solved this with a rudimentary form of resource management in which an agent is said to ‘use’ objects or other agents when they occur as parameters of a selected action operator. For instance, agent A stabbing agent B with a sword ‘uses’ agent A, agent B and the sword. If there is a conflict (a resource is ‘used’ this way by two or more action operators), then all but one action randomly aborts. This helps to create interaction, and results in a certain variability in the stories that emerge, because the fabula can have a different development depending on who successfully initiates the interaction.

8.2.4 The Plot Agent

The Plot Agent is responsible for constructing an interesting fabula. This responsibility entails the following tasks:

(1) Set up the storyworld simulation and its characters.

(2) Collect and organize causal information of the storyworld simulation into a fabula structure.

(3) Manage the narrative development so that it yields an interesting fabula.

Where the first two tasks are clear, the third task has remained rather vague. To implement this task, two aspects need to be investigated: (1) mechanisms by which the emerging fabula can be influenced and (2) ways to employ these mechanisms to achieve a more interesting narrative development. Although we initially aimed for a separation of concerns between the Character Agents living their life as a character in the storyworld, and the Plot Agent influencing the event sequence to make the fabula more interesting, there are important reasons why such a separation of concerns is somewhat problematic, as we will see in the following sections.

8.3 From Characters to Actors

Most of the work on character-centric interactive storytelling has focused on creating agents from the perspective of a character in the story. A character 'lives its life' inside the world of the story, pursuing its personal goals and experiencing emotions in accordance with this character-level perspective. This was the case in TALE-SPIN (Meehan, 1981), as well as in FearNot! (Aylett *et al.*, 2005), the I-Storytelling system and the more recent Madame Bovary remediation (Cavazza *et al.*, 2002; Cavazza, Lugrin, Pizzi, & Charles, 2007). So far, the discussion of the simulation part of The Virtual Storyteller has also mainly concerned this character-level perspective.

In section 4.5, I discussed how improv actors have a perspective beyond that of the character they play, which I called the actor-level perspective. In chapter 5, I showed that this perspective can also be expected from non-improvisers when participating in an improvised story. From this perspective, they are concerned with the desire to produce interesting dramatic interaction. For interactive storytelling, this concern is often taken up by a separate drama manager component (see section 2.2). However, such a separation of concerns requires a delicate balance between character autonomy and drama management. This section discusses this difficult balance, exploring some of the possibilities and limitations of drama management when character autonomy is to be retained, and argues for the integration of the character-level and actor-level perspectives into one agent to create a distributed approach to drama management.

8.3.1 Emergence versus Story Control: Do the Right Thing

First, let us explore the tension that exists between the bottom-up emergence of fabula as a result of believable virtual characters interacting in a virtual world, and the top-down design of an interesting plot, in which characters engage in dramatically meaningful interactions. This tension, related to the narrative paradox (see section 2.1.1), is one that any approach to interactive storytelling faces if it seeks to have both responsive, believable characters and a satisfying plot structure. To achieve such a plot structure, the characters sometimes have to be directed by the drama manager, so they do the 'right' or 'interesting' thing given certain situations (Blumberg & Galyean, 1997), where determining which thing is 'right' or 'interesting' depends on how it affects future events of the plot.

Directing Autonomous Characters

If a drama manager is going to influence how the character behaves at certain moments, then either (1) this influence is limited for instance to letting external events occur, or determining the outcome of actions, or (2) character autonomy must be sacrificed. The latter case results in semi-autonomous characters. A semi-autonomous character behaves in part based on its own autonomy, and in part based on the autonomy of someone else. This may be a human user: for instance, the characters in the game series The Sims are semi-autonomous characters since the player and the game AI share control over their behavior. Semi-autonomy is also the case in the work on *directed improvisation* of Hayes-Roth & van Gent (1997): users can give commands that constrain the behavior of improvisational computer characters.

According to Castelfranchi (1994), an autonomous agent pursues "autonomous goals", meaning that:

(1) The goals of an agent cannot be directly modified from outside; they can only change through belief changes.

(2) The beliefs of an agent cannot be directly modified from outside; the adoption of a belief is a special "decision" that the agent makes.

A requirement for achieving the willing suspension of disbelief that is so important in stories is that a character appears to be driven solely by its own autonomy. This means that an external observer does not see whether the character is fully autonomous or semi-autonomous. For believable agents, this requires the ability to incorporate directives while maintaining character believability, which is a little investigated issue. Such directives may come in two forms: prescription (do this) and proscription (do not do that) (Blumberg & Galyean, 1997; Riedl & Stern, 2006b). Blumberg & Galyean (1997) discuss the issue of exerting prescriptive and proscriptive control over (animated) autonomous agents, which can be classified into four different levels: (1) the motor skill level (move your arm), (2) the behavioral level (pick up the apple), (3) the motivational level (you want to eat) and (4) the environmental level (there is an apple on the table). The first three of these types of directives pose a potential believability problem, because they affect the character's autonomy. The challenge here is that any behavior that was not autonomously selected by the character has to be justified so that it appears to be. Only control at the environmental level does not break character autonomy according to the definition of Castelfranchi (1994).

In order to maintain autonomy, Blumberg & Galyean (1997) see external control not in the form of directives but rather in the form of "weighted preferences or suggestions" for or against certain behaviors or actions. However, from a drama management perspective, such a form of control is ultimately *unreliable*. What I mean by unreliable is that unless it checks up with the agent, the drama manager can never be sure that the suggestions are going to have the exact effect that is desired. In other words, giving suggestions or preferences may affect character behavior, or it may not, as it is "...just one more factor in the mix of internal motivations and external stimulus which ultimately determine in which behaviors the [character] will engage." (Blumberg & Galyean, 1997, pp.1–2). For instance, Louchart & Aylett (2007b) introduced the notion of *double appraisal* for virtual characters in emergent narrative, which can be understood as an example of a 'weighted preference' on the behavioral level. The idea is that at any point in time, a character has a certain choice which action to pursue next, given a particular goal plan. Rather than having this choice made randomly, the character can weigh its options actively considering the emotional effect of possible actions on other characters, thus biasing its behavior towards more emotional interaction.

To give an example of the unreliability of guidance, suppose the drama manager wants to achieve a coincidental confrontation between the protagonist and the antagonist. It might give both characters the directive to 'go to the town square', but the characters have to see if they can fit it in with a plan for their goals (e.g., the protagonist is en route to his headquarters and can arrive there via several routes, so he plans to cross the town square). Additionally, the characters must be at the town square at the same time, so the antagonist who arrives at the town square early must find a way to stall his presence. Whether the confrontation ultimately succeeds depends on how all this plays out, and on the ability of the characters to believably perform as directed.

This unreliability of guidance is perhaps the price to be paid for wanting to control autonomous agents that should stay believable. Guidance remains unreliable as long as the characters are not being used to perform some form of lookahead search. Some character-based interactive narrative systems do take this approach (Laaksolathi & Boman, 2003; Si *et al.*, 2009); however, the computational feasibility and real-time performance of a lookahead approach are decreased when a generative planner is used, as with the FAtiMA architecture and the Virtual Storyteller's Character Agent.

Overriding Character Autonomy

One exception to the unreliability of guidance is the case where the agent provides 'hooks', carefully designed to override the character's autonomy in an appropriate manner in order to offer reliable guidance opportunities (Mateas & Stern, 2000). For example, Riedl & Stern (2006b) discuss how autonomous agents can be designed that 'fail believably', that is, justify failing their own goals so that they can adopt goals prescribed by the plot. An example is a shopkeeper that can believably abandon the goal to clean the shop by receiving a phone call. They use precompiled tables of resource requirements that indicate whether the current goal of the agent can be believably abandoned, merged, or followed up by a prescribed goal. Such information can be reliably used by the prescribing agent to make a decision.

A factor that complicates the use of overriding character autonomy, say with a specific scripted sequence of character actions $< a_1..a_n >$, is that not only should $< a_1..a_n >$ be believable within the context in which it was selected, but the autonomous action selection as it continues after the execution of $< a_1..a_n >$ should also be believable. For instance, a computer-controlled James Bond character enters his hotel room and notices that a vase is out of place; there is a spotless circle right next to the vase on an otherwise dusty sideboard. After executing the script [`look-under-vase`, `seem-pleasantly-surprised`, `remove-bugging-device`, `casually-throw-device-out-of-window`], the agent should also for instance have drawn the inference that someone is after him, so that he can then autonomously select a goal to find out who this is. For a seamless integration, the internal state of the agent should be updated with the potential implications that $< a_1..a_n >$ have for it, so that it can consistently continue its autonomous behavior. This can be more or less difficult, depending on the architectural complexity of the believable agent.

8.3.2 Problems with a Separate Drama Manager

The idea of the *strong autonomy* position, discussed in chapter 2, is to separate the development of believable agents, which can be placed in a VE, from the development of a drama manager that will be responsible for the progression of the plot by guiding the agents so that they do the 'right thing' from a drama perspective. This was part of the philosophy of the OZ project (Mateas & Stern, 2000), and seems quite seductive indeed. Believable characters make decisions based on their internal state and the state of the world they inhabit, and the drama manager makes decisions based on the *story state*, which includes "information about all the characters involved in the story, plus the entire past history of the interaction considered as a story, that is, as a sequence of actions building on each other and moving towards some end." (Mateas & Stern, 2000, p.115). However, as Mateas & Stern argue, the strong autonomy position is based on a number of problematic assumptions.

The first assumption is that guidance by the drama manager is infrequent. Since the agents do not base their decisions on the story state, so goes the argument, this means that most of the time the story will be "drifting": in other words, the story does not advance. More frequent guidance is necessary, because ultimately the smallest units of story structure are at the level of character interaction (i.e., dramatic beats) which happen continuously.

The second assumption is that it is possible to decouple the design of autonomous story characters from considerations on how they can be guided. A requirement for this decoupling is that it is possible to create a relatively simple interface to reliably tell the characters what to do. As we have seen, this combination of autonomy and guidance is not trivial. There is a strong interaction between guidance and the moment-by-moment internal state of the agent, which makes such guidance ultimately unreliable. The drama manager can never be guaranteed that its guidance is successful until it turns out to be. This necessitates either (1) a much stronger coupling of concerns, whereby the drama manager directly queries and operates on the internal processes of the characters to achieve its story-level goals, or (2) equipping the characters with hooks that *do* guarantee guidance opportunities by being carefully designed in such a way that they override the character's autonomy in an appropriate manner. Both solutions make the use of character autonomy indefensible, especially given that drama manager guidance should happen frequently.

The third assumption is that since story progression often requires the characters to engage in behavior that needs to be carefully coordinated, this coordination can be handled within the agents. Mateas & Stern give the example of an argument between two characters that is meant to reveal important information:

> "In a sense, the real goal of these two characters is to conspire towards the revelation of a specific piece of information by arguing with each other. But an author who thinks of the characters as autonomous will tend to focus on the individual character goals rather than story-level goals. To make a story-level goal happen, the character author will have to somehow coordinate the individual character goals and behaviors so that as the characters individually react to each other, the resulting interaction 'just happens' to achieve the story goal." (Mateas & Stern, 2000, p.116)

The high level of coordination needed to achieve plot progression, together with the problems of character autonomy in the face of drama management that must be frequent and invasive, led Mateas & Stern to sacrifice the strong autonomy position, and instead propose the use of an architectural entity to specify character behavior at the dramatic beat level, i.e., at a level "above the individual characters" (Mateas & Stern, 2000, p.116).

8.3.3 Drama Management Properties for Autonomous Characters

In their argumentation, Mateas & Stern (2000) have a specific role for drama management in mind which does not apply to the emergent narrative approach. Here, I argue that the arguments of Mateas & Stern do not invalidate the strong autonomy position per se, but only the neo-Aristotelian model of interactive drama, in which a tight, author-given story structure is to be maintained. For emergent narrative which does not rely on this goal, these arguments instead help to identify an alternative conception of drama management.

Several assumptions can be detected in the argumentation of Mateas & Stern (2000) as well, following from their specific conception of drama management. First, Mateas & Stern assume that dramatically interesting behavior *only* happens when it is selected based on story state, and thus that drama management must be frequent. This may be true when author-given plot points must be achieved for successful drama management, but there is no such requirement for emergent narrative as it has no top-down plot design. In emergent narrative, interactions are not 'selected' to reach a specific next point in the story state, and the story will not per definition be 'drifting' in between. The question is of course what story state means in the case of emergent narrative, as there is no predetermined 'end' that the sequence of actions is moving towards. However, the sequence of actions can still be 'building on each other'.

This means that drama management decisions are additive, and are characterized by incrementality. They are not aimed at achieving a specific future course of events or a specific plot point in the future, but rather try at incrementally building on what has already emerged. At each point in the simulation, the story direction can only be influenced to a small degree.

Property 1. *If autonomous characters are used, drama management is incremental.*

Second, Mateas & Stern assume that the nature of story-level goals necessitates the careful selection and coordination of behavior in order to achieve them (e.g., the revelation of important information in an argument). Such story-level goals are incompatible with the emergent narrative approach, since the drama manager cannot 'look into the future' to see which character decisions achieve its desired story-level goals. This introduces the second property of drama management for autonomous characters, namely that it needs to be *opportune*, that is, story-level goals are pursued when opportunities occur to achieve them, rather than requiring a careful coercion of the event sequence.

Property 2. *If autonomous characters are used, drama management must be opportune.*

The argument that the design of autonomous characters cannot be decoupled from ways in which they can be guided still holds. The strong interaction between guidance and internal state of the character makes this guidance unreliable. This introduces a third property of drama management for autonomous characters, namely that story-level goals must be *optional*, that is, abandoning them does not lead to failure of the storyworld simulation.

Property 3. *If autonomous characters are used, story-level goals must be optional.*

Based on these properties, we can reframe the question whether drama management is possible for autonomous characters, into the question whether we can meaningfully define incremental, opportune and optional story-level goals. The pursuit of such goals also no longer requires a centralized drama manager per se, and opens up the possibility to distribute some of these goals over the individual characters. This approach and its advantages will be discussed in section 8.3.4.

This conception of drama management entails that the narrative quality may vary depending on the way the simulation plays out. In the absence of a top-down plot design, there is no 'right' or 'wrong' thing for the characters to do from a plot perspective. Still, there is added value for drama management. In the absence of drama management decisions, we have a standard emergent narrative simulation. In its presence, there might be opportunities to achieve a more interesting fabula than would have otherwise been obtained.

8.3.4 Distributed Drama Management: from Characters to Actors

For emergent narrative, Louchart *et al.* (2008a) propose a distribution of drama management decisions over the individual characters. The reason is that for emergent narrative — as we saw in chapter 3 — narrative is subjective and personal; what 'the story' is depends on who you ask. Consequently, drama management should focus not on the quality of the overall story, but on the quality of the story experience from the perspective of each of the characters. From this position, a distributed drama management approach seems natural.

As we saw in chapter 4, the subjectivity of narrative is a difference between emergent narrative and improvisational theater. In improv, actors *do* aim for a single story performance for an audience. As we saw in chapter 7, it is also a difference between emergent narrative and The Virtual Storyteller as a story generator, where the aim is to create narrative texts for an audience external to the emergent narrative. Still, both the improv model and narrative generation in The Virtual Storyteller can be characterized by a distributed drama management approach, as each agent carries responsibility for the story, and none of the agents controls its outcome.

The arguments in this section so far also provide a *technical* reason for a distributed drama management approach. The high interdependence of the character and drama management concerns makes it sensible to integrate these concerns within one agent. Drama management interventions may affect many decision points in the agent architecture. They may affect which perceptions the agent does or does not have (e.g., the bunny does not see the pitfall that the fox has dug for him), which inferences it makes (e.g., Romeo thought that Juliet was really dead), which emotions are felt (e.g., James Bond's sexual attraction to the spies of his villains helps to get him in trouble), which goals are adopted (e.g., Frodo sets out to destroy the ring despite his fear), and which actions are undertaken to achieve them (e.g., the chased villain can escape through a variety of routes; the hero happens to pick the correct route by 'coincidence'). Furthermore, some opportunities for drama management may only be realized *during* character-level processing. For instance, the question whether a certain action can believably be pursued at a certain point in time may depend on whether it can be made part of a goal plan. This may only be realized during planning.

In-Character and Out-Of-Character

For agent design, the concerns of character autonomy and drama management may conceptually be thought of as two roles of the agent (Arinbjarnar & Kudenko, 2009); I call these the in-character role (IC role) following Hayes-Roth *et al.* (1997), and the out-of-character role (OOC role), borrowing these terms from RPG discourse. Architecturally, these roles cannot be cleanly separated into two loosely coupled modules, because of their high interdependence. Again, a tight coupling is deemed unavoidable in order to maximize detection of drama management opportunities. See figure 8.5.

The OOC role is a tightly coupled extension of the IC role where 'guidance' takes on the form of ways to control, constrain and adapt IC processes for the sake of interesting story development, depending on the implementation of the IC role.

The IC role is the generator of character behavior. For modeling the IC role, one can draw from the large body of AI research on believable virtual characters and cognitive modeling. However, when making architectural choices, one should also take possibilities for OOC interventions into account. One can imagine there are trade-offs to be made between the complexity of the character model (the IC role) and the possibilities to influence or guide its processes.

In this sense, the IC role is not only a generator of behavior but also a model

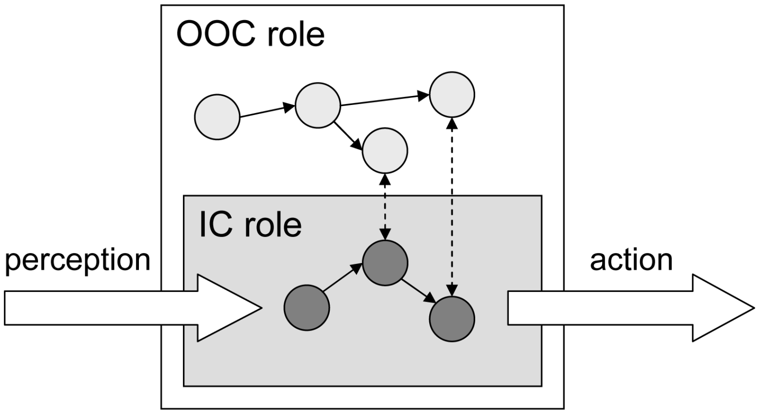

Figure 8.5: Two tightly coupled roles of a Character Agent: in-character (IC) and out-of-character (OOC). The circles represent cognitive processes.

of character consistency and continuity. For interactive drama, the OZ experiment showed that people are less critical of character inconsistencies when they participate in the drama than when they are external observers (Kelso *et al.*, 1993). This can be kept in mind when making trade-offs in agent design.

Actor-Level Goals

The assumption of the type of drama management introduced here is that it is possible to determine heuristics for story development that do not rely too much on the necessity to plan for other characters or plan too far ahead. These heuristics serve as abstract actor-level goals that aim for the achievement of more interesting stories.

Louchart's double appraisal mechanism is an example of this, where the agent tries to predict the emotional impact on other characters of actions it can choose from. Taking this prediction into account when choosing actions for execution has increased the dramatic value of stories in comparison to stories produced without this mechanism (Louchart & Aylett, 2007a).

The conception and formalization of actor-level goals for the OOC role can draw from those present in dramatic improvisation. Without aiming for an extensive list, here are some examples that I consider possible to formalize:

- Building on what was already established. As discussed in chapter 4, this is known as *reincorporating*, which increases coherence.
- Making sure to always have goals to pursue.
- Making sure that what happens affects a character personally. This is an aspect of *accepting* as discussed in chapter 4, and can be seen as a variant on double appraisal, in which not the offerer, but the accepter takes responsibility for making an action dramatically interesting.
- Establishing relationships with other characters.
- Having an attitude towards other characters (e.g., make sure you like or hate them).

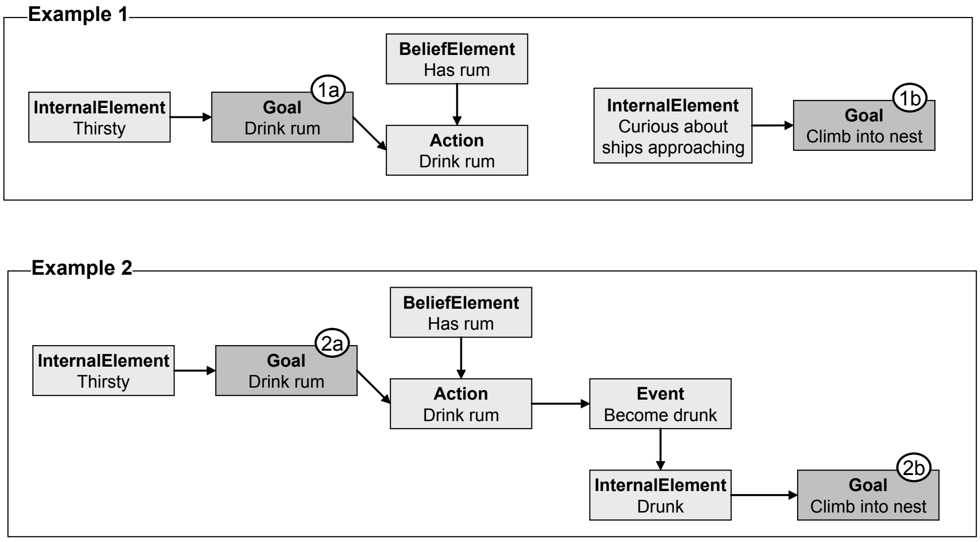

Figure 8.6: Example of causal connectedness and lack thereof of the two examples given. **Top:** goal 1a and 1b are not causally connected. **Bottom:** goal 2a and 2b are causally connected.

- Adopting goals that conflict with goals of other characters.
- Adapting emotions to maintain an emotional 'balance' according to the emotion-based dramatic tension model of figure 3.2.

Example: Coherence in Goal Selection

In improv, the notion of *reincorporating* is important for creating narrative coherence. Actors try to feed previously established details of the narrative back into their performance later on. Heuristics for this actor-level goal can be based on the causal network theory and the fabula model described in chapter 7. The important events of a story are those that are on a causal chain leading to the outcome of the story. In order to promote the occurrence of such a causal chain, the system can try to select events that can be causally connected to something that already happened.

One aspect where this is relevant is in the adoption of new goals. In The Virtual Storyteller, goals are adopted when their preconditions are met and when goal selection rules select them, but this is sometimes not enough to ensure causal connectedness. Consider the following two examples; the fabula of each is displayed in figure 8.6.

Example 1. *Pirate Billy Bones becomes thirsty and wants to drink some rum (1a). He finds a bottle of rum and drinks it. A while later, he becomes curious to know whether there are any ships approaching, and wants to climb into the crow's nest (1b).*

Example 2. *Pirate Billy Bones becomes thirsty and wants to drink some rum (2a). He finds a bottle of rum and drinks it. Then, he becomes drunk and wants to climb into the crow's nest (2b).*

An important difference between the first and the second examples, is that the two goals in the second example are causally connected, whereas the goals in the first example are not. In example 1, we can infer that goal 1b is causally connected to becoming curious, but not to goal 1a, whereas in example 2 we can infer that there is a causal chain from goal 2a to goal 2b of wanting to climb into the crow's nest.

In The Virtual Storyteller, there is an option to constrain goal selection by requiring new goals to be causally connected to those adopted earlier. This makes specific use of the causality information of the fabula generated so far. In the storyworld simulation, example 1 is only possible with the option turned off; in the constrained version, goal 1b would not be adopted. Again, this is an OOC constraint to make sure that events (in this case, goals) causally build on each other.

Increasing Actor-level Possibilities

Using this distinction between IC and OOC concerns, action pursued by a story character, as selected by the agent at a specific point in the simulation, is a function of three concerns:

- **Believability (IC).** What is the range of options the character can believably pursue based on its internal state and the state of the world? In other words, which goals can it pursue? Which emotions is it likely to feel? How does it interpret its world based on perceptions? This range of options can be increased OOC.

- **Dramatic opportunity (OOC).** Which of these options are expected to lead to the more interesting story development? In other words, which of the options contribute to the actor-level goals?

- **Variability (OOC).** Some form of story variability still needs to remain. One way to do this is to use randomness for making choices between options that are more or less equally valid.

Given the opportune-ness of actor-level goals, it makes sense to actively *create* opportunities that can then be used by the OOC role. The more choices the agent has IC at any point in time, the more chances there are to achieve actor-level goals OOC.

In improvisational theater, as we saw in chapter 4, this is done through the techniques of endowment and justification. For instance, if actor A utters the apparently neutral line "I mowed the lawn", actor B has many opportunities to make sure she has a strong emotional reaction to this line, be it positive ("Oh dear, I'm so proud you finally conquered your fear of leaving the house!") or negative ("I hate how you're so stubborn. What part of the doctor's advice 'stay in bed' do you not understand?"), depending on how the context is changed by actor B.

In section 3.2.3 I discussed methods currently used within emergent narrative to influence the event sequence, two of which can be used for endowment and justification: (1) selecting external events, (2) dynamically determining (part of) the initial state of an episode. For example, a Goal to go and eat something can be justified by the Event of becoming hungry. Then, a plan to pick apples from a nearby tree can be enabled by endowing the environment with an apple tree nearby. This means that the setting and initial state of the characters are not fixed, but are filled in during the simulation.

In the next section, I discuss an approach to modeling such late commitment decisions, and discuss one way to integrate them with IC processing within the storyworld simulation.

8.4 Late Commitment to the Initial State

The idea of *late commitment* is that much of the initial state of the storyworld does not have to be fixed at authoring time, but can be dynamically determined at run time when it turns out useful for the simulation. From the perspective of authoring emergent narrative, as discussed in section 3.3, this can be understood as a way to author the initial state in a way more in line with Firstness, i.e., in terms of possibility rather than actuality. Two reasons why this is useful for emergent narrative were discussed in chapter 3: (1) the unclear relationship for the author between the initial state and its effect on the emergence of narrative, and (2) the overcommitment made when an author has to specify every detail of the initial state.

There are two aspects to creating a model of late commitment: (1) defining a technical solution for giving the characters the OOC ability to define properties of the initial state in a consistent way; i.e., they can pretend IC that these properties have been true since the start of the simulation, and (2) determining when and why decisions should be made to define certain aspects of the storyworld at a given point in the simulation. These two aspects will be treated in sections 8.4.1 and 8.4.2, respectively.

8.4.1 Modeling Late Commitment

Using late commitment requires a mechanism to determine the conditions for asserting aspects of the initial state in retrospect, without introducing inconsistencies with what was already defined. The agents in the storyworld simulation adopt a closed-world assumption (CWA), that is, they assume complete knowledge about the world. The CWA considers propositions to be either true or false. It uses Negation as Failure (NaF): if an agent fails to find that a proposition is true, it will be considered false. As with most AI systems, this is mainly for practical reasons: it makes planning and reasoning workable. If we ask an agent to find a key, and it has no knowledge about the location of any key, it cannot make a plan. In the open world assumption (OWA), in contrast, propositions that are not true or false per se, are considered *unknown*. If we ask an agent with an OWA if a key is under the door mat, it will respond that there might be. Late commitment corresponds to the OWA, because it involves committing to the truth or falsehood of propositions that have so far been unknown, as if the agent says: “From now on, there is indeed a key under the door mat”.

Riedl & Young (2005) have made a first exploration of the benefits for story planning of leaving some propositions indeterminate in the initial state, resulting in what they call Initial State Revision (ISR) planning. Their reasons for moving away from

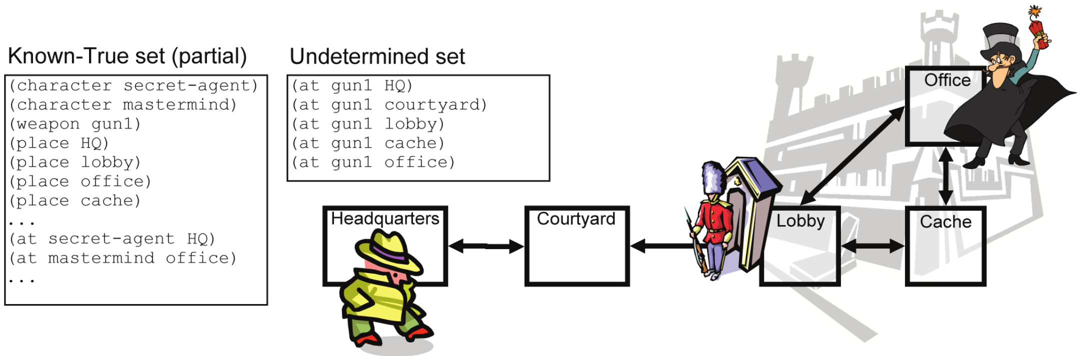

Figure 8.7: Initial State Revision (ISR) planning domain example (Riedl & Young, 2005). The location of the gun is specified as a mutex set; only one of the propositions in this set may become true.

having to completely specify the initial state of the planner are similar to our reasons for using late commitment in emergent narrative:

- An author may not have a strong disposition about some of the propositions of the initial state, but is forced to commit to such propositions anyway.
- Such a commitment keeps the space of possible story plans smaller than necessary, and may even prevent the planner from finding *any* plan at all.

Consider for example the storyworld in figure 8.7. It features a secret agent, located in his headquarters, and a terrorist mastermind, located in a heavily guarded fortress. The planner's goal is to create a story in which the mastermind dies. For this, a gun is needed to kill the mastermind. The author of the domain may have no specific disposition where this gun may be located, but if he is forced to locate it *somewhere*, he may put it at the headquarters of the secret agent. The problem is that this arbitrary choice has severe consequences: it makes it impossible for the planner to create a plan. Because the fortress is heavily guarded, there is no way for the secret agent to enter the fortress with a gun. Therefore, the gun should be located somewhere *inside* the fortress.

The ISR partial order planning algorithm of Riedl & Young (2005) allows one to specify the initial state of the planner (representing the setting of a story to be planned) in terms of propositions that have indeterminate truth value. The planner can make choices to make these propositions true or false in order to resolve open preconditions of a partial plan. To avoid inconsistencies (e.g., an object cannot be located at two different places), such indeterminate propositions are organized into *mutex sets*. A mutex set is a set of propositions with undetermined truth value, of which only one can become true. Figure 8.7 shows how the location of the gun in the secret agent world is represented as a mutex set. Once one of the propositions in the set becomes true, the other ones automatically become false.

Framing Operators

To enable late commitment within The Virtual Storyteller, we adopt a formalization similar to that of Riedl & Young, but model incomplete or undefined world states in

CarryRapier	

Preconditions:
`pirate(?char)`
`rapier(?rapier)`
`owns(?char, ?rapier)`
¬ `at(?rapier, ?loc)`
	Effects:
	`at(?rapier, ?char)`

Figure 8.8: The `CarryRapier` framing operator. Whenever there is a pirate that owns a rapier, and the rapier is not (yet) located anywhere, the `CarryRapier` framing operator can be used to commit to the fact that the pirate is carrying the rapier.

a way that is more expressive. We do not use mutex sets; instead we add a new type of operator to the story domain, which we call *framing operators*. Just like other operators used in the storyworld simulation (i.e., operators that represent character actions and storyworld events), framing operators have preconditions and effects. The difference is that the effects of a framing operator specify a *commitment* to (rather than a change in) truth or falsehood of facts of the storyworld setting.

Normal actions are performed IC (i.e., relate to the agent's character) whereas framing operators are OOC (as if the actor says to the rest of the agents: "Let's pretend my character has always hated your character."). The execution of a framing operator should create the IC illusion that it did not occur, i.e., that its effects have been true since the start of the simulation. The preconditions of the framing operator can be used to avoid inconsistencies (just like mutex sets), but also provide a mechanism to define a proper contextualization for the operator. An example is the `CarryRapier` framing operator in figure 8.8, which commits to a fact in the setting that specifies that a certain character is carrying a rapier. The preconditions contextualize the operator in an author-defined way, answering the following question: when is it believable that a certain character happens to be carrying a rapier? The `CarryRapier` operator specifies that this is the case when the character is a pirate, and the rapier is owned by this pirate. Furthermore, the rapier cannot be at two locations at the same time, so this inconsistent situation is also excluded by the preconditions.

There are three kinds of framing operators. By default, framing operators are *public*, meaning that they commit to facts that every character must assume to have always been the case. Framing operators can also be defined as *private*, meaning that only the character proposing the operator commits to these facts, which the other characters simply do not know about. Private framing operators can be used to assert secrets that a character has, e.g., that a daughter does not know that her mother is actually not her biological mother. Finally, framing operators can be *hidden*, meaning that no character commits to the facts, not even the character that planned it. This might sound strange; the reason to include hidden framing operators is that these can be used to frame such things as hidden doors, buried treasures and other aspects that a character must 'discover' via the normal, IC route of perception.

Inference Operators

Another type of operator we added in the Virtual Storyteller is the *inference operator*. Like a framing operator, an inference operator commits to facts about the storyworld. Unlike a framing operator, these facts are not considered to have been true since the beginning of the story, but rather are believable inferences that can be made from the storyworld state as it is. Unlike belief operators, these inferences affect the actual facts about the storyworld, instead of only the personal beliefs of the agent making the inferences. This means that the effects of this operator become true for *all* agents, as with framing operators, making the inference operator an OOC operator.

An example is the `StuckOnIsland` inference operator, specifying that if one is on an island, and there are no boats moored on this island, one is stuck on this island. This fact can then be the context for further action, e.g., building a raft. Another example is the `BeDrunk` inference operator, specifying that if one had more than two bottles of rum, one is drunk.

Authoring for Late Commitment

Framing operators provide authorial affordances for creating a dynamic model of the initial state of the simulation, including existents (facts about the setting and the characters), and backstory elements. For example, the author can choose to add a `HateYou` framing operator, that establishes that character A hates character B, with as only preconditions that A and B do not have a friendly relationship. This would make for somewhat flat characters that can just happen to hate each other if they so choose (OOC). The characters can be made somewhat more round if a precondition is added to the `HateYou` operator that requires a reason for the hate. For instance, `HateYou` can have a backstory precondition that the hateful character A was offended by B the previous day. Besides adding ways for characters to offend each other, one might add framing operators that establish such backstory offenses, for instance a `BeenCalledCoward` operator, which commits to the backstory fact that A had been called a coward by B (in narrative time before the simulation), and that he was offended by that incident. This way, framing operators can build on each other to further establish the setting of the emerging story at run time.

Note that the fact that late commitments are being made to existents does not mean that authorship over the existents themselves must be sacrificed. Take the `CarryRapier` example of figure 8.8 which commits to the existence of a rapier in the storyworld. At authoring time, a library of rapiers can be created, with corresponding graphics and pre-defined properties. At runtime, the variable `?rapier` is bound to one of these rapiers; the framing operator simply specifies its location property (i.e., makes sure the rapier exists at a location in the storyworld).

8.4.2 Using Late Commitment in the Storyworld Simulation

In the Virtual Storyteller, late commitment has been used for two purposes. The first is to allow the Character Agents to justify the adoption of new goals; the second is to support their action selection process by enabling a greater range of actions.

Goal Justification

For the normal IC process of goal adoption in The Virtual Storyteller, Character Agents check whether the preconditions of (author-defined) goals are met. For instance, to adopt a goal of plundering another ship it is necessary that there is another ship in sight and that the character adopting the goal is a pirate captain with the authority to make the decision to plunder. If these circumstances do not apply, The Virtual Storyteller can decide one of two things: (1) not adopt the goal or (2) *justify* the goal (OOC) by adapting the circumstances using late commitment. For instance, to make the preconditions of the goal valid, the agent can frame that there is a ship in sight and can endow its character with the role of pirate captain. A first naive heuristic used in the Virtual Storyteller to determine when to justify a goal is that the Character Agents try to always have goals to pursue. As soon as they do not have any more goals that they can pursue or adopt, the Character Agents will search for new goals that they can justify by establishing the preconditions through late commitment. A next step might be that the agents attempt to justify and adopt goals that conflict with important goals of other characters, to facilitate the emergence of interesting dramatic conflict.

Action Enablement

The Character Agents also use late commitment to support their action selection. They use a partial order planner to select actions that achieve their goals. Framing operators support this planning process by adapting the circumstances to make plans possible. For instance, if an agent playing the role of the captain of a ship has adopted a goal to find out whether an approaching ship is friend or foe, a possible plan might involve the use of binoculars to get a closer look. If these binoculars do not exist yet, the planner might not find a plan, but if it can use a framing operator that commits to them being in the captain's cabin, it can create a plan involving the captain going to his cabin to get them.

Both goal justification and action enablement make use of a partial order planner that we adapted to allow interweaving of selecting IC operators such as character actions, and OOC operators such as framing operators and storyworld events. The next section describes the algorithm of the planner incorporating late commitment, after which some more detailed examples of plans for goal justification and action enablement are given.

Both goal justification and action enablement have the effect that the elements introduced through late commitment coherently tie in with the emerging event sequence. Interestingly, as soon as a commitment has been made, it has the potential to have further causal influence on the emergence of events. For instance, as soon as a character turns out to be captain, it can start giving commands to its crew. As soon as there are binoculars in the captain's cabin, another character can frame them to be expensive gold-plated ones and steal them. This creates the kind of bi-directional causation discussed in chapter 4 that is so typical of improvisation.

8.4.3 Impro-POP: Planning with IC and OOC Operators

Let us now turn to the technical details of using late commitment to create plans such as in the above examples, by introducing Impro-POP: an adaptation of partial-order planning for interweaving IC and OOC operators.

Partial-Order Planning

Planning is the task of finding a set of actions that achieves a certain goal state. POP is a planning approach that has been used in the context of interactive storytelling and story generation research in several systems, such as MIMESIS (Young, 2002a), FABULIST (Riedl, 2004) and FearNot! (Aylett *et al.*, 2006c). In The Virtual Storyteller, POP is used by the Character Agents to construct plans of action for their character goals (Kruizinga, 2007), as in FearNot! This stands in contrast to the story planners of Young (2002a) and Riedl (2004), in which the goal state of the planner is the outcome of the whole story.

Unlike other types of planners, POP does not search through the space of possible states to find a plan. Rather, it searches through the *plan space*. A plan P in this plan space is a structure $< S, B, O, L >$ where S is a set of plan steps, B is a set of bindings to the variables of these plan steps, O is a set of ordering constraints between the steps and L is a set of causal links between steps.

The Impro-POP algorithm is based on the algorithm described in Russell & Norvig (1995, ch. 11). This is a relatively simple version of POP, which does not support conditional effects, universally quantified preconditions and goals as in UCPOP (Penberthy & Weld, 1992), or hierarchical decomposition of operators as in DPOCL (Young, Pollack, & Moore, 1994). See algorithm 1. Searching through the plan space is done by finding an open precondition c of some step S_{need} in the plan, finding steps (or new operators) that can satisfy c, and resolving potential threats to already established causal links. This way, incomplete plans are continuously being refined into better plans, until the planner finds a valid one. A valid plan contains the necessary plan steps to satisfy a certain goal state, has all preconditions of the plan steps fulfilled by other steps in the plan (including the current world state), and contains the ordering constraints that allow no possible ordering of plan steps in which causal dependencies between steps are threatened.

Because plans in our domains are often short, the algorithm is executed in an iterative deepening manner to speed up the planning process. It explores the full plan space for a given maximum number of plan steps (starting at 1), incrementing this number if it cannot find a plan at this depth.

Interweaving IC and OOC Operators in a Plan

For Impro-POP, we extended the `Choose-Operator` procedure of the planning algorithm of Russell & Norvig (1995, ch. 11) by making a semantic distinction between operators whose selection is motivated IC (e.g., normal character actions) and OOC (e.g., framing operators or unintentional events). We add the option of choosing OOC operators in a failure-driven fashion; adding such operators to the partial plan is considered only after the planner has tried reusing plan steps already in the (partial)

Algorithm 1 The Impro-POP algorithm

function IMPRO-POP(*goal, operators*) **returns** *plan*
    plan $\leftarrow$ MAKE-MINIMAL-PLAN(*goal*)
    loop do
        if SOLUTION(*plan*) **then return** *plan*
        $S_{need}, c \leftarrow$ SELECT-SUBGOAL(*plan*)
        CHOOSE-OPERATOR(*plan, operators,* S_{need}, c)
        RESOLVE-THREATS(*plan*)
    end

function SELECT-SUBGOAL(*plan*) **returns** S_{need}, c
    pick a plan step S_{need} from STEPS(*plan*)
        with a precondition c that has not been achieved
    return S_{need}, c

procedure CHOOSE-OPERATOR(*plan, operators,* S_{need}, c)
    choose a step S_{add} that is either
        – the start step S_{start} (**if** c currently holds)
        – an existing step $S_{existing} \in$ STEPS(*plan*)
        – a new step $S_{new} \in$ *operators* with c as effect, and either:
            – IN-CHARACTER(S_{new}) $\wedge$ IN-CHARACTER(S_{need}), or
            – OUT-OF-CHARACTER(S_{new})
    if there is no such step **then fail**
    add the causal link $S_{add} \xrightarrow{c} S_{need}$ to LINKS(*plan*)
    add the ordering constraint $S_{add} \prec S_{need}$ to ORDERINGS(*plan*)
    if $S_{add} \notin$ *operators* **then**
        add S_{add} to STEPS(*plan*)
        add $S_{start} \prec S_{add} \prec S_{finish}$ to ORDERINGS(*plan*)
        if S_{add} is a framing operator **then**
            for each $e \in$ EFFECTS(S_{add}) **do**
                add $S_{start} \xrightarrow{e} S_{add}$ to LINKS(*plan*)

procedure RESOLVE-THREATS(*plan*)
    for each S_{threat} that threatens a link $S_i \xrightarrow{c} S_j$ in LINKS(*plan*) **do**
        choose either
            Promotion: Add $S_{threat} \prec S_i$ to ORDERINGS(*plan*)
            Demotion: **if** S_{threat} is not a framing operator **then**
                add $S_j \prec S_{threat}$ to ORDERINGS(*plan*)
        if not CONSISTENT(*plan*) **then fail**
    end

function OUT-OF-CHARACTER(S)
    if S is an event operator or a framing operator **then return true**
    else return false

function IN-CHARACTER(S)
    return $\neg$ OUT-OF-CHARACTER(S)

plan or choosing new IC operators. This promotes the reincorporation of previously defined material if possible, which is an important improv concept.

Motivation flaws. A problem with combining IC and OOC operators in the planning process is that the planner might select IC operators in order to fulfill preconditions of OOC operators. This can lead to strange situations in terms of observed character motivation, such as a sailor hating his wife and planning to become a pirate, just so he can happen to be carrying a rapier to stab her with. The action to become a pirate has no apparent IC motivation, and should only be allowed if the action can be justified for other reasons (e.g., the sailor seeks adventure). In terms of a partial order plan, we call this a *motivation flaw* (see figure 8.9). To resolve motivation flaws, the planner only allows IC operators to fulfill preconditions of OOC operators, if these actions also fulfill preconditions of other IC operators (establishing an alternative, coincidental IC reason for the action to exist in the plan). A practical implementation of this constraint is to constrain `Choose-Operator` so that an open precondition of an OOC operator is only fulfilled using new OOC operators, or any step that was already in the plan.

Here, inference operators are not OOC in the same way as framing operators and event operators, because they represent inferences that can be intended and planned for both IC and OOC. Take for instance the `BeDrunk` inference operator. A pirate can plan to get another pirate drunk by feeding him bottles of rum. Only the *execution* of inference operators is OOC; planning and selection of it can be done IC.

Consistency flaws. When allowing the planner to use framing operators, a second constraint is needed in the planner to make sure that the effects of a framing operator never contradict preconditions of action steps that might be executed earlier than the framing operator. The reason is that it must seem as if these effects have been the case from the beginning of the story. The framing operator should always be executed *before* the action whose preconditions it contradicts. For instance, if a `Parley` action (negotiate with the enemy) has a precondition that specifies that the pirate is not carrying a rapier (for safe negotiation), there is a contradiction with the effect of `CarryRapier` specifying that the character *does* carry a rapier. The agent may use `CarryRapier` in the same plan if it also includes an action in which the character gets rid of the weapon, but `CarryRapier` may not be ordered after `Parley` (establishing the absence of a rapier). If it would, the plan is flawed and we call this a *consistency flaw* (see figure 8.9). To resolve consistency flaws, we force the planner to pretend that it needs the start state to establish the effects of the framing operator. This is done by adding a causal link from the start step to the framing operator for each of these effects. This way, the standard POP threat resolution will take care of the correct ordering.

With these constraints, the planner can believably include framing operators whenever they are useful for creating a plan. When executing a plan containing framing operators, the effects of the framing operators are translated into setting information that all the Character Agents receive and put in their knowledge base.

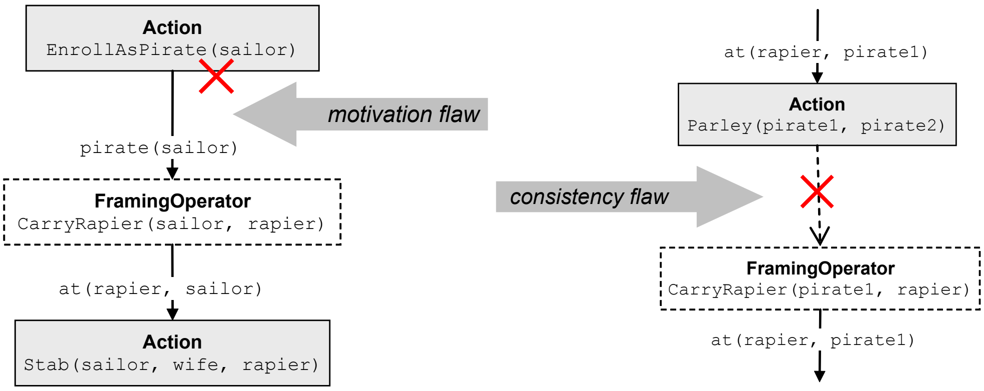

Figure 8.9: Potential flaws in plans of Impro-POP. **Left:** motivation flaw. **Right:** consistency flaw.

Planning to Justify Goals

As said before, the planner is also used for the justification of character goals. In this case, the planner attempts to find a way to satisfy currently unsatisfied preconditions of a character goal, which form the planner's goal state. The planning process is similar to that for action selection. The only difference is that a plan to justify a goal may not contain any IC operators, because the intention to establish the goal's preconditions is OOC. Therefore, the planner will only use OOC operators. After executing the resulting plan, the preconditions of the goal are met and the character can adopt the goal. This extends the set of possible goals to adopt at a given moment in time, because this set now contains:

- Goals that can be adopted because their preconditions are valid.
- Goals that can be adopted *given the successful execution of an OOC plan* that *makes* their preconditions valid.

Example

To illustrate the kinds of plans created for both action enablement and goal justification, let us consider the following example domain.

A pirate has the goal to get gold. To enable actions for a goal plan, the pirate can plan to use the `GoldInMine` framing operator that is included in the domain. This operator allows an agent to frame any mine in the storyworld to contain gold. As a constraint, the operator contains the precondition that there is no gold located elsewhere already. Using this operator, the pirate could plan to go to the mine and pick up the gold. However, there is no mine defined in the storyworld yet. This problem can be resolved using another framing operator in the domain, namely `MineAtIsland` (islands can be framed to contain mines). Using these two framing operators, the agent can make a goal plan to sail to the island, go into the mine and get the gold. This plan is shown in figure 8.10.

Then, as the pirate picks up the gold, the story gets an unexpected turn as the agent finds he can justify the goal to escape from the mine. This goal does not *seem* to

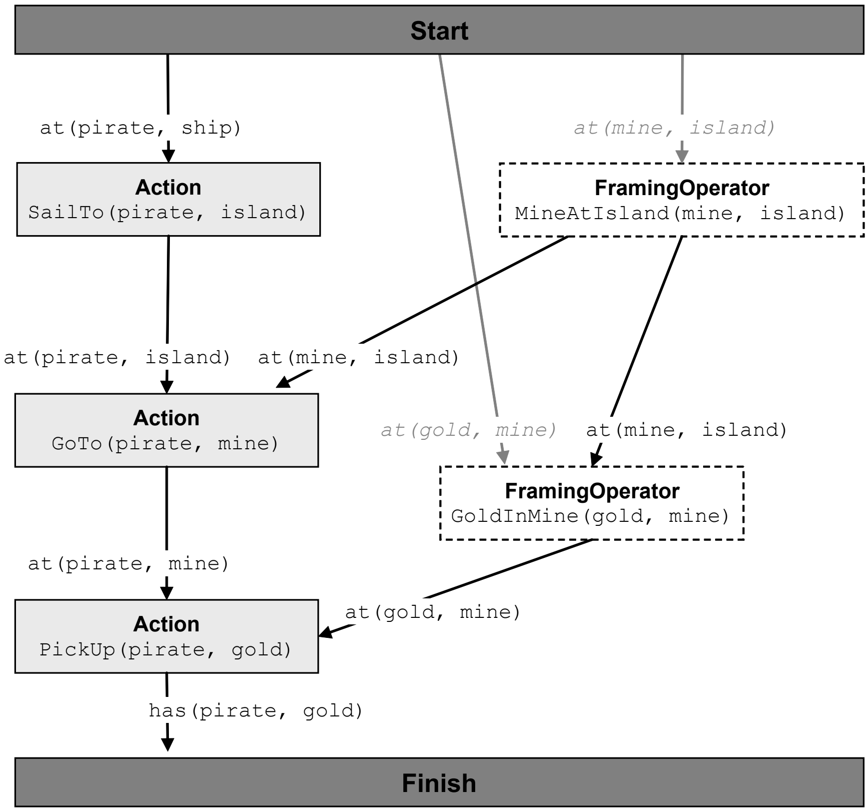

Figure 8.10: Partial order plan combining IC and OOC operators to enable a goal plan to get gold. The arrows represent causal links of the plan; the dashed rectangles represent framing operators. The faded arrows represent causal links that were added to avoid consistency flaws.

make sense at this point: the preconditions for this goal are that the character is in the mine, the mine has collapsed and the character is trapped, and these preconditions are not true. However, the domain contains operators that can *make* these true:

- The precondition that the mine has collapsed can be made true if the agent selects the `Collapse` event operator. This event operator, in turn, has a precondition that the mine must be unstable. This can be made true using a framing operator specifying that this mine is indeed unstable.
- The precondition that the character is trapped can be fulfilled using an inference operator; as soon as a character is in a mine (which is the case at this point) and this mine has collapsed (which is made true by the `Collapse` event operator), the system can commit to the inference that this character is trapped.

The resulting plan for justifying the goal to escape from the mine is shown in figure 8.11.

8.4.4 Consistency Issues of Late Commitment

We have been successfully using late commitment in several small story domains, by replacing static parts of the setting by framing operators. In chapter 9, we will see

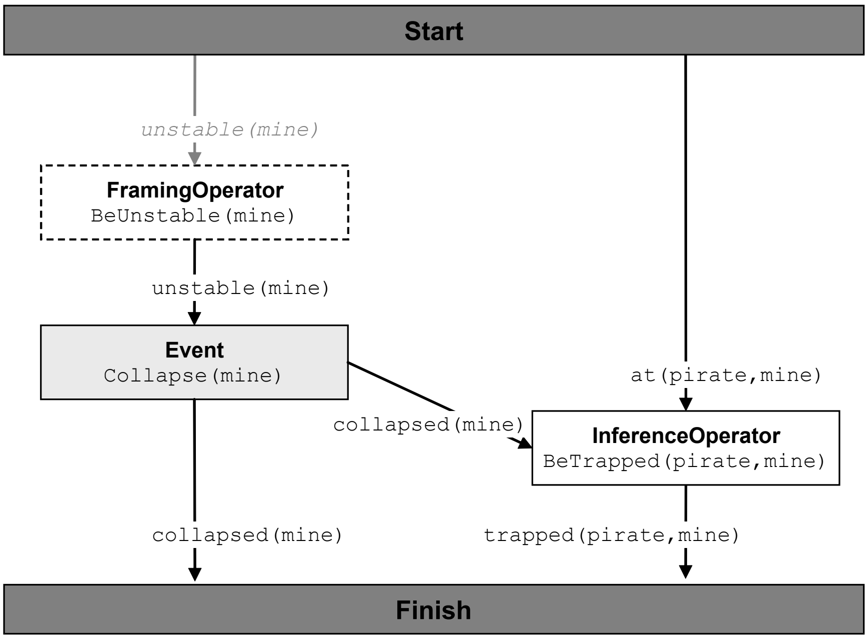

Figure 8.11: Partial order plan combining IC and OOC operators to justify a goal to escape from a collapsed mine. The arrows represent causal links of the plan; the dashed rectangles represent framing operators.

some examples of this. The challenge is to deal with the consistency issues that the use of late commitment raises.

Consistency is primarily an issue with information that is *explicitly* conveyed to the audience. Although the audience complements this information with interpretations and meaning-giving connections (which Oatley (1994) suggests are the result of the audience 'thinking for the characters'), it is not problematic for the audience when new information breaks such connections (as long as it does not contradict explicitly given information). Indeed, this leads to emotional arousal and puts the previous events in a new perspective.

The preconditions of a framing operator help to prevent many inconsistencies, but private consistency checking by one agent is ultimately not enough. We discuss here three consistency issues that must be considered when using late commitment.

The first issue involves the impact that the execution of a (public) framing operator has on characters other than the one that executes it. Since framing operators build on a shared reality, all characters must be able to unconditionally accept all effects of the framing operator as facts; otherwise the operator should be aborted. The Character Agents have a mechanism to get approval from all the other characters before executing a framing operator. See figure 8.12. Currently, the other characters always accept; the decision whether to accept or reject a framing operator needs further exploration. The other characters have to check if a proposed framing operator is consistent with their personal world view; if it is not, they should refuse it or justify the inconsistencies (e.g., "I only *thought* that there was no more rum, but forgot about that one bottle."). Since the execution of a framing operator leads to setting changes that are 'new' only from an OOC perspective, there are implications for the agents'

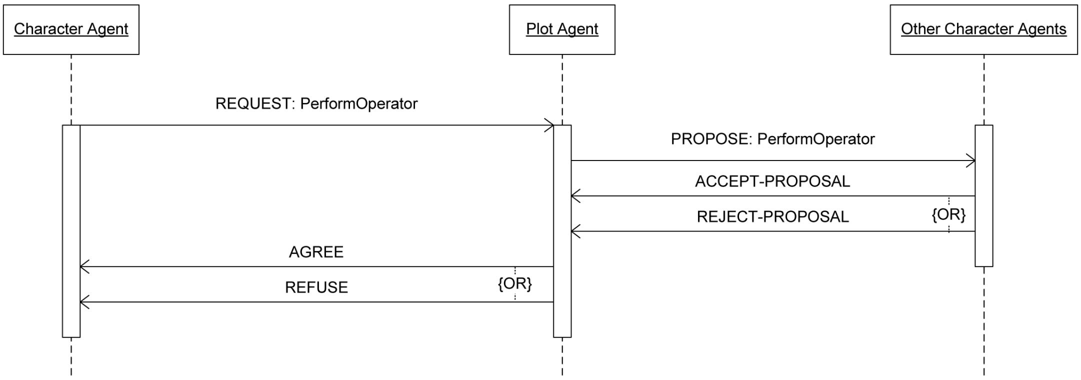

Figure 8.12: Sequence diagram of the negotiation protocol for the execution of a framing operator.

design of the IC cognitive processes. The agents must be able to believably bypass these processes and adopt the new information directly as 'old' knowledge, without for instance having an emotional response to it, or at least they must be able to assess whether they can *not* do this, so that they have to refuse the operator.

A second issue involves the fact that operators that were executed in the past imply commitments to the initial state that are currently not being taken into account. Impro-POP disallows plans in which an effect of a framing operator contradicts preconditions of actions earlier in the plan, but this does not capture the constraint that framing operator effects should also not contradict preconditions of actions that were already executed.

This goes wrong because the agents currently use Negation as Failure to assess the falsehood of facts. For instance, the `Parley` example action of section 8.4.3 has a precondition that the agent does not carry a rapier. After executing this action, the character should no longer be allowed to frame a rapier later on in the simulation, for instance to attack its enemy when the negotiation goes sour. A solution to this issue would be that the preconditions of actions that specify which propositions must be false are explicitly *asserted* as being false as soon as they are executed, instead of only relying on Negation as Failure to assess the falsehood of facts, as is currently done.

A final issue concerns the presentation of the story (e.g., in natural language, or graphics). An assumption underlying late commitment is that the setting knowledge that is not yet defined in the system (and thus can be framed), is also not communicated to the reader or interactor of the story. While this assumption applies to a large extent to textual representations, it may apply much less to graphical representations, in which showing a pirate also shows whether he is carrying a rapier or not. In this case, explicit consideration is needed for what is exactly being communicated. Framing operators that deal with the domain of interpersonal relationships ("Let's pretend I was your father") or backstories ("Let's pretend you have hurt me in the past") may be less problematic, since they are often conveyed through dialog.

Taking this into account, the freedom to introduce aspects of the storyworld in a late commitment fashion is constrained by the way in which the story is presented, in terms of medium and genre expectations. In a visual medium one needs to make sure that the displayed virtual world does not overly constrain the possibilities to define

Table 8.1: Planning and execution of operators. The labels *cf* and *mf* indicate flaws that must be taken care of when using the operator in this mode. *cf*: consistency flaws. *mf*: motivation flaws. The label *neg* indicates that the execution of the operator needs to be negotiated with other characters.

Operator type	Goal of Planner		Execution	
	IC	**OOC**	**IC**	**OOC**
Action	✓	-	✓	-
Belief	✓	-	✓	-
Expectation	✓	-	✓	-
Inference	✓	✓	-	✓
Event	*mf*	✓	-	✓
Framing	*mf*, *cf*	*cf*	-	*neg*

this world differently when necessary. For example, in a realistic 3D environment, it might appear strange when a broom pops up out of nowhere the moment a cleaning lady wants to sweep the living room floor. A cartoon-like visual medium might have fewer problems with this. A textual medium offers the most flexibility; one can always rely on the potential presence of the broom unless its presence was specifically denied. In a graphical medium, displaying the living room without a broom can remove this potential. This is one of the reasons why improvisational theater makes little use of props and uses mime instead.

8.4.5 Wrapping Up

Summarizing, we made two key distinctions:

(1) Between operator *planning*, and operator *execution*. For both, an operator may be considered IC or OOC. Only for inference operators is there a difference between planning and execution; they can be treated as both IC and OOC during the planning process, but are OOC upon execution.

(2) Between IC and OOC planner goals. The achievement of the success conditions of a character goal is an IC planning goal; satisfying the preconditions of a character goal in order to justify its adoption is an OOC planning goal.

Table 8.1 indicates whether an operator can be used for a given type of planning goal, and whether the planner must take care of motivation flaws and consistency flaws when incorporating the operator. It also indicates whether the execution of the operator is IC or OOC, and whether the operator needs to be negotiated with other characters before it is executed.

8.5 Conclusions

This chapter discussed the simulation subsystem of The Virtual Storyteller. The subsystem produces a fabula (according to the formalization introduced in chapter 7), as a result of Character Agents that play the role of a character in the story, together with a Plot Agent that facilitates the simulation. Following the emergent narrative approach, there is no guiding plot to determine what the characters in the story do.

The Character Agents are based on the FAtiMA architecture used for the FearNot! system (described in chapter 3), but their design has focused on several novel aspects:

- The ability to explain their cognitive processes in terms of causality, so they form a causal network of events constituting the fabula of the emergent narrative.
- The use of *beliefs* and *expectations*, to model believable but possibly wrong inferences in a world that is otherwise largely unknown.
- The inclusion of an *out-of-character* perspective on the simulation, allowing the Character Agents to select external events, framing operators and inference operators, and to make sure that the goals they adopt follow coherently from the event sequence so far.

The focus on these novel aspects came at the expense of the incorporation of an underlying emotional and personality model of the virtual characters. The absence thereof in the current version of The Virtual Storyteller must not be understood as a statement that it is not important for emergent narrative; indeed, earlier versions of The Virtual Storyteller *did* incorporate an emotional model (Theune *et al.*, 2004).

The out-of-character perspective offers a distributed approach to drama management, which is characterized by the pursuit of actor-level goals that are *incremental*, *opportune* and *optional*. This is a first step towards developing agents that are aware of their dramatic context, and try to seize opportunities to make it more interesting. Such an approach does not necessarily solve the lack of plot coherence that is characteristic of character-centric approaches, but does go beyond existing methods of narrative control of autonomous characters.

The technique of late commitment allows virtual agents to make run-time commitments to previously undefined aspects of a virtual storyworld using operators that we call *framing operators*. To this end, the Impro-POP algorithm was introduced: an adaptation of a standard partial order planning algorithm that also considers framing operators (and other OOC operators such as events) when resolving open precondition flaws, while ensuring that an agent never selects actions IC with the OOC intention of making framing operators possible. The use of IC and OOC operators within the planning process is one example of how the two roles are sometimes architecturally inseparable. Impro-POP facilitates plan construction for action selection and enables the agent to justify the adoption of new goals. The benefit of late commitment is that it takes away the responsibility of the author to commit to the exact properties of the initial state of the storyworld for a particular simulation run. Furthermore, it offers the characters more flexibility in their ability to influence their behavior for the sake of the story; they can to a certain extent *choose*, from an actor-level perspective, to adopt goals and enable actions, by filling in the world around them.

We have described some of the consistency issues of using framing operators in the storyworld simulation. Further experimentation will reveal if there are more, how fundamental they are, and how they can be resolved. It is likely that ultimately, only a part of the inconsistency issues can be resolved. This is also due to the fact that the knowledge representation always underspecifies what is being communicated to an audience. An open question is to what extent such inconsistencies destroy suspension of disbelief in an *interactive* setting in which the user participates as a story character. Again, as was also concluded in the OZ experiment, inconsistencies might be less of a problem from the limited, personal perspective of an interactor than from the global story perspective of a spectator or reader (Kelso *et al.*, 1993).[1]

The use of framing operators is certainly not limited to action selection and goal justification. It would be interesting to investigate what other processes can benefit from the use of late commitment. For instance, framing operators might enable perceptions (e.g., discovering a hidden door) or facilitate emotional reactions. These investigations are in service of the longer-term aim to develop criteria for story progression that allow the agents to take a more proactive stance towards story development (e.g., try to have goals that conflict).

The approach of late commitment does not invalidate the current method of authoring a predetermined dramatic frame, but simply extends it. Parts of the setting may be translated to framing operators, and other parts of the setting may remain static.

[1] Inconsistencies can also be found in the improvised stories of the experiment described in chapter 5. For instance, the third subject tells Richard and the barman that she was caught by customs with 30 kilograms of cocaine in her suitcase, but later maintains her boyfriend had put it in there without her knowledge. Of course this is an inconsistency: it is impossible to miss the fact that ones suitcase is suddenly 30 kilograms heavier than normal.

Part IV

Reflection

9 Discussion

> "And, as we remember from the set up for the story, no one knows about any bear food in this world. Between Arthur and George they only know about one worm. So the story could not have turned out any other way. As soon as the audience decided that hunger was Arthur's problem he was doomed. He made many plans, none of them had a chance of working, the end."
>
> **Noah Wardrip-Fruin**
> Commenting on the story generator TALE-SPIN, (Wardrip-Fruin, 2006, p.254)

In this chapter I reconsider the authoring of storyworlds for The Virtual Storyteller and the emergent narrative approach in general. First, in section 9.1 I provide a description of the authoring of two small story domains following the iterative authoring cycle of chapter 3. In section 9.2 I then discuss some open issues with the implementation of the simulation layer of The Virtual Storyteller. Parts of this work were published in Swartjes & Theune (2009b).

9.1 Two Case Studies

This section discusses two small story domains that were authored with The Virtual Storyteller: the PLUNDER domain about pirates and the RED domain based on the "Little Red Riding Hood" folktale. These domains are discussed here with a focus on the authoring process and the resulting event traces, rather than on the precise formalizations that underlie the authored material or on the presentation of the stories as a narrative text. In particular, the focus is on content authoring; much of the generative processes described in chapter 8 could be reused across domains.

9.1.1 Pirates

The Pirates story domain PLUNDER[1] is the main domain that the Virtual Storyteller project has been focusing on. Pirates portray stereotypical behavior that is somewhat easier to model than, say, the behavior of characters in psychological thrillers. This property is shared with the domain of fairy tales, but unlike fairy tales, we believe that pirate tales evoke fewer expectations of story structure for the reader (e.g., adherence to Propp's morphology).

Authoring Process

PLUNDER has an overarching storyline (a crew of pirates going on a treasure hunt) that forms the theme for several story subdomains, created in the course of time within the project. We brainstormed about the following questions: (1) what are some subdomains that we can conceive of to start building simulations around? (2) what are typical roles of pirates in such subdomains? (e.g., captain, boatswain) (3) what do pirates want and do there? (e.g., drink rum, commit mutiny) (4) what are typical objects associated with these subdomains? (e.g., ship, treasure map, pirate flag). To this end, we also analyzed several comic books of the Redbeard series by Jean-Michel Charlier, in order to distill characteristic pirate personality, goals and behavior. We considered subdomains in which simple stories would take place: in a bar where a crew is assembled, on a ship en route to a treasure island, and on the island where the treasure is buried.

Our initial, naive authoring approach was to enforce a co-creation process by creating a 'big bag of domain content' to bootstrap the authoring process, and to see if we could use it as a basis for subsequent iterations. The first subdomain we developed was called *on the ship*. We created two pirate characters: Anne Bonney and Billy Bones. We implemented a few goals that these pirates might have aboard a ship, and added some actions that allowed the characters to construct goal plans. For goal justification, we also added some events and framing operators. See Table 9.1.

Cycle 1. In an example simulation run (see figure 9.1), Anne Bonney used a framing operator to endow herself to be the ship's captain, framed the presence of a water supply filled with water, and selected an event that the water supply became exhausted (lines 2-4 and 8). This was done to satisfy the preconditions of the goal to replenish the water supply, one of several goals that could have been chosen for goal justification. After execution of these operators, the goal was adopted and she started acting to satisfy the goal (from line 10). Billy Bones chose to justify the goal to drink rum. To this end, he selected an event to become thirsty for some rum, and used a framing operator to establish the fact that there was rum available in a crate in the hold of the ship (lines 1, 5 and 6). This justified the adoption of the goal to drink rum. Executing the plans made for their respective goals, Anne Bonney sailed to a nearby island, went ashore and started replenishing the water supply, while Billy Bones opened the hatch to the hold, went to the hold, picked up the bottle of rum and got himself drunk. After this, Billy Bones framed himself to hate Anne Bonney (line 16) to justify and

[1]Pirates Looming in Unscripted Narrative: towards Dramatic Emergent Role play.

adopt the goal to kill her. Planning how to do this, he endowed himself with a rapier (line 19) and also went ashore to find and stab Anne. After his death threat (line 22), which is a reactive action selected based on the preconditions that (1) the character has adopted the goal to kill someone, (2) the character faces the victim, and (3) the character has not uttered this threat yet, Anne Bonney responds by adopting a goal to defend herself, triggering a reactive action to communicate this fact (line 23). In a plan to defend herself, she frames herself to also carry a rapier. Unfortunately, she is too late and is stabbed to death (lines 25 and 26 happen simultaneously).

A certain incoherence can be observed in the resulting event sequences. The causal network theory on which we base our fabula formalism (chapter 7) relates narrative coherence directly to the causal connectedness of the events (Trabasso *et al.*, 1982). It follows that coherence would be improved if the events were better causally connected, as was also suggested in chapter 3, e.g., when actions of one goal lead up to the adoption of another goal, or cause a conflict between goals and attitudes. Yet, Billy Bones' goal to kill Anne Bonney had no such causal connection to earlier fabula elements, including his own goal of getting drunk. We diagnosed this as a flaw in the AI, which we solved by further constraining the goal adoption process of the characters, so that they would only adopt goals that are at least partially caused or enabled by earlier events (as described in the previous chapter). After this debugging step, we took the co-creation view, adding more content to allow for more causal connections while building on the goals already present. So far, drinking rum, replenishing the water supply and killing a fellow pirate had little to do with each other. So, we ended up somewhat artificially adding possibilities for causal connections. For instance, we made it possible for a character to hate drunken pirates (not very pirate-like!), lead-

Table 9.1: Operators for bootstrapping the Pirates subdomain *on the ship* (informal representation).

Goal	Actions	Framing operators	Events
Drink rum	– Open hatch – Go to hold – Pick up rum	– Rum bottle is in hold	– Become thirsty
Replenish water supply	– Sail to island – Go ashore – Replenish water supply	– Pirate is the captain – Ship has a water supply	– Water supply becomes exhausted
Kill a fellow pirate	– Go to pirate – Draw rapier – Stab pirate	– Pirate hates someone – Pirate has a rapier	

1 Billy Bones becomes thirsty for some rum.
2 ∗ *The ship has a water supply.*
3 ∗ *The water supply contains water.*
4 ∗ *Anne Bonney is the captain of the ship.*
5 ∗ *There is a bottle crate in the hold of the ship.*
6 ∗ *There is a rum bottle in the bottle crate.*
7 Billy Bones opens the hatch to the hold.
8 Suddenly, the ship's water supply is exhausted!
9 Billy Bones walks to the hold via the ladder down.
10 Anne Bonney sets sail towards Treasure Island.
11 Billy Bones takes the bottle of rum out of the rum crate.
12 Anne Bonney walks to the deck via the ladder up.
13 Billy Bones drinks rum from the bottle of rum.
14 Moored at Treasure Island, Anne Bonney sets foot on land.
15 Anne Bonney walks back and forth, replenishing the water supply with water from a pond of fresh water on the island.
16 ∗ *Actually, Billy Bones hates Anne Bonney and wants to kill her.*
17 Anne Bonney becomes thirsty for some rum.
18 Billy Bones walks to the deck via the ladder up.
19 ∗ *Billy Bones carries a rapier.*
20 Billy Bones draws a rapier.
21 Moored at Treasure Island, Billy Bones sets foot on land.
22 "Prepare to meet your seaman's grave, Anne Bonney!" says Billy Bones.
23 "No way, Billy Bones!" says Anne Bonney.
24 ∗ *Anne Bonney carries a rapier.*
25 Billy Bones stabs Anne Bonney with a rapier.
26 Anne Bonney draws a rapier.

Figure 9.1: Sample story trace in the PLUNDER domain. Sentence generation is based on simple sentence templates. Starred sentences represent framing operators.

ing to murder. Another somewhat artificial addition for causal connection between goals was to add a goal to drink from the water supply (rather than to drink rum), so it would become exhausted.

Cycle 2. The newly added content resulted in the expected causal connections. See figure 9.2. For instance, Anne Bonney got drunk (line 8), after which Billy Bones saw her drunk, hated her for this (line 10), and decided to pick a fight.

Although we were on track towards the emergence of more coherent narratives, we felt that the initial arbitrary choices in story content required nontrivial work in order to embed the content within a larger causal context. It seems that this issue was at least partially caused by the 'big bag of domain content' approach. From this authoring experiment we concluded that a process of co-creation might benefit from a tighter integration of authoring and feedback, bootstrapping the authoring process from minimal content. We used this insight in the authoring process of the RED story domain, discussed next.

1 ∗ *The water supply contains water.*
2 ∗ *Billy Bones is the captain of the ship.*
3 Suddenly, the ship's water supply is exhausted!
4 Anne Bonney becomes thirsty for some rum.
5 Billy Bones sets sail towards Treasure Island.
6 Anne Bonney takes the bottle of rum from the deck.
7 Billy Bones walks back and forth, replenishing the water supply with water from a pond of fresh water on the island.
8 Anne Bonney drinks rum from the bottle of rum.
9 Billy Bones becomes thirsty for some rum.
10 ∗ *Billy Bones hates drunkards.*
11 "Prepare to meet your seaman's grave, Anne Bonney!" says Billy Bones.
12 ∗ *Anne Bonney carries a rapier.*
13 "No way, Anne Bonney!" says Billy Bones.
14 Anne Bonney draws a rapier.
15 ∗ *Billy Bones carries a rapier.*
16 Anne Bonney stabs Billy Bones with a rapier.

Figure 9.2: Example story trace in the PLUNDER domain, condensed version. Sentence generation is based on simple sentence templates. Starred sentences represent framing operators.

9.1.2 Little Red Riding Hood

The story domain RED[2] was developed for participation in the *Little Red Riding Hood Panel: The Authoring Process in Interactive Storytelling* at the ICIDS 2008 conference (Spierling & Iurgel, 2008).

Authoring Process

The co-creation mindset meant that we immediately let go of the goal to reproduce the original Little Red Riding Hood story, using it only as inspiration for the characters and their interactions.

We used three Character Agents playing the roles of Little Red Riding Hood (Red), Grandma, and Wolf. To enable a tighter feedback loop between authoring and story generation, we did not bootstrap the authoring process with a 'big bag of domain content' this time. Rather, we started with a simple and minimal design of a storyworld (e.g., a small setting, one goal and actions that can achieve it). In the case of the RED storyworld, this meant that the initial setup of the storyworld contained the goal (and accompanying actions) to bring a cake to Grandma. To enable the expression of this goal, a small storyworld topology was authored for the setting (a path from Red's house to the forest, and from the forest to Grandma's house) along with some actions (to skip from one location to another, and to give something to someone). With these initial ideas and their implementation, we started the iterative authoring cycle.

Cycle 1. A predictable story 'emerged' during simulation: Red skipped to the forest, then to Grandma's house, and gave her the cake. We chose a continuation in which

[2] Red's Emergent Drama

Grandma would eat the cake, and also wanted to enable Wolf to eat the cake, by stealing it. So we added a goal to eat something, and an action to take something from someone else. To enable goal justification, we added an event to become hungry. Furthermore, we added reactive actions for characters to greet each other.

Cycle 2. In the simulation, neither Grandma nor Wolf could adopt any goals: for them, the preconditions for available goals did not match the initial state of the storyworld. So they both justified goals to eat something by selecting the event (out-of-character) to become hungry. On her way to Grandma, Red met Wolf, who had adopted the goal to eat something and took the cake from Red. However, since Red still wanted to bring the cake to Grandma, she took the cake back from Wolf. Wolf still wanted to eat the cake, so again took he the cake from Red. This 'cake fight' continued until Red skipped to Grandma's house with the cake before Wolf managed to take the cake from her. Then, a similar situation occurred with Grandma, who did not know that Red was going to give her the cake. Because she was hungry, Grandma took the cake from Red. This also happened to solve Reds goal that Grandma had the cake. Now Red had no more goals to adopt, so she selected the event to become hungry and adopted the goal to eat something. This caused Red to take back the cake from Grandma, and eat it herself.

Some of this behavior was expected, some was surprising and inspiring (e.g., we could let Red be an assertive girl), and some was undesired, resulting from a domain underspecification: only mean persons take something from someone when it does not belong to them; nice people ask. Furthermore, if the cake can be taken away from Red without the possibility of taking it back (e.g., if Red is not mean), a response is needed to this event. We chose to have Red cry as a plausible dramatic response for little girls.

So in the implementation phase, we added a framing operator (`BeMean`) that can endow a character to be mean; furthermore, we wanted only one character in the storyworld to be mean. We added a `Cry` reactive action, triggered by someone taking something from a character without consent. Preemptively, we constrained the action selection rule for the `Cry` action so that it is only applicable to little girls.

Cycle 3. A resulting event trace of the storyworld simulation can be seen in figure 9.3. In the simulation, Wolf framed himself to be mean (line 7), facilitating a plan to take away the cake from Red. After this mean action by Wolf, Red started crying (line 14). This was as expected. As authors, we considered how the simulation might continue at this point. Red might go to Grandma to seek support. In revenge, Grandma might poison a cake and feed it to Wolf. We considered how this might open up alternative possibilities in the simulation for the cake to be poisoned by Red in an attempt to poison Grandma in case *Red* happens to be the mean one (an idea was to add a goal specifying that mean characters try to poison others). Further ideas to reuse content material were that Wolf might be allowed to satisfy his hunger by eating Grandma, or by following Red and eating them both. Red might be given the option to be distrustful and avoid interaction with Wolf.

We only implemented one of these ideas. We added a goal to seek support and added speech actions for Red to tell Grandma what happened, and to ask her what to do (lines 15-16). We also added a goal for Grandma to avenge her granddaughter by poisoning the wrongdoer, and actions that allowed a goal plan.

This is where expectation schemas proved to be very useful. In her mind, Grandma reasoned that one can expect someone to die from eating something that is poisoned, and that one can expect someone who is given a cake to eat it. These expectations, captured in two expectation schemas (`ExpEat` and `ExpDieFrom`), enabled her to construct the plan of figure 8.2. A partial execution of this plan can be seen in lines 20 and 21. However, it turned out that Grandma did not even have to give Wolf the cake as planned; being mean and hungry still, Wolf just took it away from her and ate it. When Grandma replanned, it turned out she could now achieve her goal by selecting a `Die` event (line 24), which has the preconditions that someone indeed ate something poisonous.

In some simulation runs, Red left Wolf before he had taken the cake from her. As she then met Grandma, who kept on baking and eating cakes, we incorporated a simple comedic end to the narrative by adding a reactive action for Red, faking Reds awareness of this obsessive cake binging. Line 15 of figure 9.4 shows this action. The preconditions of this goal are that Red has seen Grandma eat at least two cakes.

By using small incremental iteration cycles as in the RED domain, authorial choices are always made in a larger story context, avoiding problems of ending up with incoherent story content. Still, to avoid authoring a linear story, we found it useful to actively consider the ways in which authored material might also be used in different simulation runs (e.g., poisoning as an act of meanness). This is a way to increase density of the story landscape, as discussed in Louchart *et al.* (2008b).

9.2 Some Issues of Autonomous Characters in Dramatic Interaction

From the authoring of the story domains, we found recurring issues that result from the use of autonomous characters for dramatic interaction.

Turn-Taking

We saw in the 'cake fight' example how Wolf takes the cake from Red because he wants to have it, after which Red takes the cake from Wolf because *she* wants to have it. This interaction can continue infinitely. Making one character 'mean' avoided this problem but did not solve it structurally. Another example of an infinite interaction sometimes occurs in the PLUNDER domain when Billy Bones and Anne Bonney want to fight each other. Billy is in the hold of the ship; Anne is on the deck. Both select an action to go to each other's location; afterwards, Billy is on the deck and Anne in the hold. Again, both select an action to go to each other's location, and we return to the initial situation. Had one of them stayed put for an extra round, both would have been able to satisfy their goal. This issue could be solved by allowing only one character to select an action each round. But for high-contingency mimetic virtual environments, this is perhaps an unsatisfactory solution. For instance, it takes away

1 Grandma becomes quite hungry.
2 Wolf becomes quite hungry.
3 Little Red Riding Hood skips to the forest.
4 “Hello, Little Red Riding Hood!” says Wolf.
5 Grandma bakes the chocolate cake.
6 Grandma eats the chocolate cake.
7 ∗ *Wolf is mean.*
8 “Give me the birthday cake,” says Wolf and forcefully takes it away from Little Red Riding Hood.
9 Little Red Riding Hood skips to Grandmas house.
10 Wolf eats the birthday cake.
11 “Hello, Little Red Riding Hood!” says Grandma.
12 Grandma becomes quite hungry.
13 Wolf becomes quite hungry.
14 Little Red Riding Hood bursts out in tears.
15 “Oh Grandma,” says Little Red Riding Hood, “Wolf stole the birthday cake from me!”
16 “What should I do, Grandma?” asks Little Red Riding Hood.
17 Little Red Riding Hood becomes quite hungry.
18 Grandma bakes the apple pie.
19 “Well, Little Red Riding Hood,” says Grandma, “I have a plan to poison Wolf. You just hold on!”
20 With a few drops of cyanide, Grandma poisons the apple pie.
21 Grandma shuffles to the forest.
22 “Give me the apple pie,” says Wolf and forcefully takes it away from Grandma.
23 Wolf eats the apple pie.
24 Wolf dies.

Figure 9.3: Sample story trace in the RED domain, in which Wolf takes away the cake from Red. Sentence generation is based on simple sentence templates. Starred sentences represent framing operators.

the possibility to interrupt actions (block a sword stab). This points at the importance of incorporating a turn-taking model and mechanisms for actor-level cooperation: it is in the interest of the narrative that potentials for interaction are not missed.

Cancelling

In the ‘cake fight example’, Wolf taking the cake communicates story state progression (e.g., Wolf is mean), Red taking it back *also* communicates story state progression (e.g., Red is assertive), but if Wolf then takes it back a third time, this does *not* communicate story state progression (we already knew the wolf wanted the cake back). At the least, this issue points at the kind of story progression that goes beyond causality; although the events are still causally dependent on each other in the ‘cake fight’, there is no transformation of story state.

This relates to the improv notion of *cancelling*. When improv actors ‘cancel’, changes in story state are reversed and the story does not advance. For instance, actor A might say “Let’s go outside!” but then they discover it is raining and go back inside. Improv actors learn to avoid cancelling as much as possible.

1 Wolf becomes quite hungry.
2 Grandma becomes quite hungry.
3 Little Red Riding Hood skips to the forest.
4 “Hello, Wolf!” says Little Red Riding Hood.
5 Grandma bakes the chocolate cake.
6 “Hello, Little Red Riding Hood!” says Wolf.
7 Little Red Riding Hood skips to Grandma’s house.
8 Grandma eats the chocolate cake.
9 “Hello, Little Red Riding Hood!” says Grandma.
10 “Here you go, Grandma!” says Little Red Riding Hood, giving the birthday cake to Grandma.
11 Grandma becomes quite hungry.
12 “Oh, hey, Grandma!” says Little Red Riding Hood.
13 Grandma eats the birthday cake.
14 Little Red Riding Hood becomes quite hungry.
15 “Riiiiiight,” says Little Red Riding Hood, “well, I will just let you enjoy your cakes then, Grandma, goodbye!”

Figure 9.4: Sample of a more peaceful story trace in the RED domain, in which Wolf does not take away the cake from Red. Sentence generation is based on simple sentence templates.

Focus

When Red arrives at Grandma’s house, she bursts out in tears and says to her: “Oh grandma, the wolf has taken the cake away from me!” However, this action has no effect on Grandma. She happily continues her own line of action. Only after Red asks her “What should I do?” Grandma’s response is triggered. Figure 9.5 shows a striking similarity with a lack of awareness by characters in the game *The Sims 3*.

This may be seen as a lack of social awareness and as something that might be solved at the character level, for instance, by incorporating an event appraisal model. However, there is also an underlying problem that relates to the notion of *yielding* as described in chapter 4. Rather than there being a single focus in the interaction, both characters keep the focus of the drama by maintaining their own line of action. Sometimes, characters might have to be able to yield to the actions of other characters. At a simple level, this was incorporated into the action scheduling mechanism of the World Agent (see section 8.2.3), by disallowing concurrent execution of actions that used the same resources and nondeterministically aborting all but one of these actions. In the RED domain, for instance, this has the effect that sometimes Red’s speech acts abort because Grandma is baking a cake, and sometimes Grandma’s action to bake a cake aborts because Red is speaking.

Perhaps a fruitful direction is to define the *performance* of actions as something fundamentally joint; not as something one character does, but as something that all the characters involved do. There may be a single intent for the action (e.g., Red wants to tell Grandma what happened and selects this action), but a joint performance of it (e.g., Red speaks, Grandma listens). This points at the importance of investigating the specification of joint intentions and joint behavior at the actor level, as also supported in the ABL language underlying Façade (Mateas & Stern, 2002).

9.3 Conclusion

For The Virtual Storyteller, we found that taking the co-creation view using an iterative authoring cycle allows for a flexible incremental approach to storyworld authoring. Such an approach reduces the authorial impasse that the author of an emergent narrative faces. We have first used the iterative authoring cycle for one of the subdomains of PLUNDER, and used a further refined approach in the RED domain. We found that bootstrapping the authoring cycle with minimal storyworld content, followed by small authoring cycles, helps in achieving coherence and density of the story landscape. Based on this refined version, we aim to develop more subdomains of the PLUNDER domain.

One aspect to keep in mind with this design methodology is that it has no explicit consideration for the density of the story landscape. One might end up with a plethora of different paths with little or no causal interconnections. We found it important to have an explicit concern for the reusability of content in different contexts.

Another more general issue with the authoring of story domains is one that likely generalizes to other interactive drama approaches: as authors we had to continuously keep in mind that the free-flowing creative ideas in the idea generation phase subsequently require precise formalizations of these ideas in the implementation phase. This doublethink hurts the sort of rough, sketchy 'trying out' mentality that is perhaps essential to authoring, especially as long as authorial intent has not yet fully crystallized.

So far, the domains developed have been rather small in scale. An open question is how the authoring approach proposed here scales up. We foresee two factors that

Figure 9.5: Screenshot of The Sims 3, from the *Alice and Kev* blog of Burkinshaw (2009). The blog tells the story of a homeless family in The Sims 3. The subscript accompanying the screenshot illustrates the issue of focus: "They fight, as the daughter makes a salad, oblivious to the events."

may complicate upscaling. First, since the simulation is nondeterministic, there is no systematic way to explore all possible simulation runs and the unexpected effects that result from any implementation step. Second, the authoring approach is meant to be additive, but might in practice require revisiting earlier choices. Since process and content authoring at any point in the authoring process affect the outcome of the simulation in fundamental ways, it may be possible that authoring choices made early in the authoring process can be undermined in subsequent authoring iterations, especially where these cannot be detected from the logical representation. These are issues that need further exploration.

10 Conclusions

> "I wanted a perfect ending. Now I've learned, the hard way, that some poems don't rhyme, and some stories don't have a clear beginning, middle, and end. Life is about not knowing, having to change, taking the moment and making the best of it, without knowing what's going to happen next. Delicious ambiguity."
>
> **Gilda Radner**
> American actress and comedian (1946 – 1989)

In this chapter, I reflect on the major contributions and findings of the research presented in this thesis. These can be gathered into three themes: (1) improvised interactive drama, (2) authorship of emergent narrative systems and (3) late commitment. After discussing each of these themes, I conclude by providing directions for future work.

10.1 Towards Improvised Interactive Drama

This thesis has presented preliminary steps towards a poetics and aesthetics of what can be called an *improvised interactive drama* approach. We can define improvised interactive drama as a form of AI-based interactive drama, which differs from neo-Aristotelian interactive drama in the sense that there is no guiding plot to steer the action. Moreover, improvised interactive drama goes beyond emergent narrative in that the agents take on a collaborative, actor-level perspective, as improv actors do. For its formulation, we drew lessons from dramatic improvisation, in particular the work of Keith Johnstone (Johnstone, 1979, 1999). Character-level intentions to achieve character goals are combined with actor-level intentions to achieve more interesting drama. Following recent work (Louchart, 2007; Louchart *et al.*, 2008a), we use the term *distributed drama management* for this approach. We identified three properties for actor-level drama management goals in line with this approach: (1) incremental, (2) opportune and (3) optional. These properties are incompatible with the idea of

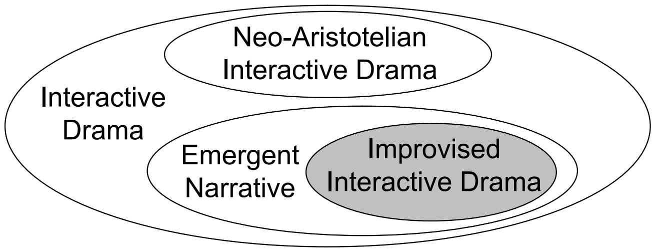

Figure 10.1: Improvised Interactive Drama in relation to other forms of Interactive Drama.

coercing characters into enacting an author-given plot, and call for alternative ways to assess and achieve dramatic development.

To explore what the experience of improvised interactive drama would be like, experiments were run in which improv actors took on the role we envision for the Character Agents. We saw that subjects, like the improv actors, also adopted an actor-level perspective, making actor-level decisions in order to have a more interesting dramatic experience.

10.2 Authoring Emergent Narrative

The thesis contributes to the discussion of authorship for interactive storytelling applications. This has remained somewhat anecdotal for the emergent narrative approach, leading to observations that authoring for emergence is a paradox (Spierling, 2007), that the indirect relationship between what can be authored and what emerges is problematic (Iurgel, 2007), and that the emergent narrative approach is based on the indefensible expectation that more complexity will eventually give rise to stories (Crawford, 2004).

This thesis contributed to the discussion by clarifying the role of human authorship within emergent narrative. First, we characterized the task of the human author as that of giving shape to a landscape of possible stories by creating virtual characters, a storyworld, and mechanisms for narrative control. The authoring process is one of *implicit creation* (Spierling, 2007), meaning that the story landscape is not directly authored, as some sort of branching narrative, but 'implied' by underlying generative models. We took from this story landscape metaphor the notions of *boundaries*, *density* and *dead ends* as practical authoring considerations.

Second, we clarified the role of authorial intent within emergent narrative authoring in order to resolve the impasse that the author faces for the actual creation of a story landscape: it is problematic to place authorial intent either at the level of actual story lines, as they emerge indirectly, or at the level of personality models of characters, as character personalities are conveyed by the choices characters make in the context of story lines. To this end, we made a distinction between (1) the rules of the underlying generative model, giving rise to a constellation of possible story developments, (2) the actual event sequences as they can be witnessed at run time, and (3) the macroscopic 'point' of the storyworld simulation as taken by users who observe and/or interact with the storyworld simulation. We argued for a way of working in which authorial intent may change depending on what the system will produce; authoring becomes the art of creating reciprocal attunement between authorial intent and system behavior, where each may change in the process. We termed this a 'co-creation' mindset, as opposed to a 'debugging' mindset which involves creating and adapting the behavior of the storyworld simulation so it comes to match with a preconceived authorial intent.

We proposed an iterative authoring cycle aimed at this co-creation process. The authoring cycle was used for the creation of two small story domains: the PLUNDER domain about pirates and the RED domain, which is loosely based on the 'Little Red Riding Hood' fairy tale. We found that in practice it helps to keep the iterations small, in order to achieve density and coherence of the resulting event sequences, and that it is important to keep density of the story landscape in mind by considering how story content can be reused in different situations.

10.3 Late Commitment

We made first steps towards understanding the computational mechanisms for creating improvised interactive drama. Most notably, we presented a model of *late commitment*, in which the idea is that rather than completely pre-specifying the initial state of the simulation, as is currently done for emergent narrative, aspects of this initial state are determined in retrospect, i.e., during the simulation. At the same time, the illusion is created that the initial state always contained these aspects. Late commitment was inspired by improvisational theater, where the action and dialog also gradually introduce new information about the fictional reality of the scene.

By specifying a more dynamic model of the initial state, agents are given more flexibility to actively determine the course of events as actors of their story. We used late commitment for two purposes: (1) enabling the construction of plans that were otherwise not possible, and (2) justifying goals by making their preconditions true. Together with event operators (representing for instance the collapse of a mine), framing operators belong to a group of out-of-character (OOC) operators, where operators representing normal character actions, beliefs and expectations belong to a group of in-character (IC) operators. To facilitate plans and justify goals, we proposed a planning algorithm called *Impro-POP* that can interweave IC and OOC operators while keeping the plans believable from an IC perspective:

- If the agent creates a plan for a character goal, each IC operator must appear motivated by the character goal.
- If the agent creates a plan to justify a goal, the *whole plan* is OOC and may not contain IC operators.

We addressed consistency issues raised by the use of framing operators, both for the execution of a framing operator (e.g., all characters must agree on the operator being executed, characters must not appraise the new information) and for interweaving OOC operators with IC operators to construct believable goal plans (e.g., IC actions may not be blindly used to satisfy preconditions of OOC operators).

10.4 Future work

A system like The Virtual Storyteller is never finished. There are many open threads of work that can bring benefit to the design of emergent narrative. The incorporation of an emotional model, as was present in a previous version of The Virtual Storyteller, seems an important next step. From FearNot!, a system that is architecturally very close to The Virtual Storyteller, we can learn that the incorporation of *probabilistic effects* of actions is important for generating emotion, because it allows the agent to realize that its plans involve risks of failure. An interesting new aspect in the line of the ideas proposed in this thesis could be that actions may have effects that the agent that plans these actions is not aware of at the character level, but can be taken into account at the actor level. An example is a genie appearing from a bottle being rubbed, planned at the actor level but leading to surprise at the character level. Another example is the agent dying from drinking rum, because it was poisoned.

In this section, we highlight some further possible directions for future work that we have already started investigating, but not to such an extent that we were able to assess their implications and value in the context of actual story domains.

10.4.1 Case-Based Reasoning for Narrative Inspiration

We have found in general that authoring in Firstness, that is, specifying the dynamic model of the storyworld for simulation, could still benefit from some way to specify story content in Secondness, that is, as (short) actual sequences of events. One idea here is to use Case-Based Reasoning techniques, similar to MINSTREL (Turner, 1994). Swartjes *et al.* (2007); Swartjes (2007) introduced the notion of a *narrative case*, a short piece of fabula, using the representation of chapter 7, that has a certain amount of contextual completeness and expresses believable character behavior in the context of an interesting dramatic interaction. Narrative cases may be authored directly, using a fabula specification tool, or captured based on rehearsals in interaction with the characters themselves, drawing from the work of Kriegel & Aylett (2008).

With narrative cases, agents can tap into the sort of script knowledge, or scaffolds, that children use in pretend play; improv actors in a dramatic performance also tap into stereotypical plot fragments. Narrative cases may guide the narrative development as a source of behavior suggestions for the characters as to what should be done next. We have termed this *narrative inspiration* (Swartjes *et al.*, 2007). Within story planning, recent work has also focused on harvesting this kind of example-based knowledge (Riedl & Sugandh, 2008).

Offline, a library of *suggestions* for actions, beliefs, goals etc. can be compiled based on these narrative cases. These suggestions are rules of the form `IF` *`context`* `THEN` *`suggestion`*. The idea of Turner's TRAMs as used in MINSTREL to creatively transform and adapt cases (Turner, 1994), can be used to transform cases into similar cases, so that one author-given case may yield a variety of different 'creative' suggestion rules. Online, these suggestion rules may fire when they match the current state of the emerging fabula. As with scripts (see section 8.3.1), these suggestions should not override character autonomy, but require the agent to be able to incorporate the events within its own cognitive state. For instance, action suggestions might be used within the planning process to give preference to plans in which the action occurs. Goal suggestions might result in more priority being given to the adoption of the suggested goal, and the goal might have to be justified using late commitment. This is similar to the 'suggest' procedure recently proposed by Si *et al.* (2009).

The offline part of the system as described above was implemented, but the actual online integration with the cognitive processes of the Character Agents was not made. This makes it difficult to give an indication of its relevance, that is, how often opportunities arise in which the suggestions from this library are applicable in comparison to the effort of authoring a library of narrative cases.

10.4.2 Plot Threads

Recent work within The Virtual Storyteller project has focused on achieving some sort of dramatic arc (in accordance with Freytag's triangle, discussed in chapter 3) in the event sequence. To this end, we have been developing the notion of *plot threads* (Tommassen, 2009), which are similar to the episode definitions of FearNot!, apart from the fact that they are meant to seamlessly tie in with the emerging event sequence, rather than changing the setting and narrating an introduction to a new episode. A plot thread is a data structure that prescribes the (type of) characters that should be available, and the preconditions that should be true when the plot thread is started. It also contains character goal suggestions.

Currently, the domains presented in chapter 9 contain only one plot thread in order to set up characters and optionally give them initial goals. In future work, the Plot Agent would use these plot threads to make the narrative go through the dramatic phases of Freytag (i.e., exposition, inciting event, rising action, climax, falling action, dénouement) by introducing primary and secondary conflicts. Conflicts between characters can be introduced by suggesting conflicting goals to the characters. The Plot Agent can construct an OOC plan including events, framing operators or inference operators, in order to make the preconditions of the plot thread valid and start it. The job of the characters is to incorporate the goal suggestions of the plot thread, for instance, using goal justification to make their preconditions true.

An example of a plot thread that introduces a secondary conflict is described by Tommassen (2009, p.59). This thread, called `MonkeyBusinessAdventure`, can occur when a pirate character's ship crashes on an island due to a heavy storm. This thread aims at creating a conflict between a group of blood-thirsty monkeys that want to attack and cook up the character in a big cooking pot, and the pirate character that wants to escape from the island. Starting the plot thread requires the use of framing operators so that (1) there are monkeys on this island, (2) these monkeys are bloodthirsty, and (3) there is a cooking pot on this island.

One way to manage the emergence of narrative in this approach is to enable or disable certain special actions, events and framing operators during certain dramatic phases. For instance, during the climax and falling action phases, the protagonist receives access to additional operators that give him an advantage over the antagonist. Examples of such operators are a `deal-final-blow` action that always succeeds in killing the antagonist in a sword fight, a `gust-of-wind` event that fortunately blows the ship of the protagonist to a desired location, and a `prison-bars-are-loose` framing operator that enables the captured protagonist to finally escape. Conversely, operators that can believably bring a character at a disadvantage might be enabled in this phase, so that an antagonist can attempt to bring misfortune to himself. This is a typical example of an actor-level concern, being in direct opposition to a character-level concern, in service of the drama.

The usability of plot threads can be properly evaluated as soon as story domains large enough in scale are authored, which is a stage we have not yet reached with The Virtual Storyteller. Also, proper use of plot threads currently fully relies on characters accepting goal suggestions specified in the plot thread. However, as discussed in chapter 8, this kind of guidance is ultimately unreliable if character autonomy is to be respected. The notion of plot threads needs further exploration to account for cases in which the goal suggestions are *not* being taken up by the characters.

10.4.3 Perceptions

Currently, every agent has complete awareness of its environment and the changes within it. This may only be believable when characters stay in one location, but not for the domains we considered in this thesis, in which there are more locations.

Current work on The Virtual Storyteller has focused on perceptions. Theoretically, events and changes in the environment can be divided into three categories: (1) those that the character cannot believably perceive; (2) those that the character cannot believably miss; (3) those that the character may or may not perceive. Besides defining functions to determine which category an event or world change belongs to when it occurs, we make use of the fact that from the actor-level perspective, the agent remains omniscient, and is afforded to make actor-level choices in category (3) about whether or not a perception occurs at the character-level, depending on what is better for the story.

Furthermore, if agents are allowed to reason about perceptions of other characters, this allows deception. It allows characters to *hide*, or — as in the 'Little Red Riding Hood' fairy tale — allows Wolf to pose as Grandma. At the actor-level, Red knows that Wolf is posing, whereas at the character-level, she does not. We have begun to explore computational processes necessary to model this kind of reasoning.

Finally, the use of beliefs and expectations becomes even more important when the agent must plan with limited knowledge. There is a strong unexplored link between expectation schemas and the idea of offers. Expectations carry a certain promise for future interaction. For instance, Grandma's expectation that Wolf will eat her poisoned cake more or less promises to the audience that this will happen. Wolf should perhaps aim to either make this expectation true, or replace the offer with an alternative (Wolf insists that Grandma takes a piece first). This requires a level of actor-level negotiation that goes further than is currently implemented.

10.4.4 Goal Selection

Goal selection by characters is an important aspect of the production of narrative, which has been largely unaddressed in work in The Virtual Storyteller. In chapter 8, we looked at an actor-level coherence heuristic for picking next goals to adopt. But also at the character level, there are opportunities for extending the current goal selection mechanism. For instance, in adopting new goals, characters often have certain significant choices to make. An enemy ship appears; do we plunder it, or try to make friends? The captain gives the order to set sail despite a fierce storm coming up; do we obey, or bail out? A pirate finds a treasure map; does he set out to find the treasure, or sell the map for a high price? Therefore, we have been looking at the notion of a *dramatic choice*, i.e., from a set of goals enabled by a situation, a character must choose one, and discard the others (Bragt, 2010). We think that allowing authors to organize character goals in terms of dramatic choices is a promising extension to the current possibilities for goal authoring and goal selection.

Another feature concerning goal selection that is currently lacking in The Virtual Storyteller is the notion of a goal hierarchy, as in Cavazza *et al.* (2002). According to Trabasso & van den Broek (1985), the hierarchical embedding of goals gives narratives an episodic structure. For instance, a pirate has the goal to become wealthy. When he finds a treasure map, he adopts a subgoal to look for the treasure. As further subgoals of this, he wants to find a crew, get a boat and travel to the island where the treasure is buried. In a sense, a partial-order plan can already be seen as a hierarchical goal structure, where the conditions of a causal link translate to (sub)goals, motivating the actions that achieve these conditions. But this lacks the semantic expression of subgoals that an author may want. The new turn for The Virtual Storyteller would be to apply late commitment to the construction of such goal hierarchies. Rather than adopting lower-level goals (e.g., go to a pirate bar) in service of higher-level goals (e.g., find crew members), the characters would do the opposite, and attempt to integrate lower-level goals into higher level goals that are committed to later in time. This way, higher-level goals gradually emerge as the storyworld simulation progresses. For instance, the goal to go to a bar can later become part of a higher-level goal to look for a treasure hunt crew, to drink away ones sorrow, or to meet with a fellow pirate, depending on the emerging circumstances in which this must be decided. Similarly, for partial-order planning, the goal for which actions have been pursued can be changed retrospectively if this is useful, as long as all actions that were already pursued in service of the old goal can be incorporated into a plan for the new goal.

10.4.5 Making The Virtual Storyteller Interactive

The ultimate step for The Virtual Storyteller is to make it interactive. In an interactive version of The Virtual Storyteller, the user would act from the perspective of one of the characters. The turn that can be made here would be that we do not have to aim for a fabula that is consistent from the perspective of *all* characters anymore. This creates an opportunity for more radical forms of narrative control, as recently presented by Si *et al.* (2009). By explicitly modeling what the user does and does not know, just as we are already modeling what each character does or does not know, we can 'cheat' with the consistency as long as we maintain a consistent perception for the user. Using late commitment, we can retrospectively (1) introduce actions that have purportedly happened elsewhere; (2) change aspects of the world that the user has not seen yet; (3) change the internal state of characters (e.g., their goals) that have not had ramifications for behavior visible to the user yet.

As the sample scenario below suggests, we might find that late commitment decisions that are visible to the user might not disrupt the experience; indeed, they can act as offers to the user to infer what to do in the environment.

> *Curtains go up. You find yourself on a ship, as you hear the cracking of the wooden planks of what appears to be a big Brigantine.* We are pirates, *you realize when you see the Jolly Roger pop up out of nowhere and start to wave in the wind. Suddenly, a broom pops up in your hand.* Hmm, I'm the boatswain again, *you think as you start mopping the deck. Suddenly, you hear a cry from the crow's nest as a few cannons appear next to you.* Are we going to plunder a ship, *you wonder excitedly. Your excitement is confirmed when you hear someone yell "Ship in sight!" and from below deck pirates start to man the cannons...*

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Summary

One of the more recent developments in interactive entertainment, art and media is the notion of *interactive digital storytelling*. One of the goals pursued here is to be able to build highly immersive, highly interactive fictional worlds in which a user can have the first-person experience of being a character in a story that unfolds in part based on the actions of the user. For this, we must go beyond the branching narrative models used in the games industry; it requires organizing story content using novel procedural and generative (AI-based) representations.

One particular approach to creating this kind of experience is that of *emergent narrative*. In the emergent narrative approach, the storyworld is inhabited by a collection of intelligent, autonomous agents, each playing out the role of a character in the storyworld. The story is not scripted, but collaboratively emerges based on the interactions of these characters with each other and with the storyworld they inhabit. The unscripted nature of emergent narrative solves the *narrative paradox*, the apparent clash between the user's freedom to interact within a virtual environment, and the goal of the system to tell a story within this environment.

The use of AI-based story generation techniques for creating interactive storytelling applications has significant ramifications for the authoring process in comparison to traditional story writing. It creates tensions between what an author envisages for the final experience, what an author is afforded to express with the system, and what actually occurs at run time, which is partially unpredictable and uncontrollable by the author due to the generativity of the AI formalisms used. This is especially true for emergent narrative, where the author faces the paradox of 'authoring for emergence'.

At the same time, for creating interactive storytelling environments, it is also important to have an understanding of what would motivate users to take action within such environments. However, due to the lack of playable prototypes, and the great effort of creating these, our understanding of user agency is still limited.

This thesis presents a conceptual and technical contribution situated within the emergent narrative approach, aiming to better understand agency and authorship of unscripted narrative in virtual environments. It does this by drawing comparisons with the theory and practice of dramatic improvisation. The thesis is organized in four parts. Part one, *Narrative in Virtual Environments*, illustrates some of the challenges of using virtual environments for interactive storytelling: the narrative paradox, the high amount of authoring required, the necessity of using story generation techniques and the resulting trade-off between story generation and authorial control.

The approach of emergent narrative is discussed in detail, and a model for authoring is proposed that goes beyond the current, rather technical discourse on emergent narrative authoring by instead investigating its processes of constructing meaning. By using C.S. Peirce's three 'modes of being', the model clarifies how the paradox of authoring for emergence can be resolved and illustrates how authorial ideas interact with system implementation. This frames authoring as a *co-creation* between author and storyworld-under-development, decreasing the tension between authorial control and system generativity. In this conception, authoring must be iterative; in each authoring cycle, authorial decisions are made in the context of what actually happens in the simulations that have occurred so far.

Part two, *Dramatic Improvisation*, draws the comparison between emergent narrative and the practice of dramatic improvisation, as both are based on a collaborative emergence of drama. The process of story construction within improvisational theater is described based on the work of Keith Johnstone, resulting in guidelines for the design of agents for emergent narrative. The improvisational theater model is also used to clarify agency within emergent narrative, by means of an experiment in which human improv actors were given the task to immerse a participant in an engaging improvised dramatic experience. Interestingly, the poetics of dramatic improvisation, in which each actor has the perspective of both a character *within* the world of the story and a collaborative actor *of* this storyworld, appears to extend naturally to subjects that have little to no experience with dramatic improvisation.

Part three, *The Virtual Storyteller*, describes the design of a system that generates simple stories based on the emergent narrative approach. This system, called The Virtual Storyteller, generates stories in two phases: (1) the simulation phase, which uses an emergent narrative setup to simulate a particular course of events (a fabula, for which a formal model is given), and (2) the presentation phase, in which the fabula produced is used to construct a narrative text. Some of the techniques used in dramatic improvisation were translated into architectural components of the agents in order to open up an actor-level perspective on the story construction process. Most notably, the concept of *late commitment* is introduced to refer to the ability of agents to retroactively define aspects of the initial state of the storyworld, as is also done in dramatic improvisation. A formalization and implementation of late commitment was made for The Virtual Storyteller, where it is used to justify the adoption of character goals and to enable plans of action for these goals.

The thesis concludes with part four, *Reflection*, which discusses the authoring process, the simulation and resulting event sequences of two sample story domains. The claims of this thesis are illustrated here: it is shown that in addition to informing agency, a model of dramatic improvisation also holds promise for the design of believable agents involved in the collaborative emergence of narrative, as well as for understanding the iterative process of authoring for emergence.

Samenvatting

Een van de recente ontwikkelingen in interactieve media, kunst en entertainment is het idee van *interactief digitaal verhalen vertellen*. Een van de doelen die hier nagestreefd worden is om het mogelijk te maken om zeer immersieve, sterk interactieve fictieve werelden te creëren waarin een gebruiker een verhaal kan beleven vanuit het perspectief van een van de karakters van het verhaal, waarbij het verhaal zich ontvouwt deels op basis van de acties van de gebruiker. Hiervoor moeten we voorbij modellen gebaseerd op vertakkende verhaallijnen zoals die in de gamesindustrie gebruikt worden; het vereist dat verhaalinhoud gespecificeerd wordt in de vorm van nieuwe procedurele en generatieve (AI-gebaseerde) representaties.

Een specifieke aanpak voor het creëren van zo'n soort ervaring is die van *emergent narrative*. In de emergent narrative aanpak wordt een verhaalwereld bevolkt door een verzameling intelligente, autonome agents, die elk de rol spelen van een verhaalkarakter. Het verhaal is niet voorgeschreven, maar ontstaat collaboratief uit de interacties van deze karakters met elkaar en met de verhaalwereld waarin ze zich bevinden. Het niet-voorgeschreven karakter van emergent narrative lost de *narrative paradox* op: de schijnbare botsing tussen de vrijheid van de gebruiker om interactie te hebben met een virtuele omgeving, en de doel van het systeem om een verhaal te vertellen in deze omgeving.

Het gebruik van AI-gebaseerde verhaalgeneratietechnieken voor het creëren van interactieve verhaaltoepassingen heeft verstrekkende gevolgen voor het creatieproces in vergelijking tot het traditioneel schrijven van verhalen. Het creëert spanningen tussen wat de auteur voor ogen heeft voor de uiteindelijke ervaring, wat de auteur kan bewerkstelligen met het systeem, en wat er daadwerkelijk gebeurt als het systeem draait, wat voor de auteur deels onvoorspelbaar en oncontroleerbaar is vanwege de generativiteit van de AI formalismes die gebruikt worden. Dit is in het bijzonder waar voor emergent narrative, waar de auteur voor de paradoxale taak staat om 'emergentie te creëren'.

Tegelijkertijd is het voor het creëren van interactieve verhaalomgevingen ook belangrijk om te begrijpen wat een gebruiker motiveert om actie te ondernemen in zulke omgevingen. Door het gebrek aan speelbare prototypes en de moeite die het kost om deze te maken, is ons begrip van *agency* van gebruikers binnen interactieve verhalen beperkt gebleven.

Dit proefschrift maakt een conceptuele en technische bijdrage aan de emergent narrative aanpak, met als doel om een beter begrip te krijgen van agency en auteurschap van niet-voorgeschreven verhalen in virtuele omgevingen. Het doet dit door vergelijkingen te trekken met de theorie en pratijk van toneelimprovisatie. Dit proefschrift bevat vier delen. Deel één, *Narrative in Virtual Environments*, bespreekt enkele uitdagingen van het gebruik van virtuele werelden voor interactieve verhalen: de narrative paradox, de grote hoeveelheid authoring die nodig is, de noodzaak van het gebruik van verhaalgeneratietechnieken en de resulterende afweging tussen verhaalgeneratie en controle over de evaring. De aanpak van emergent narrative wordt in detail besproken en een model van het creatieproces wordt voorgesteld dat verder gaat dan de huidige, nogal technische bespreking van de creatieve taak voor emergent narrative, door te kijken naar het proces van betekenisvorming dat bij dit creatieproces komt kijken. Door gebruik te maken van de drie 'zijnswijzes' van C.S. Peirce, verheldert het model hoe ideeën van de auteur een wisselwerking hebben met systeemimplementatie. Dit maakt de creatie van emergent narrative eigenlijk een *co-creatie* tussen auteur en verhaalwereld-onder-constructie. Door het op deze manier te zien wordt de spanning tussen controle van de auteur en generativiteit van het systeem verkleind. In deze kijk moet het creatieproces iteratief zijn; in elke creatieronde maakt de auteur keuzes in context van wat daadwerkelijk gebeurt binnen de simulaties.

Deel twee, *Dramatic Improvisation*, trekt de vergelijking tussen emergent narrative en de praktijk van toneelimprovisatie, aangezien beiden gebaseerd zijn op een collaboratieve emergentie van verhalen. Het proces van verhaalconstructie in improvisatietheater wordt beschreven aan de hand van het werk van Keith Johnstone, wat resulteert in lessen voor het ontwerpen van agents voor emergent narrative. Het improvisatietheatermodel wordt ook gebruikt om agency binnen emergent narrative te verhelderen door middel van een experiment, waarbij menselijke improvisatieacteurs de taak kregen om een deelnemer te betrekken in een pakkende, geïmproviseerde verhaalervaring. Interessant is dat de poëtiek van toneelimprovisatie, waarbij elke acteur het perspectief aanneemt van zowel een karakter *in* het verhaal alsook van een acteur *van* het verhaal, zich ook lijkt te lenen voor deelnemers die weinig tot geen ervaring hebben met toneelimprovisatie.

Deel drie, *The Virtual Storyteller*, beschrijft het ontwerp van een systeem dat simpele verhalen genereert volgens de emergent narrative aanpak. Dit systeem, dat The Virtual Storyteller heet, genereert verhalen in twee fases: (1) de simulatiefase, waarin een emergent narrative opzet gebruikt wordt om een specifieke gebeurtenissenvolgorde te simuleren (een fabula, waarvoor een formeel model wordt gegeven), en (2) de presentatiefase, waarin de geproduceerde fabula gebruikt wordt om een tekstueel verhaal te construeren. Sommige technieken die gebruikt worden in toneelimprovisatie zijn vertaald naar componenten van de agent-architectuur, zodat de agents een acteurperspectief op het verhaalconstructieproces krijgen. In het bijzonder wordt het concept van *late commitment* geïntroduceerd, dat verwijst naar de mogelijkheid van agents om met terugwerkende kracht aspecten van de beginsituatie van de verhaalwereld te definiëren, zoals ook gedaan wordt in toneelimprovisatie. Voor The Virtual Storyteller is een formalisatie en implementatie gemaakt van late commitment. In het systeem wordt het gebruikt om het aannemen van karakter-doelen te rechtvaardigen, en om plannen voor deze doelen mogelijk te maken.

Het proefschrift eindigt met deel vier, *Reflection*, waarin het creatieproces, de simulatie en de resulterende gebeurtenissenvolgordes van twee voorbeeld-verhaaldomeinen besproken worden. Hier worden de beweringen van dit proefschrift geïllustreerd: het laat zien dat naast het beter begrijpen van agency, een model van toneelimprovisatie ook potentie biedt voor het ontwerpen van geloofwaardige agents die betrokken zijn bij de collaboratieve emergentie van verhalen, alsook voor het begrijpen van het iteratieve creatieproces voor emergent narrative.

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