THE UNIVERSITY OF SUSSEX

# MEXICA: A Computer Model of Creativity in Writing

Submitted for the degree of D. Phil

Rafael Pérez y Pérez

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## Declaration

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I hereby declare that this thesis has not been submitted, either in the same or different form, to this or any other university for a degree.

**Rafael Pérez y Pérez**

**To the memory of my mother:**

**Ma. Del Pilar Pérez Álvarez**

**who died in México City while I was starting this research in England, and who taught us never to give up.**

**Dedicated to my nephew and godson:**

**Tomás García Pérez**

**who was born in México City while I was completing this research and whom, since he was conceived, fought to live and never gave up.**

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## ABSTRACT

The goal of this research is to develop a computational model of the creative process of writing in terms of Engaged and Reflective States, which attempts to complement and extend previous models based on problem solving approach. The Engaged State can be described as a state in which the writer is intensely involved in the production of material related to the task. Such a production guided by tacit constraints (e.g. cultural background) relies on previous experiences and stored mental schemas, and avoids the use of deliberate planning and explicit story-structures to develop the tale. The Reflective State can be described as a state where the writer analyses and/or evaluates the current work and also deliberately explores and transforms a conceptual space. The main hypothesis of this research is that a cycle between the Engaged and Reflective States constitutes an important part of the creative process.

MEXICA is a computer model designed to study the creative process in writing in terms of the cycle of engagement and reflection. It is designed to generate short stories about the MEXICAS (also wrongly known as Aztecs). MEXICA is a flexible tool where the user can set the value of different parameters to constrain the writing process and explore different aspects of story generation.

In general terms the program consists of two main routines: the first, based on a set of previous stories defined by the user through a text file, creates a group of data-structures representing abstract story schemes in long-term memory; the second, refers to these schemes while following a cycle of engagement and reflection to create new stories.

An evaluation of MEXICA indicates that it provides a suitable framework for the study of the Engaged and Reflective States although different improvements are needed to generate full complete stories.

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You tell me then that I must perish
like the flowers that I cherish.
Nothing remaining of my name,
nothing remembered of my fame?
But the gardens I planted still are young –
the songs I sang will still be sung!

**Huéxotzin**
**Prince of Texcoco**

Ca. 1484

(Quoted in Jennings, 1980)

# Chapter I

## Introduction

The goal of this research is to develop a computational model of the creative process of writing in terms of engagement and reflection. It attempts to complement and extend previous models based on predefined story structures or problem solving techniques. The Engaged State can be described as a state in which the writer is intensely involved in the production of material related to the task. Such a production is guided by tacit constraints (e.g., cultural background), relies on previous experiences and stored mental schemas, and avoids the use of deliberate planning and explicit story-structures to develop the tale. The Reflective State can be described as a state where the writer analyses and/or evaluates the current work and also, as Boden (1992) points out, deliberately explores and transforms a conceptual [problem] space. In this work, the writing process consists in the production of coherent and interesting stories as a result of the interaction between engagement and reflection.

A computer program called MEXICA has been developed with this purpose. It writes (frameworks for) short stories about the Mexicas —the old inhabitants of what today is México City, also inaccurately known as Aztecs—. (This author believes that computerised story telling is far from producing stories similar to those created by human beings. Thus, although during this work MEXICA's outputs are referred as stories, what the system generates are frameworks for short stories). MEXICA's stories are represented as sequences of actions involving two characters (although actions involving one or three are also allowed). MEXICA has two main processes: the first creates all data structures in memory from information provided by the user. The second, based on such structures and as a result of a cycle between engagement and reflection, produces new stories.

The present work has the following goals. The development of a computer model that:

- Produces stories as result of a clear interaction between engagement and reflection.
- Produces material during engagement without the use of problem-solving techniques or predefined story-structures.
- Produces novel and interesting stories.
- Allows users to experiment with different parameters that constrain the writing process.

### 1.1 Writing as an Analytical Activity.

Torrance, Thomas & Robinson state that "The models of text production that currently dominate writing research (or, at least, currently are most cited in writing research articles) describe writing as the conscious and analytical application of specific cognitive strategies in pursuit of rhetorical goals"

(Torrance et al. 1996, p.189). However, Torrance et al. disagree with this position and believe that discovering what to say is part of the writing process. Other authors have expressed similar ideas. For example, the philosopher Monroe C. Beardsley writes: “In other words, as the poet moves from stage to stage, it is not that he is looking to see whether he is saying what he already meant, but that he is looking to see whether he wants to mean what he is saying.” (Beardsley 1965, cit. in Rothenberg & Hausman 1976, p.307). Carlos Fuentes[1] affirms that “The novel is a verbal search of what is waiting for to be written” (Fuentes 1993, p.28). In an interview, Aldous Huxley expresses similar ideas:

> Interviewer: Do you block out chapters or plan the over-all structure when you start out on a novel?
> Huxley: No, I work away a chapter at a time, finding my way as I go. I know very dimly when I start what's going to happen. I just have a very general idea, and then the thing develops as I write. Sometimes -it's happened to me more than once- I will write a great deal, then find it just doesn't work, and have to throw the whole thing away. I like to have a chapter finished before I begin the next one. But I’m never entirely certain what’s going to happen in the next chapter until I’ve worked it out. Things come to me in driblets, and when the driblets come I have to work hard to make them into something coherent. (Huxley, cited in Plimpton 1963, p.165)

However, even when this aspect of the writing process has been highlighted, most AI and psychological models fail to incorporate it. For example, computerised storytellers are mainly based on story grammars or problem solving methods. Story grammars provide a formal representation of plot’s structures. “A grammar consists of a set of production rules that re-write strings of symbols. Symbols that can be re-written are called non-terminals; those which cannot are terminals. Starting with a distinguished non-terminal, the rules are applied until a string of terminals is obtained.” (Rowe & Partridge 1993, p. 45). Problem solving techniques consist of “exploring the [problem] space to try to find some path from the current state to a goal state.” (Rich and Knight, 1991 p.31). None of these approaches explicitly represent this “discovering what to say” aspect of writing.
Thus, it is necessary to develop systems that include the advantages of problem-solving techniques and pre-defined story structures, but at the same permit modelling this discovering feature of writing.

## 1.2 The Approach: engagement and reflection.

Sharples’ (1994, 1996) account of the writing process offers a frame that can be used to develop a model that includes these characteristics. For him, writing consists of a cycle of engagement and reflection:

> An engaged writer [guided by tacit constraints] is devoting full attention to the task of creating text (whether it be notes or fully fleshed-out prose). Reflection consists of “sitting back” and reviewing all or part of the written material, conjuring up memories, generating ideas by association, forming and transforming ideas, and planning what new material to create and how to organize it. (Sharples, 1996 p.144)

[1] All quotes originally written in Spanish are free translations by the author.

This approach allows combining the view of writing as an analytical activity requiring evaluation and problem solving, and writing as a way to discover what to say. But furthermore, it offers a model where these two different aspects of the writing process interact and work together to produce novel written material.

How can a computer model of engagement and reflection contribute to the study of writing? Following Eglen (1997, p.2) computer models have three main uses:

- First, it allows us to verify that the theory works (at least at a computational level). That is, it can demonstrate that it is plausible to develop stories as a result of an engagement-reflection cycle. This is important since there is no other way to explicitly "observe" how the different elements in the theory work together to produce a text.
- Second, a computer model forces the modeller to think about all the details of a hypothesis rather than just concentrating on the cardinal components of it. Sharples' description of the writing process is very general; he does not include any detail of the cognitive processes involved in his account. Therefore, a computer model can provide valuable information in that respect.
- Third, and as a complement of the previous two points, a computer model allows easy testing of the hypothesis under different circumstances, which in some cases can be difficult or not feasible to perform in human subjects.

## 1.3 Outline of the Thesis.

Chapter II provides a literature review. It is organised in four sections:

- The first recapitulates different views about the creative process.
- The second discusses some of the writers' thoughts about writing.
- The third examines different theories of the writing process.
- The fourth describes and analyses computer models of story generation.

Chapter III provides a mapping between Sharples' account of writing and the computer model topic of this research. It includes:

- General description of Sharples' account of writing.
- A general introduction to MEXICA's architecture.

Chapter IV provides details of the way MEXICA works. The chapter clarifies in depth the processes followed to:

- Create all the structures in memory necessary to produce stories.
- Produce material during engagement (e.g. how to retrieve information from long-term memory, how to update working memory).
- Reflect on the material produced so far (e.g. how to break impasses, how to evaluate the story in progress).

Chapter V analyses some of the stories created by MEXICA. It includes:

- An example where the reader can trace step by step the story development.
- Examples to examine how outcomes change when different parameters in the system are modified.
- Examples of inadequate tales produced by the system.

Chapter VI provides an evaluation of MEXICA as a computer model. It includes an evaluation of:

- The stories produced by MEXICA.
- The interaction between engagement and reflection during the production of stories in MEXICA.
- The processes used to produce novel and interesting stories.
- The facilities offered by the system to experiment with the model.

Chapter VII presents the conclusions of this work: MEXICA demonstrates the plausibility of developing computer models of creativity in writing in terms of engagement and reflection. The chapter includes:

- A recapitulation of MEXICA.
- A section of future work. It describes how to improve the actual routines, which new routines can be added, and starting points for further research.

# Chapter II

# Literature Survey

> Then while I was blocking out words – you just mouth out sounds and some things come – I found the words 'Martha my dear'.. I remember George Harrison once said to me, 'I could never write songs like that. You just make 'em up, they don't mean anything to you.'.. These songs grow. Whereas it would appear to anybody else to be a song to a girl called Martha, it's actually a dog, and our relationship was platonic, believe me. (Paul McCartney cited in Miles 1997, p.498)

The objective of this chapter is to offer to the reader different views of the writing process. The chapter is divided in four sections:

- The first recapitulates different positions about the creative process.
- The second discusses some writers' thoughts about writing.
- The third examines different theories of the writing process.
- The fourth describes and analyses computer models of story generation.
- The fifth defines some key terms.

The present research focuses on the hypothesis that a cycle of engagement and reflection constitutes an important part of the creative process in human beings. The first section in this chapter reviews some of the statements where different writers, composers, researchers and philosophers have expressed similar ideas.

The second section describes writers' opinions about writing. In particular, this section concentrates on the importance in composition of writer's previous experiences. These ideas influenced the design of the Engaged State in the prototype developed as part of this research.

The third section describes five different accounts of the writing process. The first account sees problem solving as an important part of writing. The second describes writing in terms of story-grammars. The third suggests that writing (as speech) is an automatic activity, which is not driven by goals or pre-defined structures. Finally, the last two accounts consider all these views as part of the same process.

The fourth section describes four computer models of story generation and one of general cognition. These programs are based on different theories of writing and constitute relevant examples of what have been done in the field.

The fifth section offers a definition of terms such as *story* and *creativity*.

## 2.1 Some Antecedents.

With the aim of making the exposition as clear as possible, the ideas in this section are presented in a kind of evolutionary process towards the Engaged and Reflective States account and they do not necessarily follow a chronological order.

The view of creativity as a process where ideas form without control or rational intervention of the author has been mentioned for centuries. To explain this phenomena different theories have arisen: divine power (Maritain 1953), Collective Unconscious (Jung 1923), fears for death and will for immortality (Rank 1932), conflicts between artist's dependence on his mother and at the same time destructive impulses toward her genitals (Lee 1940), are some examples. The following comment illustrates this view: "... poems are not of man or human workmanship, but are divine and from the gods, and that the poets are nothing but interpreters of the gods, each one possessed by the divinity to whom he is in bondage" (Aristotle 1928, cit. in Rothenberg & Hausman 1976, p.33).

On the other hand, the view of creativity as an author-directed procedure, i.e. "a special kind of problem-solving process" (Getzels and Csikszentmihalyi 1972, cit. in Rothenberg & Hausman 1976, p.163) has also occupied the minds of many people. A statement that supports this position can be found in Poe's description of the process he followed when he wrote his famous poem "The Raven". Poe claims that "no one point in its composition is referrible [referrable] either to accident or intuition- that the work proceeded, step by step, to its completion with the precision and rigid consequence of a mathematical problem" (Poe 1846, cit. in Rothenberg & Hausman 1976, p.59)

These seemingly contradictory views of creativity as either something out of conscious control of the author or on the other hand as a rational guided problem-solving process, start to be seen as something related in some studies and reflections on artists' methods of working. In such studies, both positions are put together as parts of the creative process although, nevertheless, they still are seen as different manners of being creative.

This situation is illustrated by some of Copland's descriptions of composers: "the Franz Schubert type... is more spontaneously inspired. Music simply wells out of him..." while "The constructive type... constructs a musical work, day after day, in painstaking fashion." (Copland 1955, p.22). Another example is given by Spender who talks about two kinds of poets: "The difference between two types of genius is that one type (the Mozartian) is able to plunge the greatest depths of his own experience by the tremendous effort of a moment, the other (the Beethovenian) must dig deeper and deeper into his consciousness, layer by layer." (Pender 1946, p.116). Benedetto Croce states that "Knowledge has two forms: it is either *intuitive* knowledge or *logical* knowledge; knowledge obtained through the *imagination* or knowledge obtained through the *intellect..*" (Croce 1909, cit. in Rothenberg & Hausman 1976, p.328). Other researchers have also shared this dual division or classification. Hartley and Branthwaite (1989) talk about two kind of writers: the 'Thinkers' who "spent more time thinking about what they were doing" and the 'Doers' who "seemed to think less about what they were doing". Chandler (1992) describes how "Planners tend to think of writing primarily as a means of recording or

communicating ideas which they already have clear in their minds; Discoverers tend to experience writing primarily as a way of 'discovering' what they want to say."

Finally, this dichotomy turns into a partnership when both positions are seen as different elements of the same activity. Beardsley illustrates this situation when he asserts that:

> Though there are no universal *stages* of the creative process, there are two clearly marked *phases*, which constantly alternate throughout. They involve an interplay between conscious and preconscious activities. There is the *inventive* phase, traditionally called *inspiration*, in which new ideas formed in the preconscious and appear in consciousness. And there is the *selective* phase, which is nothing more than criticism, in which the conscious chooses or rejects the new idea after perceiving its relationships to what has already tentatively been adopted. (Beardsley 1965, cit. in Rothenberg & Hausman 1976, pp.308-309)

Following the same line, Wellek and Warren describe how in primitive societies, in order to get an inspired state, the shaman (prophet or poet) may voluntarily put himself into a trance or may involuntary be 'possessed' by some ancestral spirit-control. Thus, they define two kinds of writers: the 'possessed', i.e. the shaman, the prophet, and the "'maker', the writer who is primarily a trained, skilful, responsible craftsman... But of course these types must be understood as not mutually exclusive but polar... we have to think of the writers as both 'maker' and 'possessed'." (Wellek and Warren 1970, pp. 84-85). Sharples (1994) has summarised these views in what he has called Engagement and Reflection: "[Engagement] is being 'caught up' in a task, so that you are thinking with it, not about it..." (Sharples 1994, p.387). "Reflection allows one to think about the creative act and to view the result as an entity, available to be moulded and revised..." (Sharples 1994, p.389).

## 2.2 Writers Views about Writing.

During the Second International Symposium Creativity and Cognition 1996 at Loughborough University, the Dutch artist Fré Ilgen expressed in one of the expositions his concern about the necessity of researchers listening more frequently to what artists have to say. This section attempts to echo Ilgen's request and "listen" to what writers have to say about writing. Thus, some interviews and self-reports of well-known writers that have influenced the present research are briefly mentioned.

The use of such self-reports as a tool to study creativity has received much criticism (see e.g. Weisberg 1993). The main disadvantage of this methodology resides in its lack of control over the accuracy and/or objectivity of artists' accounts. For example, Vicente Leñero (1983) has written that when journalists or researches have asked him to talk about the "intimacy" of his most famous novel *Los albañiles*, in order to defend himself from adverse comments or to capitalise on positive appraisals, he invented social worrying, narrative searches, etc. which never were really present during the writing process. Vargas Llosa (1971) also has pointed out how unsound testimony can be. Thus, pressures like expectations about how the creative process works, artist's intentions, political positions, etc might shape self-accounts. However, on the other hand, this methodology offers important advantages; the

most significant of them is the opportunity to collect information, sometimes very private information, from an important number of well known creative artists with completely different backgrounds which would be impossible to obtain using different methods.

### 2.2.1 Writers' Experiences.

Writers' experiences are the material from where they build their stories (novels, poems, etc.). In the words of David Lodge, "Novels burn facts as engines burn fuel, and the facts can come only from the novelist's own experience or acquired knowledge." (1996, p.27) Vargas Llosa (1966) expresses the same idea when he declares that the starting point for a writer is his/her experience, and that s/he does not have any other starting point than his/her own experience of the world.
But experiences do not just give writers actions to put together in a story; they also provide the substance necessary to build structures in the writer's mind which allow her/him to see and link events, ideas, feelings, etc. in novel and surprising ways. This point is better explained through an example.

Mario Vargas Llosa (1966) describes how experiences in Victor Hugo's life influenced him to write *Les Miserables*. When Victor Hugo was young, a line of prisoners he saw on the street shocked him. He decided to write a short story about prisoners and prisons. When he was looking for information to write his book he visited the prison and discovered that there were some individuals serving life sentences because they had stolen a piece of bread. This situation made him feel angry and he came to realise the social injustice of those days. He tried to find a solution for that injustice: he talked in Parliament, wrote some articles, and at the same time he tried to write a story about the convicts' life. However something was wrong with the story, it did not satisfy him, and he left it.
While he was trying to improve prisoners' life and change the penal code, he heard about a wonderful, charitable and compassionate bishop who was living in a small town in France. Victor Hugo got excited about the story of this man and decided to write a novel whose main character was a similar bishop. In this manner, he signed a contract with a publisher and he began to write. However, when he finished the first version he got the same feeling he had had when he wrote the book about the prisoners: something was lacking and he left the project again.
He kept on writing verses and novels for some years, until one day he got the idea of combining the prisoners and bishop themes and wrote a new novel. Nevertheless, this project failed again; he had the feeling that the text was not authentic enough and he abandoned it when the French revolution started in 1848. Victor Hugo played an important role as mediator during the war; he visited all the barricades trying to get a truce while the insurgents invaded his house. However, in all those moments -writes Vargas Llosa- without him being aware of it, he was accumulating that definitive third experience which would give to the convicted and bishop's stories that social, epic and historical dimension, that kind of fervour, of ferment found on the streets, which gives all its greatness to *Les Miserables*. Victor

Hugo wrote the last version of the novel many years later, when he was in exile on an island in the Pacific Ocean.

This example described by Vargas Llosa clearly shows how previous experiences in Victor Hugo's life were essential in order to write the novel. *Les Miserables* is not a book about the French Revolution but a book that, based on historical events, presents a new view of that world to the reader. Thus, from a cognitive psychology perspective, those experiences provided Victor Hugo with an important set of mental structures that allowed him to produce a piece such as *Les Miserables*.

This idea of modifying one's own experiences to write original stories is shared by different authors. For example, Faulkner affirms that "a writer needs three things, experience, observation, and imagination..." (cited in Plimpton 1958, p.120). Julieta Campos thinks that "the novel is an inextricable alliance between memory and imagination" (1973, cit. in Klahn & Corral 1991, p.225). And Carlos Fuentes writes "What does a writer provide to his nation but the same that he demands from himself: imagination and language?" (1993, p.20). For these writers imagination plays an important role in the creative process. But what do writers understand imagination to be? According to Gabriel García Márquez, "imagination is a special faculty that artists have in order to create a new reality starting from the reality in which they live" (1979, cit. in Klahn & Corral 1991, p.123). Carlos Fuentes sees imagination as the "transformation of experience into knowledge" (1993, p.11). Mario Vargas Llosa supports these ideas when he writes "novels are not written in order to describe life but to transform it adding something new to it" (1984, cit. in Klahn & Corral 1991, p.401). He describes novels as "a [Striptease] but in reverse order: the writer starts with a nakedness which is the experience of reality and he dresses it, he covers it... in order to hide such a reality from readers and also, in many cases to hide it to himself." (Vargas Llosa 1966, cit. in Klahn & Corral 1991, p.349)

The key phrases here are "transformation of experiences" to create "new realities". The Representational Redescription model (Karmiloff-Smith 1995) seems to explain (at least in part) this process.

> ... a specifically human way to gain knowledge is for the mind to exploit internally the information that it has already stored (both innate and acquired), by redescribing its representations or, more precisely, by iteratively re-representing in different representational formats what its internal representations represent. (p 15)
> The end result of these various redescriptions is the existence in the mind of multiple representations of similar knowledge at different levels of detail and explicitness. (p. 22)

In this way, the structures obtained through redescription allow creating new events, relations, etc. That is, they "are the seeds of creativity" (Karmiloff-Smith 1993, p.28). It is hypothesised in this research that writers experiment this (or a similar) redescription process, and when their experiences have been re-represented in what Karmiloff-Smith refers as the explicit format, they are able to use them, not

always consciously, to link events in novel ways. Because this representational process provides new structures not present before in their minds, writers can write things they could not before. Thus, it is hypothesised that in order to create new realities, it is necessary to have multiple mental representations at different levels of abstraction of those experiences.

How can all these ideas been applied in this research? It is out of the scope of this work to investigate the redescription process (Karmiloff-Smith 1993, 1995). However, the concept of multiple representations of similar knowledge at different levels of abstraction, and their role during writing are important in the present work. Can MEXICA (the computer-prototype implemented in this research) transform experiences to create new realities? No, for two reasons. Firstly, it cannot have experiences. And secondly, the cognitive process necessary to perform such an activity to a human level is too complex. However, the present research attempts to provide a computer model where the same data encoded in multiple representations are the basis for the production of new material.

## 2.3 The Writing Process.

This section describes four accounts of writing where different positions are represented:

- Section 2.3.1 describes Hayes' general framework of writing based on the problem-solving approach.
- Section 2.3.2 analyses the story grammars approach (i.e. predefined story-structures).
- Section 2.3.3 describes Torrance's et al. account where writing (as speech) is seen as an automatic process, i.e. the production of material is not guided by explicit goals or predefined structures.
- Section 2.3.4 describes Gelernter's general model of creativity, where the problem-solving position and the automatic position are seen as complementing each other.
- Section 2.3.5 describes Sharples' engagement-reflection account of writing, where these two positions are seen as strongly interacting with each other.

This section attempts to offer a general perspective of those accounts that have been important in this research. See Levy & Ransdell (1996) for recent research in the writing process.

### 2.3.1 Hayes' Framework of Writing.

In 1980 Hayes and Flower published a model of the writing process, which had an important influence in the field. Recently, Hayes (1996) presented a new framework for the study of writing, which

attempts to clarify some aspects contained in the 1980 model, as well as to incorporate some of the new findings in the field.

Hayes states that his new framework does not describe major aspects of writing in detail. That is, although the framework includes well developed parts (e.g. clearly structured models of planning and text production), elements that are starting to take shape or which have just begun to be useful are also incorporated. In the same way, the relation between parts in the framework has not yet been clearly defined. Thus, the framework offers general aspects of the process rather than detailed descriptions.

The framework is divided in two main components: the task environment and the individual. Within the task environment component, Hayes includes social aspects (e.g. culture, type of audience) and physical aspects (e.g. the writing medium used) that affect the writing process. Hayes states that, since he is a psychologist and not a sociologist or cultural historian, he prefers to concentrate on the individual component. This component is constituted by four elements: Motivation/Affect, Working Memory, Long-term Memory and Cognitive Process.

1. The Motivation/Affect element is related to the nature of motivation in writing. Hayes establishes a strong link between motivation and writer's goals. He also includes within the Motivation/Affect element aspects like how beliefs about writing influence writer's motivation, affective responses to some texts, etc.

2. Working Memory has two major functions: to store information (particularly phonological and visual-spatial information) and to perform some cognitive activities (e.g. mental arithmetic, logical reasoning and semantic verification).

3. Long-term Memory stores writer's knowledge about vocabulary, grammar, audience, topic, and so on. An example of this kind of knowledge is the task schemas. Task schemas are packages of information that indicate how to carry out a specific task. They include information about the goals of a task, the processes to be used in order to accomplish the task, the sequencing of those processes, and criteria for evaluating the success of the task. Long-term memory also includes knowledge about the audience, topic, linguistics and genre.

4. Regarding the Cognitive Process, Hayes affirms that the primary cognitive functions in writing are text interpretation, reflection and text production:

- Text interpretation consists of creating internal representations from external sources. Examples of these functions are reading, listening, and scanning graphics.
- Reflection consists of creating new internal representations from other internal representations. Examples of these processes are problem solving (including planning), decision making and inferencing. Hayes states that problem solving —i.e. finding the steps necessaries to reach a goal— "constitutes a substantial part of any but the most routine composing activities" (Hayes 1996, p.20). The same occurs when people have to evaluate alternatives, i.e. decision making (e.g. what position to take in a controversial topic, what points to highlight). Thus, "like problem solving, decision making is also an important component of all but the most routine writing tasks" (Hayes

1996, p.21). Inference, which is not necessarily goal oriented, consists in deducing new information from old (e.g. writers make inferences about the knowledge and interest of audiences).

- Text production consists of producing written, spoken or graphic outputs from internal representations. Hayes suggests a model of text production. Cues, built from the writing plan and from the text produced so far, are used to retrieve into working memory a package of semantic content. A surface structure to express this content is created and stored in an articulatory buffer. When all the content is expressed or when the buffer is full, the writer articulates —either vocally or sub-vocally— the sentence part. Then, an evaluation occurs; if the articulated sentence fulfils the evaluation requirements it is written down and the process starts again. Otherwise, it is rejected and a new sentence part is built and evaluated.

All elements in the individual component (Motivation/Affect, Cognitive Process, Working Memory and Long-term Memory) interact with each other. The same occurs between the individual component and the task environment

The new framework differs from the 1980 model in the following aspects:

- Special attention to the role of working memory
- Inclusion of the visual-spatial dimension.
- Integration of the Cognitive Process and Motivation/Affect
- Reorganisation of the Cognitive Process. New and more specific models of planning, text production and revision.

### 2.3.2 Story Grammars.

Story grammar theories have been developed with the objective of creating a theory of story understanding. From a story grammar's perspective stories are considered as linguistic objects, which have a constituent structure that can be represented by a grammar. That is, story grammarians see stories as something linguistically analogous to sentences; therefore, since sentence grammars characterise the constituent structure of sentences, story grammars represent the constituent structure of stories. Since Lakoff (1972) developed the first story grammar based on Propp's (1968) studies on Russian folktales, different authors have developed their own grammars (e.g. see Rumelhart 1975, Mandler and Johnson 1977, Pemberton 1984). A grammar consists of a set of rewrite rules. Symbols that can be rewritten are called non-terminals; symbols that cannot be rewritten are called terminals. The following is an example of part of a story grammar developed by Thorndyke (1977, cit. in Black and Wilensky 1979):

Story -> Setting + Theme + Plot + Resolution
Setting -> Characters + Location + Time
Theme -> (Event)* + Goal

Plot -> Episode*
Episode -> Subgoal + Attempt + Outcome
Attempt -> Event* or Episode

The first rule in the grammar specifies that a Setting, a Theme, a Plot and a Resolution form a story. The second rule establishes that the Setting can be rewritten in three components: Characters, Location and Time. Now, the Theme is formed by one or more optional Events that initiate a Goal State (observe the notation used in this rule: the parenthesis indicates that the Event is optional, and the start symbol indicates that the Event can occur one or several times). The following rule indicates that a Plot is formed by one or more Episodes. A Subgoal state, an Attempt and an Outcome constitute an Episode. An Attempt is formed by one or more Events, or by a whole Episode, and so on.
Story grammars have been the centre of a polemic. While some authors believe that story grammars are important for story understanding, others argue that they are not the right approach. For instance, Black & Wilensky (1979) see several problems with story grammars. They state that sometimes story grammars cannot distinguish between stories and nonstories; as a consequence, they classify nonstories as stories. As an example they show how, if some of the elements that grammars used to recognise stories (e.g. setting, goals, a protagonist) are included in a procedural description text, the grammar classifies the text as a story. These authors state that the opposite problem also occurs. That is, story grammars are unsuccessful in generating many types of valid stories; as a consequence such valid stories are rejected by the grammar. As an example, they mention how story grammars can only represent stories where a main character is attempting to achieve a single goal; thus, stories with multiple and conflicting goals cannot be managed by the grammars and are classified as nonstories. Black & Wilensky suggest that studying the knowledge that readers require to understand characters' attempt to achieve goals "would be a more successful research framework than the story-grammar approach" (p. 223). Wilensky (1983) has pointed out what he believes is at the core of the problem with story grammars: he states that —while sentences are textual objects— stories are mental objects and cannot be treated as linguistic elements. Therefore, the whole approach is ill conceived. Another critic, Garnham, states that "almost none of the knowledge that we use in understanding texts has been shown to be specific to stories, and even less of it to the structure of stories" (Garnham 1983, p.153).

The followers of story grammars have a different opinion. They claim that story grammars represent the structure of stories (Mandler 1983, p. 603) but from particular domains, e.g. oral tradition (Mandler & Johnson 1980, p. 306). That is the reason why some valid stories are classified as nonstories by grammars; i.e. a valid story that does not belong to the domain cannot be recognised. Story grammars represent a kind of knowledge that people have that allows understanding and generating stories (Bereiter 1983, p. 593, Mandler 1983, p. 603). Thus, independently of the formalism used to study stories, some characterisation of their constituent structure is necessary and —as Rumelhart points out (1980)— story grammars provide it (Mandler & Johnson 1980, p. 310). Thus, Mandler concludes that a

“story grammar characterises a particular type of text; it involves an analysis of the constituent structure and ordering rules for such texts and thus is similar to the analysis of other linguistic objects, such as sentences” (Mandler 1983, p. 603).

### 2.3.3 Writing as an Automatic Process.

Torrance, Thomas & Robinson (1996) have pointed out how "Discovering what to say is part and parcel of the writing process" (p.189) and therefore the necessity of theories of writing which account, not just for the process of how ideas are transformed into text, but the way writers generate such ideas. According to them, at least two positions regarding theories of idea generation can be found: the strategic and the automatic. With reference to the strategic position, Torrance et al. point out how most of the research in text generation describes writing as a conscious and analytical problem solving process in pursuit of rhetorical goals. "Idea generation is characterised as an explicit and effortful process involving deliberate and strategic search for ideas"(p.189). An example of this position is Hayes & Flower (1980) model.

Standing by the second position, Torrance et al. suggest that instead of the analytical, strategic, cognitive activity view, writing (like speech) can be seen as a largely automatic and implicit process. Their position is based on research on human memory and theories of concept retrieval. The following are the core points of a summary made by Torrance et al. regarding such theories.

The retrieving of concepts from long-term memory works as follows. When a probe is presented in working memory, an automatic activation of related concepts in long-term memory is produced. Those concepts more strongly related to the probe are more likely to be retrieved than those less related. That is, the strength of the association between them determines whether or not an idea is retrieved. In this way, the content in the probe determines which concepts are brought into working memory.

Raaijmakers and Shiffrin (1981, cited in Torrance et al. 1996) claim that probes are formed by permanent and nonpermanent cues. The former remain unchanged during the retrieval process, while the latter are constantly modified. These changes take place in two possible situations. If a concept is retrieved, it replaces one of the nonpermanent cues selected at random and becomes part of the probe. Otherwise, if after several attempts a probe is unsuccessful in retrieving something from memory, the nonpermanent cues are "purged and replaced with the next few concepts to be retrieved." (Torrance et al. 1996, p.192).

Two points are highlighted from this summary:

1) The decisive importance of probe's content in concept-generation.
2) How a fully automatic procedure that determines such content “can result in the successful generation of a large number of concepts of a given theme.” (Torrance et al. 1996, p.193)

Torrance et al. notice how problem-solving models of writing describe similar stages for idea generation, and they summarise them as follows:

1. The writer identifies a memory probe and searches long-term memory in order to retrieve a proposition (e.g. an essay topic).
2. A process to evaluate the retrieved proposition takes place.
3. Optionally, if the proposition passes the evaluation, it is written.

If more ideas are required the process is repeated. Torrance and his colleagues suggest that, under this position, the most evident source of concepts for the writer to create the probe is the writing assignment; furthermore, additional cues are possible obtained from the analysis of the rhetorical demands of the writing task.

Thus, under the automatic position an automatic process determines the content of the probe. Under the problem-solving position, writing assignments and rhetorical demands determine the content of the probe, and an evaluation process takes place.

Within this framework, the results of a study where students were asked to write an essay about the pros and cons of decriminalising drugs are presented by Torrance et al. (1996). Its objective was to investigate the importance of strategic and automatic processes in the production of appropriate ideas for inclusion in an essay. They conclude that the results of their study “point to an idea generation process that has more in common with simple models of memory retrieval than the more strategic problem-solving account developed earlier.” (pp. 203-204) Nevertheless, they do not deny that problem-solving strategies can play an important role in writers' idea generation process.

“Much of the work on the psychology of writing ... has started from the premise that mature writing is essentially an explicit, analytic, and strategic cognitive activity... An alternative ... may be to start from the other end with the premise that writing, like speech, is largely automatic.” (p.205)

### 2.3.4 High and Low Focus.

Although not explicitly developed as a writing theory, Gelernter’s (1994) ideas of creativity are relevant to this work. He claims that the way in which a person thinks depends on a characteristic called “mental focus”. Focus is a continuous spectrum of cognitive activity ranging from high to low. At the high end of the spectrum, the thought is analytic and penetrating. “As we set off down-spectrum, thinking becomes less penetrating and more diffuse, consciousness gradually ‘spreads out’ and... emotions starts gradually to replace logical problem-solving as the glue of thought” (p. 5). Gelernter claims that creativity can be reduced to the discovery of new analogies during Low Focus, which occurs when one thought triggers another one which is related to it by shared emotions.

Sharples (1996) points out some problems with this theory. Gelernter sees emotions as the way to link thoughts; however, as Sharples mentions, other things such as a colour, a sound, etc. can also work as a link between thoughts. Gelernter's theory also excludes the possibility of analytical thought as a generator of creativity. Nevertheless, Sharples acknowledges the utility of seeing High and Low Focus as part of the same spectrum of thinking, as a way to understand writing. "When a person sits back and thinks, there is no barrier between the free association of ideas and the controlled transformation of mental spaces or the solving of problems." (Sharples 1996, p.134)

### 2.3.5 Engagement and Reflection.

This chapter has exposed two general views of creativity and writing: either as an explicit problem-solving activity, or as an automatic, low-focus process. Sharples (1996) merges these two views into one theory: for him the writing process consists of a cycle between engaged writing and deliberate reflection, guided by constraints.

During engagement the writer is completely absorbed, creating written material on an external medium. Working memory is fully devoted to the task and as a result no other deliberative cognitive activity (with the exception of speaking the words out loud) can be performed. When the writer needs to reflect on the material produced it is necessary to stop the engaged state; in this way, intervals of engagement and reflection arise.

"Reflection consists of 'sitting back' and reviewing all or part of the written material, conjuring up memories, generating ideas by association, forming and transforming ideas, and planning what new material to create and how to organize it." (Sharples 1996, p. 144)

In this way, Sharples' theory of writing suggests that "it is the entire cycle of engagement and reflection that pushes composition forward, with engagement providing new material for consideration, and reflection offering a reinterpretation of the material and new plans to be enacted." (Sharples 1996, p. 144)

Sharples' views of the writing process form the basis of this research. A more complete description of his account is presented in Section 3.1.

## 2.4 Computer Story Generation.

Most computers models developed to simulate and/or study the writing process are based on problem-solving techniques or story grammars. This section reviews some of these models, as well as a general model of human cognition, in order to present an overview of the field. The section is divided in five parts:

- Section 2.4.1 describes SOAR, a general model of human cognition based on problem-solving techniques.
- Section 2.4.2 describes TALE-SPIN, a computer model of writing based on problem-solving techniques. TALE-SPIN writes stories by setting goals for the characters and recording their attempts to achieve them. Thus, this system is concern with character-level goals.
- Section 2.4.3 describes MINSTREL, a computer model of creativity and writing. This program is a case-based problem-solver. In contrast with TALE-SPIN, MINSTREL is concern with author-level goals, and makes use of predefined story structures.
- Section 2.4.4 describes GESTER. This program is a model of story generation based on the story-grammar approach.
- Section 2.4.5 describes GRANDMOTHER. This system combines the story-grammar approach employed in GESTER with problem-solving techniques to produce stories.

Each of these computer models studies different aspects of story developing: some are concern with story structures, and others with characters' goals or the author's goals. Some of these programs mix these two positions (predefined structures and problem-solving techniques). In this way, these programs are illustrative examples of computer models of writing. For a general review and/or analysis and current research of creativity and AI see Rowe and Partridge (1993), Boden (1992, 1994, 1996), Dartnall (1994).

### 2.4.1 SOAR.

SOAR (Laird et al. 1987) is a problem-solving architecture and a model of human cognition. It is not explicitly designed for the study of creativity but to model general intelligent behaviour. It is driven by goals and subgoals which represent what the system wants to achieve. SOAR has been run on different AI problems which range from simple games to typical expert system tasks.

All its knowledge is encoded in long-term memory as a production system. The retrieval of information from long-term memory (including information about available plans and preferences about how the system should behave in its current situation) takes place in an elaboration-phase/decision-procedure cycle called the decision cycle. During the elaboration phase the current content in working memory is matched against all the rules in long-term memory. An important characteristic in SOAR is that all rules in which preconditions are satisfied are triggered in parallel, i.e., if the preconditions of one hundred rules are fulfilled, then one hundred rules are fired. Elaboration may take many steps because the information produced (by the productions) in one step may allow other elaboration to be made (new rules to be fired); so, elaboration ends when quiescence is reached. In this way, during this phase all relevant knowledge available about the current situation is brought into working memory. The decision

procedure, an architecturally fixed heuristic, selects an action to be followed from the available alternatives, and then the cycle starts again with more elaboration being made.

An impasse can occur when there are no alternatives available or the information to take a decision is not sufficient or inconsistent. Then, SOAR answers by creating a goal (a new problem) to break the impasse and the cycle starts again. SOAR has a learning mechanism called chunking; whenever a goal is achieved, the solution found is generalised and added to the set of productions in order to avoid future impasses in similar situations. Since SOAR's long-term knowledge is represented as a single memory organisation (a production system), the system requires bringing to working memory all knowledge it has related to a particular situation to keep on working. This method of retrieving relevant information during the production of material does not seem very efficient.
The main difference between SOAR and the present research is pointed out by the fact that SOAR is a problem-solving architecture driven by specific goals (or states) to achieve, i.e., a system which focuses all its resources on achieving a particular state in a problem space. In contrast, this research employs a computer model of creativity in writing that avoids the use of goals as a way to guide its production of material.

### 2.4.2 TALE-SPIN.

TALE-SPIN (Meehan 1981) is a program that writes stories about characters who have to solve problems like being hungry, tired, etc. in a simulated world. That is, TALE-SPIN stories are generated by setting goals for characters and then recording their attempts to reach the goal. The following is an example of a story created by TALE-SPIN:

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.

All events are represented in terms of Conceptual Dependency (CD) expressions. Some models which describes knowledge about the story-world (e.g. that bees lives in beehives, bears eat honey, etc.) are provided. Also, the system is given a set of problem-solving procedures (i.e. explicit information of how to deal with problems of transportation, acquisition of objects, acquisition of information, persuasion, etc.) and forty-one inference functions. Such functions are used to compute the consequences of an event (in TALE-SPIN each CD expression, i.e. each event, has associated a set of these inference functions which generate new CD expressions).

The program starts with an initial dialogue between the user and the system where s/he defines the set for the story, i.e., who are the characters participating, who is the main character, (and specially) what is the problem that this main character needs to solve, etc. Once this initial event has been defined the top level cycle starts: an event is "asserted", i.e. it is recorded (which means that if the event represents a goal it is included in a PLAN-LIST, otherwise it is added to memory) and all its consequences computed (i.e. all the inference functions associated to that event are executed). Then, each of the inferences generated is asserted and all the consequences of each of such inferences are also asserted, and so on. When no more consequences can be generated the PLAN-LIST is sent to the problem solver: calls to the right procedures to solve the problem are done which produce new events to be asserted and the cycle keeps on going; the story ends when the main character's problem is solved.

TALE-SPIN manages four types of inferences. Type-1 or "backwards inferences" indicate which previous states or acts are necessary for a particular situation to occur; e.g. type-1 inferences from "Betty bee gave the honey to Sam bear" are that Betty had the honey and that the honey was near Betty, i.e. a transfer of possession (ATRANS) must be preceded by the acquisition of the possession by the right character (CONT) and by the proper location of the possession (LOC). When there is a goal to achieve TALE-SPIN applies backwards inferences to establish a path between the desired goal and the actual state of the story-world.

Type-2 inferences are the consequences of an event. The generation of consequences forms the core part of the writing process in TALE-SPIN. Some of them are context free but many depend on the state of the story-world: e.g. what facts characters know or what attitudes they have towards each other. Type-3 inferences indicate which states are the preconditions for acts and Type-4 inferences indicate what other acts might follow a particular one.

Part of an example of the inference process given by Meehan is now reproduced. Having George Ant and Wilma Bird as characters, if George falls into a river an inference from that is that George is in the water. Two inferences from that are that George and Wilma are aware that George is in the water. When someone is in the water it is inferred that the person might die. This sets up the goal to avoid or undo the event. The inference of having a goal is to call the problem solver, etc.

Using inferences of type one or two, characters in TALE-SPIN can produce some plans using hypothetical simulations; e.g., Type-1 inferences can be used to plan how to achieve a specific goal, while inferences of Type-2 can be used to foresee the outcome of an event. Because hypothetical

simulations are based on the character's knowledge of the world which can differ from the real status of the story-world, plans based on such simulation do not always work for the characters.
Finally, to give the reader an idea of the way in which the problem solver mechanism works, a portion of another given example is re-created. This is a story about Betty bee and Sam bear where the main problem is that Sam bear is hungry. The program knows that bears eat honey, so the routine for acquisition of objects is called in order to get the honey. This routine calls the routine for acquisition of information in order to let Sam know where to look for it, in this case, at Betty's beehive. Now, the routine for acquisition of objects tries to apply one of the different plans it has associated to get the honey, e.g., ask if the honey is free, persuade Betty Bee to surrender it, steal it, etc. For this example the option of stealing the honey is selected since it is the only one whose preconditions are satisfied. This option has associated the plan of make Betty bee move away from the beehive in order to take the honey, so a new procedure is called to achieve this subgoal, and so on.

TALE-SPIN is a program that showed (probably for the first time) how problem-solving techniques can be applied to story telling. After twenty-seven years (the first versions of the program were run in 1976) its influence in the field is still present. For example, in her review of AI models of the arts Boden refers to MINSTREL (one of the latest story-writing systems developed, see next section) as "a more powerful version of TALE-SPIN." (1996, p.281). So, the problem-solving approach introduced by TALE-SPIN became the model to follow for a significant number of AI researchers working with story telling.
However (naturally), the program has important shortcomings. One of the most significant is its extreme rigidity. In TALE-SPIN all possible directions a story can follow have been previously defined. That is, it is not able to surprise the programmer (and any user who has used the system a couple of times) with an original story. Another important limitation of the system comes from its lack of differentiation between characters and author's goals. That is, because TALE-SPIN is driven just by the characters' goals whose aims are to solve particular problems, uninteresting stories like "John Bear is hungry, John Bear gets some berries, John Bear eats the berries, John Bear is not hungry anymore" can arise.

Meehan mentioned "Stories are certainly *more* than problem-solving narratives, but they may not be less." (p. 203) The present research attempts to explore those other aspects of stories not covered by problem solving.

### 2.4.3 MINSTREL.

MINSTREL (Turner 1993) is a computer program that writes short stories about King Arthur and his Knights of the round table. It is a case-based problem-solver where past cases are stored in a episodic

memory. Stories are created using predefined themes; such themes are represented as schemas and have explicit specifications about the structure of the story. The following is an example of a story created by MINSTREL:

Once upon a time there was a lady of the court named Jennifer. Jennifer loved a knight named Grunfeld. Grunfeld loved Jennifer.

Jennifer wanted revenge on a lady of the court named Darlene because she had the berries which she picked in the woods and Jennifer wanted to have the berries. Jennifer wanted to scare Darlene. Jennifer wanted a dragon to move towards Darlene so that Darlene believed it would eat her. Jennifer wanted to appear to be a dragon so that a dragon would move towards Darlene. Jennifer drank a magic potion. Jennifer transformed into a dragon. A dragon moved towards Darlene. A dragon was near Darlene.

Grunfeld wanted to impress the king. Grunfeld wanted to move towards the woods so that he could fight a dragon. Grunfeld moved towards the woods. Grunfeld was near the woods. Grunfeld fought a dragon. The dragon died. The dragon was Jennifer. Jennifer wanted to live. Jennifer tried to drink a magic potion but failed. Grunfeld was filled with grief.

Jennifer was buried in the woods. Grunfel became a hermit.

The writing process in MINSTREL consists of instantiating all the schemas that make up the theme. When MINSTREL cannot find events in episodic memory which instantiate such schemas, a set of heuristics called Transform Recall Adapt Methods (TRAMS) are applied. Basically, TRAMS make small transformations into the schema-specifications used as index to recall from episodic memory, creating a new slightly different index. Then, MINSTREL tries to find an event which instantiates the new specifications; if it fails, a recursive call to the TRAM's procedure is made, a new TRAM is selected producing a new slightly different specifications and another attempt to recall from memory is executed.

This process continues until an event is instantiated or no more TRAMS can be applied. If all selected TRAMS fail, MINSTREL goes back one layer in the recursive procedure, selects a new TRAM between the options available in that layer, and continues with the search (i.e. backtracking). When an event is instantiated, MINSTREL goes back layer by layer adapting the event found to the original specifications in each layer.

Turner defines TRAMS as the heart of the creative process in MINSTREL. To demonstrate their power he gives an example where from two episodes in memory three new episodes unrelated to the original ones are created. The goal is to create a scene where a Knight kills himself. The original episodes in memory are 1) a Knight fights and kills a troll and 2) a Princess makes herself intentionally ill by drinking a potion. One of the solutions MINSTREL comes across when solving the problem is that a Knight intentionally drinks a potion in order to kill himself. To achieve this result MINSTREL applies two TRAMS to the second episode in memory. The first “recognizes that being killed is similar to being injured ... [that is, it] ‘guesses’ that an action which is known to result in injury might also result in dead” (Turner 1993, p.116). So the TRAM substitutes a potion to make someone ill for a potion to kill someone. The second TRAM allows the character Knight to be substituted by the Princess. Thus, the episode where the Princess makes herself ill is recalled, Princess is substituted by Knight and a

potion to make someone ill by a potion to kill someone. This produces the scene where the Knight kills himself drinking the potion.
Finally, together with thematic goals (to select and instantiate a theme), MINSTREL also manages (all of them as author level goals) drama goals (how and when to include suspense, tragedy, etc.), consistency goals (to avoid inconsistencies in the story) and presentation goals. The story ends when all these goals are achieved.

Important differences exist between MEXICA and MINSTREL's philosophy. Probably the most important of them is Turner's view of creativity just "as an extension of problem solving" (Turner 1993, p.75); by contrast, the present research sees problem solving as one of several different elements which participate during the creative process.
Regarding MINSTREL's architecture, although TRAMs seems to be a powerful tool in some cases they appear to be written for the special purpose of achieving a specific episode. For example, in the case of the Knight who wants to commit suicide, it is difficult to picture how a TRAM which "guesses" or "recognizes that being killed is similar to being injured" (p.116) can work in a different context. To illustrate this situation, the reader can imagine a Knight who is sewing his socks and pricked himself by accident; in this case because the action of sewing produced an injury in the Knight, MINSTREL would treat sewing as a method to kill someone.
TRAMs are selected using the specifications of the problem as an index, i.e., episodic memory contains past problems and associated TRAMs; thus, the programmer decides which TRAMs go together with particular episodes. This association TRAM-episode might lead to programmer-influences in the way MINSTREL develops a tale. That is, when developing a story MINSTREL is not really selecting which TRAMS to use but trying all the TRAMs previously selected by the programmer for a specific episode.
One of the most impressive characteristics of MINSTREL is its ability to create stories where revenge, deception, mistaken beliefs, etc. take place. However, these situations are not really created by the system. MINSTREL has ten heuristics that explicitly indicate the structure that such scenes have and the way to construct them. So, again predefined procedures with precise information on how to achieve particular events play a considerable role in MINSTREL's outcomes. Another important limitation comes from its lack of flexibility in the organisation of its tales: all stories MINSTREL produces are structurally predefined, i.e. MINSTREL is not able to create a story with a surprising twist or an unexpected end.

MINSTREL is a very complex program which has pointed out the utility of small modifications as a way to solve problems. Although TRAMs in MINSTREL seem at times to be too specific, they can be a powerful tool during problem solving. Also, MINSTREL indicates the importance of author-level goals in storytelling, particularly theme, consistency, drama and presentation's goals. On the other hand, TRAMS tailored to the specific genre of the story, and inflexibility in story's structure and some scenes' structures are the most important limitations of MINSTREL.

Finally, Turner's view of MINSTREL as a "prima facie evidence that artistic ability can be explained in terms of problem-solving, and that *no further or different cognitive process need be stipulated*." (p. 244, italics are mine) seems to be naive, and the present research attempts to demonstrate the importance of studying those other cognitive process not covered by problem-solving techniques and MINSTREL.

### 2.4.4 GESTER.

Pemberton (1984) developed a general model of story structure based on old French epics. She studied nine mediaeval poems concerning the adventures of a family of French Christian fighters and described their structures in terms of a grammar.
The starting symbol in Pemberton's grammar is *complex stories*. It consists of one or more *simple stories*. The simple story is expanded as follows:

SIMPLE STORY-> initial situation + ACTIVE-EVENT + final-situation
ACTIVE-EVENT-> COMPLICATION + ACTION-SEQUENCE
COMPLICATION-> motivating-motif* + motivation
ACTION-SEQUENCE-> PLAN + QUALIFICATION + ACTION + resolution
ACTION-> action* + STORY + ACTION | action*
PLAN-> informing-act* + plan-proper
QUALIFICATION-> qualifying-act* + qualification-proper
The asterisk means that the element can be repeated.
(Cited in Sharples 1991)

Pemberton (1987, 1989) used this grammar to implement a program called GESTER (GEnerating STories from Epic Rules). GESTER has access to information about story structures in the form of the story grammar (story structure rules), and about the epic sub-genre in the form of a discourse grammar (story world rules) and a database describing objects and attributes in the epic world (story world database). The story world rules describe how to select the actors and actions in a story, restrictions on possible combinations of such actors and actions, as well as several inference steps (e.g. how to deduce if a subject can be an ally or an enemy). The story world database includes facts about objects and relations. For example, facts as social status, marital status, family and social relations, nationality and gender, are stored in this database. Pemberton states that a full theory of story production must considerate knowledge of:

a. story structure
b. the audience

c. the author
d. the cultural context
e. the rules of the sub-genre

GESTER includes knowledge about points a) and e), and it is assumed that knowledge about the cultural context d) is present in the rules of the sub-genre. The story structure rules are described in a general way in order they can be used in the production of different type of stories when they are combined with the appropriate story world rules and facts.

To produce a story GESTER expands the *complex story* rule and goes through the tree defined by the grammar, making choices according to the information in the story world rules and the story world database, until the terminal symbols are reached. In the present version of the program, a complex story consists of just two simple stories. There are four possible situations where two simple stories can be linked:

- When one story causes the other (referred as *cause*).
- When an event in the first story motivates the second (referred as *motive*).
- When the active elements of one story follows the elements of the other (referred as *then*).
- When two stories share one or more characters (referred as *same actor*).

Stories move from a starting point where something is lacking in the story world, to a point where the missing element is either solved or repeated. To produce coherent stories GESTER employs three general "features":

1. Story features define how simple stories are joined together (possible values are: cause, motive, then and same actor), whether a story will be successfully resolved, if a story involves friendly or hostile interactions, and particular types of motivating act.
2. Role features assure that actors have the same role during the whole story.
3. Transformation features control the mapping between story line and discourse level. Pemberton defines four levels for the French epic texts: 1) textual level, 2) discourse level, 3) story line level and 4) narrative model level. The words and phrases that the reader experiences constitute the textual level; Pemberton refers to this level as the lexicalised version of the discourse. The discourse is in turn a modified version of the story line. That is, the story line contains the sequence of all events occurring in the story and the discourse consists of the same elements but arranged in a more convenient manner for telling. Finally, the narrative model —the highest level— is the abstract form of the story line level. Thus, transformation features control the interaction between level 2) and 3). "Lexicalisation rules" are included in the story world rules module.

The following is an example of a story created by GESTER:

Charles lacked a city.

As a result of hearing of Narbonne Charles wanted Narbonne.
Then Aymeri agreed to help Charles.
Then Charles and Aymeri rode to Narbonne.
Then, Charles attacked the walls of Narbonne, currently controlled by Baufumez, helped by Aymeri.
Thibaut and Clarion threw burning pitch down on Charles and Aymeri.
Charles and Aymeri retreated.
Then, Charles attacked the walls of Narbonne, currently controlled by Baufumez, helped by Aymeri.
Thibaut and Clarion threw stones down on Charles and Aymeri.
Charles and Aymeri broke into Narbonne.
As a result of seeing Blancheflor Charles wanted Blancheflor.
Charles succeeded in getting Narbonne.
Charles praised god. Charles forgot to reward Aymeri. Charles threw Thibaut into prison.
Then Charles planned to obtain Blancheflor for Charles.
Then Aymeri refused to help Charles because he was not rewarded.
Then Bertrand agreed to help Charles.
Charles abducted Blancheflor, currently controlled by Thibaut helped by Bertrand.
Because Thibaut was in prison he did not oppose Charles and Bertrand. Clarion opposed Charles and Bertrand in getting Blancheflor.
Charles succeeded in getting Blancheflor.
Charles praised god.
Charles rewarded Bertrand.

By contrast with other story grammars, Pemberton's grammar does not go to the degree of describing the story style or content. Instead, in GESTER, such a grammar only creates a general frame for the story; facts and rules about the characters and their world are then used to create the final outcome.
Its main shortcoming (also the case for other programs based on this approach) is its rigidity. GESTER is only able to produce stories that satisfy its grammar and is not able to modify its knowledge to generate different outcomes. For example, GESTER cannot create a story-plot which does not involve the lack of something. Another problem with GESTER is that it only produces general outlines; i.e., it requires some procedures to elaborate more details in the stories it produces. This possibility is open since its grammar does not go to the level of defining the actual words of the story; in this way, some processes could be added to fill some of the grammar's slots with more detailed text.

It is worth pointing out that an adequate structure is a necessary characteristic of any good story, and story grammars provide the means to ensure it. Thus, it is necessary to find a way that allows employing the advantages offered by story-grammars but in a more flexible way.
In this way, as Pemberton states, "We need a much richer model of story processing than that which could be offered by either the story grammar or the goal directed model alone." (Pemberton cited in Casebourne, 1996 p.149)

### 2.4.5 GRANDMOTHER.

GRANDMOTHER (Casebourne 1996) is a program that combines the story grammar approach with problem solving techniques. It utilises Pemberton's grammar (see Section 2.4.4) to establish a general structure for a story but fills some of the slots (the qualification and action sequences) with text

generated by a planning system. The following is an example of an output produced by GRANDMOTHER:

Once upon a time there was a queen called Emma who lived in a city called Atlantis. She had lived there happily for many years, but then one day a villager called Rebekka came to her city and killed her husband. Filled with hatred for Rebekka, Emma thirsted for revenge. She resolved to hurt Rebekka. Emma wondered how she might go about achieving her goal. She thought for a long time and eventually came up with a plan. She decided to find Rebekka and murder her. However in order to kill Rebekka, Emma would need an army. Rebekka was a powerful villager, but she was vulnerable to an army. Luckily Emma already had an army, so she could embark immediately on her quest. *Emma prepared to set off on her quest, but first Emma looked for Rebekka in Atlantis, however she didnt find her there. Emma sailed from Atlantis to the sea. Emma sailed from the sea to Noone. Emma looked for Rebekka in Noone, however she didnt find her there. Emma rode through the forest. This part of the forest was dark, Emma was a little scared. Emma looked for Rebekka in the forest, however she didnt find her there. Emma continued to ride through the forest. This part of the forest was green and pleasant. Emma looked for Rebekka in the forest, however she didnt find her there. Emma rode from the forest to Chilbolton. Emma looked for Rebekka in Chilbolton, and Emma found Rebekka in Chilbolton. Emma ordered her army to attack Rebekka. Rebekka received a mortal wound, and died immediately.* So Emma finally got what she wanted. Which shows that ruthlessness and violence, prevail over weakness. The End.

The text generated by the planning system module is in italics. The grammar is used as a kind of template, where the slots are filled with suitable values obtained either from the user or a database or the planning module. For example, the **initial situation** is generated filling the following predefined structure: “Once upon a time, there was a <type of protagonist> called <name of protagonist> who lived <protagonist’s home>.”

The planning module is provided with a plan to follow by the grammar. Such a plan consists of a list of actions to be performed sequentially. So, the planner takes the first action in the list and tries to perform it; then, takes the second one, the third and so on. When the list is empty the plan has been successful. When an action is not successfully performed, the plan list is modified. Although travel actions are not included as part of the plans, they can be added to the story at any point when the plan cannot be executed.

The main aim in GRANDMOTHER is to prove that two different approaches for story generation can be combined, resulting in a more powerful system. In this way, “Pemberton’s grammar ensures a story will always develop from a potentially interesting initial problem, through a problem solving stage, to a pre-specified resolution. The planning module allows certain elements to be developed more flexibly than is possible by simple selection from allowable segments of text” (Casebourne 1996, p.151)

However, Casebourne did not do anything to avoid inheriting the limitations of both methods, already described in previous examples in this section. So, although GRANDMOTHER combines story grammar and problem solving techniques, the stories it produces are very rigid.

## 2.5 Some Definitions.

Based on the analysis made in this chapter, an initial definition of story and creativity is offered:

- In this research a *story* is defined as a sequence of events or actions which are coherent and interesting.
- In this research *creativity* consists of producing novel and appropriate narratives (Sharples 1996). A narrative is considered appropriate when it satisfies the requirements of coherence and interest established for a story.

Chapter III describes Sharples' account of writing in detail and the general architecture of MEXICA. Based on these descriptions the concepts "coherent", "interesting" and "novel" are clarified. Section 3.2.6 offers a complete definition of the terms *story* and *creativity*.

## 2.6 Summary.

This chapter presents different perspectives of the writing process.

- The first section examines the opinion of different philosophers, writers, composers, etc. about creativity from an engagement-reflection point of view.
- The second section presents writers thoughts about writing. It is stressed the importance of writers' experience in composition.
- The third section describes five theories about writing: Hayes' framework of writing (problem-solving), story-grammar approach, Torrance's et al. automatic position, Gelernter's ideas about writing and Sharples' engagement-reflection account.
- The fourth section describes illustrative examples of computer models of story structures, the writing process and general cognition: SOAR (based on problem solving), TALE-SPIN (based on character-level goals), MINSTREL (based on author-level goals and predefined structures), GESTER (based on story-grammars), GRANDMOTHER (based on story-grammar and problem solving).

# Chapter III

# Engagement-Reflection.

The aim of this chapter is to establish a mapping between the Engagement-Reflection theory and the computer model topic of this research. It is organised as follows. The first section describes Sharples' account of the writing process. It is divided in five parts: the importance of constraints in the creative process; how the written material is generated; useful similarities between design and writing; the influence of the environment in the writing process; and how all these elements are joined to form the engagement-reflection account of writing.

The second section in this chapter describes how, based on Sharples' account, a computer model of the writing process is developed and implemented in a program called MEXICA. This part includes an analysis of the main components of the model, how they interact, and what is expected from MEXICA. The first step to develop the model consists of restricting Sharples' account to achievable limits. Then, the main computer structures representing the constraints, which will guide the writing process, are defined. Different elements which form the Engaged and Reflective States are described, and examples of the creative process in MEXICA shown. Finally, the characteristics embodied by the four possible ways in which the system can operate are explained, and key terms like "story" and "creativity" are defined. The whole section stresses the flexibility that the system offers for the user to experiment with different parts of the model.

## 3.1 Sharples' Account of the Writing Process.

Sharples (1996, 1994, 1991) has established a general account of the processes that human beings follow during writing. According to his account, creative writing consists of cycles of engagement and reflection guided by constraint. During engagement "the writer devotes full attention to creating a chain of associated ideas and turning them into text." (Sharples 1996, p. 143). During reflection the writer reviews the material produced, explores and transforms possible options, produces plans and constraints which guide furthers periods of engagement.

His account includes five main aspects:

- Importance of constraints.
- Generation and analysis of text.
- Similarities between design problems and writing.
- Writers and their environment.
- Writing as creative design: the Engagement-Reflection cycle.

These five components are now described in detail.

**A. Importance of Constraints.**

Based on Boden's account of cognition and creativity (Boden 1992), Sharples makes a distinction between novelty and creativity. For example, the sentence "A pink rainbow flooded into my cup of steaming coffee" is a novel sentence. But, is it creative? In order to answer this question, he explains how it is possible to build a system that, following the rules of grammar, can write well-structured sentences (like the one in the example) which probably have not been uttered before. However, the texts generated by this system would in most cases lack any sense. A famous example that shows how syntax can be separated from semantics is the sentence "Colorless green ideas sleep foriously" (Chomsky, 1957). Like in the previous example, this sentence does not seem mean anything coherent but sound like an English sentence. Thus, as well as being grammatical correct and novel, writing must be appropriate to the task and audience. Sharples claims that constraints make possible the generation of appropriate text. In this way, what distinguishes novelty from creativity is the setting of the right constraints. Therefore, the study and analysis of constraint is necessary for a comprehension of creativity.

Constraints can be classified as internal (e.g. author's beliefs, knowledge, experience) and external (e.g. editor's requests, external resources). Constraints play an important role in the engagement-reflection model. Sharples suggests that during engagement constraints work as a generator and filter (i.e. they act as cues stimulating the association of ideas linked previously to similar contexts). Through constraints the writer circumscribes the search in long term memory to those mental schemas appropriate to the task.

For reflection, if a generative system (e.g. rules of grammar) is combined with the right set of constraints (e.g. appropriate schemas of knowledge and rhetorical structures) the writer obtains a conceptual structure (or conceptual space) that can be explicitly explored and transformed during reflection. In order to explore and transform a conceptual space, it is necessary to represent such constraints and schemas as explicit entities.

In summary:

> we can distinguish creativity from novelty in that creativity involves setting appropriate constraints to form a conceptual space that is relevant to the writer's purpose, bringing aspects of that conceptual space into conscious awareness, and then deliberately exploring and transforming it to create an original and valuable product. (Sharples 1996, p. 130)

**B. Generation and Analysis of Text.**

The idea of two mental activities, one where written material is generated and another where such material is analysed and evaluated, has different antecedents (see Chapter II). Sharples, for example, calls up in his account the processes of knowledge telling and knowledge transforming (Scardamalia and Bereiter, 1987). During knowledge telling, the features of a generated idea motivate to link a new one, whose characteristics produce a new idea to be recalled and so on, forming a chain of associated ideas. When this process is completed as a purely mental activity, Sharples refers to it as daydreaming. During knowledge transforming the material produced is analysed and restructured. It must fulfil the writer's beliefs about the

writing topic and the writer's knowledge about the theme and writing goals. If they diverge, the material generated or the plan is modified in order to keep the unity between them.

Gelernter (1994) suggests similar ideas in a general account of creativity. He talks about a continuous spectrum of cognitive activity that ranges from high focus (characterised by analytical thought) to low focus (where ideas are linked together by emotions). Gelernter claims that creativity boils down to the discovery of new analogies (during low focus) that occur when one thought triggers another one which is related to it by shared emotions.

Sharples complements this view suggesting that both high and low focus thinking contribute to creativity. When low and high focus are employed to produce text, they become the processes of knowledge telling and knowledge transforming.

**C. Similarities between Design Problems and Writing.**

Based on studies of how designers think (Lawson cited in Sharples 1996) Sharples points out important similarities between design problems and writing. For example, design problems and writing cannot be fully specified and both are open-ended. This contrasts with the classic problems studied by cognitive psychology and artificial intelligence (e.g. chess or the Tower of Hanoi) where a fixed set of goals is established and the process can continuously be evaluated in terms of the proximity of the actual stage to a goal. Writers and designers do not have a simple function to evaluate each stage. Another example is how both processes involve finding as well as solving problems. "It is central to modern thinking about design that problems and solutions are seen as emerging together rather than one following logically upon the other" (Lawson cited in Sharples 1996, p. 136).

Probably, one of the most important ideas in design which can be applied to writing is that of the primary generators. The term comes from a study made between architects (Darke cited in Sharples 1996) where it was observed how they become attached to a simple idea in the early steps of the design process. Such an idea worked as a framework constraining the universe of alternatives. Sharples notices how some talented writers also talk in terms of primary generators:

> I had an idea of what I wanted to do, but there was something missing and I was not sure what it was until one day I discovered the right tone – the tone that I eventually used in One Hundred Years of Solitude. It was based on the way my grandmother used to tell her stories. She told things that sounded supernatural and fantastic, but she told them with complete naturalness. When I finally discovered the tone I had to use, I sat down for eighteen months and worked every day. (García Márquez, cited in Plimpton 1985, p. 323).

**D. Writers and their Environment.**

In his account Sharples stresses the importance that tools (e.g. pencils, word processors), external representations (e.g. drawings, maps, printed sheet of paper), media (e.g. computer screen, blackboard), and resources (e.g. thesaurus) have in the writing process. He claims that the intrinsic properties of tools and media used, and the way users experience them, can affect the type of cognition performed during

writing. The same happens with external representations which, for example, can work as a kind of external memory where ideas are kept and when necessary shared with other persons. Finally, he points out how proper and accessible resources avoid unnecessary distractions and allow writers and designers to become absorbed in the task.

**E. Writing as Creative Design: the Engagement-Reflection cycle.**

Based on the ideas reviewed in previous sections, Sharples (1996) establishes three main aspects of his account:

1. "A writing episode starts not with a single goal, but with a set of external and internal constraints. [e.g. writer's knowledge and experience, demands of the task, primary generator.]" (p. 142)
2. "As the writing progresses, constraints provide the tacit knowledge to guide the writing process." (p.143)
3. "The movement between engaged writing, guided by tacit constraint, and more deliberate reflection forms the cognitive engine of writing." (p. 143)

Engagement involves the continuous production of material on an external medium. Such material is generated through a train of associated ideas. As an important characteristic, the mental resources of an engaged writer are committed to the task and no other cognitive activity can be performed except uttering the words loud as they are produced. In this way, if the writer needs to reflect on the material it is necessary to stop the engaged state. This causes cycles of engagement and reflection.

During reflection the writer 'sits back' to perform three activities: reviewing, contemplation and planning. Reviewing consists of reading and interpreting the written material, which allows re-representing as explicit knowledge the procedures performed during composition. That is, Sharples suggests that reviewing can provoke the spontaneous re-representation of knowledge described by Karmiloff-Smith (1992 and see Chapter II). During contemplation new ideas are formed either through an activity of high focus thinking (e.g. deliberate knowledge exploration) or low focus thinking (e.g. associating analogous thoughts linked by common emotions, themes or experience). During planning, based on the results obtained from contemplation, plans and intentions to guide further periods of engagement are created.

In this way, Sharples' account of writing suggests that is the interaction between engagement and reflection which moves composition forward. From such an interaction emerges different rhythms of work; a writer can switch very quickly between engagement and reflection (e.g. when a writer checks each sentence as it is written) or have long periods of engagement followed by analytical revisions of the entire piece of writing. Those changes in the engagement-reflective rhythm produce different types of observed writing activity.

## 3.2 The Computer Model.

The main objective of this research is the development and implementation of a computer model based on Sharples' account of writing. Sharples' account is very general and involves many aspects that are impossible to include in a single PhD project. For that reason, it is necessary to narrow the account and implement only the core parts of it. Thus, the Engagement-Reflection cycle forms the backbone of the computer model, and Sharples' ideas related to the role of constraints and similarities between design and writing influence important parts of the model.
The computer model topic of this research has been implemented in a program called MEXICA. This program is divided in two main parts: the first transforms a database into appropriate data structures in memory. The second makes use of such structures to develop novel stories. MEXICA has been designed to allow any person interested in the model to experiment with it. Thus, a set of parameters that control different aspects of the engagement-reflection cycle and which can be modified by any person working with MEXICA have been included as part of the system.

### A. Differences between the Computer Model and Sharples' Account.

Three important differences arise between the computer model and Sharples' account. First, the present work does not include any research into memory limitations and the effects that the environment and tools have in the writing process. Thus, all the material produced during engagement is generated in (an unlimited short-term) memory and at the end of the process it is printed out on an external medium. In Sharples' account the engagement process consists of externalising (as it is produced) the material. In this way, it is possible to study the influence that the ambience has during the composition process.

The second difference is related to low focus thinking: all processes simulating it are performed only during engagement. The author of this work is not convinced of the idea of including low focus thinking during reflection. The reason is that low focus thinking embodies many typical characteristics of engagement. So, to include it during reflection would imply assigning engagement characteristics to reflection. What this author suggests is that, if during reflection it is necessary to generate new material, the writer must switch to an engaged state, produce the required material and then return to the reflective state to continue with the process s/he was performing. In this way, each state keeps its own characteristics.

The last difference has to do with the processes performed during reflection. The Reflective State described by Sharples includes theories of Representational-Redescription (Karmiloff-Smith 1992), high and low focus thinking (Gelernter 1994), and complex problem solving techniques, each of them possible topics for a PhD research. So, it is necessary to narrow this enormous spectrum to achievable limits. Thus, the following considerations have been made:

- It is out of the scope of this work to make any research regarding the Representational-Redescription theory.
- It is out of the scope of this research to develop or improve problem solving methods for the writing process.

**B. Limiting the Scope of Constraints.**

In his account Sharples affirms: “The constraints come from a combination of the given task, external resources, and the writer’s knowledge and experience. Implicit constraints guide the writing process, and a writer represents some of these as explicit conceptual spaces.” (Sharples 1996, p.127)

In this work, the task-oriented constraints are fixed in the model. That is, the system only writes short stories about the Mexicas. As explained in part A of this section, external resources (and the constraints arising from them) are out of the scope of this research. Thus, in the present work only constraints due to writer’s knowledge and experience are taken into account for the writing process.

Computer models (at least the present one) cannot have experiences, so it is necessary to incorporate into the system a way to represent them. Inspired by the ideas expressed by some writers on how the material written by others authors is a great source of technical knowledge and experiences (see Chapter II), a set of tales –denominated Previous Stories– forms the material used to create the structures representing such writer’s knowledge and experiences (see Section 3.2.1-B for more about structures built from Previous Stories). Since Previous Stories play a crucial role in the model, anyone interested in experimenting with MEXICA must be able to manipulate them in an easy way. Thus, a simple method to define tales is required. It must allow specifying of characters and the actions they perform. Also, a way to specify what actions can be performed in any story is needed (i.e. what actions the computer model can process). Such actions are denominated Primitive Actions (PA). In this way, any user of MEXICA can have easy control of the PAs and the set of Previous Stories. Notice that the concept of user has been introduced. A user is any person (not necessarily a programmer) interested in experimenting with the system. As in the case of the Previous Stories, MEXICA provides the user with many parameters that control important parts of the writing process. A detailed list of such parameters can be found in section 4.5.

## 3.2.1 Analysis of Constraints.

In their model, Scardamalia and Bereiter (1987) called “rhetorical” and “content” to the conceptual spaces that mould and constrain text production.

> In the content space, the knowledge states can be roughly characterized as beliefs, and the operations [which can be performed in the content space] are the inferring, the hypothesizing, and so on that lead from one state of belief to another. In the rhetorical space, the knowledge states are various representations of the rhetorical situation, which includes the text and the goals it subserves. The operations, accordingly, are ones that alter the text, goals, or relations between them. (Scardamalia and Bereiter 1987, p.146)

Rhetorical and content constraints are part of the engagement-reflection model. However, in order to make as simple as possible the explanation of MEXICA, in this work constraints have been organised in a

different way. They are divided in four types: context constraints, knowledge constraints, guidelines constraints and general constraints. They can be summarised as follows:

1. Context constraints encode the actual state of affairs of the story in progress.
2. Knowledge constraints encode the knowledge necessary for:
    - Retrieving logical following actions during the developing of a tale.
    - Producing interesting stories.
    - Exploring the conceptual space defined by the Previous Stories.
3. The guidelines constrain the production of material to satisfy requirements of novelty and interest.
4. The general constraints include rhetoric and content constraints not included in the previous classifications and which are necessary in order for MEXICA to work properly. They encode the knowledge necessary to assure that the story in progress develops (i.e. to avoid loops) and to assure that the events in the story in progress satisfy basic beliefs about the world.

The criteria used in this research to group constraints is based on how they are built or updated in memory. Knowledge constraints are built when the system starts (i.e. before MEXICA begins to develop a new story). They are created from data extracted from the file of Previous Stories and once they have been allocated in memory they are not altered. Context constraints and guidelines are created during the development of the story in progress. Context constraints are updated each time an action in the story in progress is performed. The guidelines constraints are updated during reflection each time an analysis and evaluation of the story in progress is performed. Finally, general constraints are established by the programmer as part of the code and never change.

**A. Context Constraints.**

The different events occurring in a story when it unfolds modify the circumstances or context surrounding the story-world. In this research, such circumstances are called context constraints or story-world context. It is assumed that any event in a story has associated a set of consequences which modifies such a story-world context; from now onwards those consequences are also referred as postconditions. Thus, context constraints are structures which represent the current story-world state of affairs. During the writing of a tale, the selection of an appropriate following action (i.e. what is the next event in the story) depends on the current story-world context and what a writer knows or believes is a logical next action. For example, a story can start as follows: “It was December 1847. When the sun started to shine and the snow covering the fields reflected that melancholy which only could be found in this part of the country...” Due to the context defined by these first sentences, it is not expected that the story continues with some characters wearing swimming costumes and going to the beach to sun-bathe. However, it would not be surprising to find that the story proceeds with some young lovers going ice skating on a frozen lake, or some farmers searching for some wood to warm their homes. As the story develops more constraints arise creating frameworks which guide the story.

**B. Knowledge Constraints.**

Knowledge constraints are constituted (following Sharples) by writer's experience, knowledge and beliefs about writing goals, the writing topic and world in general. In order to be able to implement them in MEXICA, it is necessary to narrow this broad definition. So, knowledge constraints are divided in three classes: what is called Abstract Representation, Tensional Representation and Concrete Representation.

The Abstract Representation.- The Abstract Representation encodes part of the knowledge necessary to retrieve an appropriate (following) action during story development. To build these structures MEXICA performs a detailed analysis of the Previous Stories, and stores in long-term memory each of the story-world contexts and the action which follows that context. In other words, for each action in each tale in the Previous Stories, MEXICA gets the actual story-world context, re-represents such a context in more abstract terms and stores it in long-term memory as a new structure. Then, it links to that structure the following action performed in the story. In this way, MEXICA establishes a relation between the structures in memory representing story-world contexts and (logical) next actions to perform. The Abstract Representation establishes the universe of all possible events that MEXICA can retrieve from memory during engagement.

The Tensional Representation.- Different authors have pointed out how the tension produced in the reader is one of the core elements in fiction. For example, Claude Bremond (1996) classifies the different sequences of events in a narrative as processes leading towards either an improved or degraded state, which can or cannot be reached. In its simplest form, during a process of degradation a state of tension is created by introducing forces or obstacles that oppose a more satisfactory state. On the other hand, during the development of a process of improvement, an obstacle that stands against such a more satisfactory state is eliminated. These two processes can be combined in intricate ways producing complex stories. Clayton expresses similar ideas when he describes conflict, complication and climax, falling action and resolution as parts of stories (Clayton 1996, p.p. 13-15). For Clayton a desire and the presence of one or more obstacles to achieve such a desire form conflict. During complication the difficulties introduced by the conflict arise incrementing the tension produced in the reader, until the climax is attained. Finally, during falling action and resolution "Picking up the pieces, knots are unravelled, a new stability is reached.." (Clayton 1996, p. 15. For a good analysis of the elements involved in fiction see Vargas Llosa, 1997). These processes of degradation or state of tension and improvement have important implications in the present research. In MEXICA it is assumed that a story is interesting when it includes degradation-improvement processes (i.e. conflict, complication and resolution). Thus, the Tensional Representation encodes part of the knowledge necessary to produce sequences of events in the story in progress that combine degradation-improvement processes. As in the case of the Abstract Representation, MEXICA performs a detailed analysis of the set of Previous Stories to build the Tensional Representation.

The Concrete Representation.- The Concrete Representation encodes the set of Previous Stories in memory. That is, it can be seen as a copy of the file of Previous Stories but in memory. The Concrete

Representation is used during reflection to explore (and sometimes transform) the conceptual space defined by the set of Previous Stories. This is useful, e.g., when breaking an impasse. The Abstract and Tensional representations are built from implicit information encoded in the Previous Stories, while the Concrete representation comes from explicit information in such a file.

The Abstract, Tensional and Concrete Representations are structures that represent different aspects of the Previous Stories at different levels of abstraction.

**C. Guidelines.**

During reflection MEXICA evaluates if the material produced during engagement (i.e. the story in progress) satisfies the requirements of novelty and interest (see Section 3.2.3-A). As a result of such an evaluation MEXICA produces a set of requirements called guidelines, which purpose is to influence the production of material. That is, if during the evaluation performed in the Reflective State MEXICA detects that the story in progress does not fulfil some of the novelty or interest requirements, some guidelines are set to constrain the production of material during engagement in order to improve it. Thus, a group of routines (called filters, see Section 3.2.2) eliminate some of the actions retrieved during engagement which do not satisfy the guidelines. The routines to verify guidelines are very flexible. That is, guidelines only attempt to have some influence over the production of material, not to control it. Thus, MEXICA is not very strict on eliminating actions that do not fulfil the guidelines (see Section 4.3.2.3 for an explanation of how the routines to check guidelines work). Each time MEXICA performs an evaluation during the Reflective State the guidelines are updated, i.e. they are very dynamic constraints. Guidelines can be pictured as messages sent by the Reflective State to the Engaged State; e.g. if the story in progress is too "flat" and it is necessary to increase the Tension to the Reader the following guideline can be set: "eliminate all those actions which do not complicate the conflict".

**D. General Constraints.**

General constraints are formed by a set of requirements, which must be satisfied by all events retrieved from memory during engagement. Like in the case of the guidelines the filters verify this condition is fulfilled. But in contrast with the guidelines, MEXICA is very strict regarding general constraints; thus, the filters eliminate any action that does not satisfy such requirements.
General constraints have two main purposes:

- To guarantee the flowing of the story in progress.
- To prevent the story in progress from including events which do not fulfil certain basic beliefs or knowledge about the writing topic and world in general.

Flowing of the story.- In MEXICA a story flows when a degradation or improvement process arises or develops in its plot. Thus, the general constraints eliminate those actions that do not contribute to the

flowing of the tale. MEXICA has a simple requirement to ensure that a story flows: the postconditions of any action retrieved from memory during engagement must modify the story-world context. That is, the context represents the state of affairs of the story-world including those circumstances that produce conflict. Any action whose postconditions do not affect the context is not helping to make the story flow. This kind of action only obstructs the correct development of the story and can generate scenes lacking coherence. For example, the reader can imagine a dramatic story where two knights are face to face just about to fight. If the hypothetical author of this fiction suddenly makes an association about ice-creams, and decides to continue the story with a description of his favourite types of ice-creams –which definitely would not affect the story-world context and make the story move on– this tale would include a scene lacking any sense. Thus, the idea is to eliminate any associated event that does not help to develop the story. There is also a technical problem related to this point. If retrieved actions do not modify the story-world context the system might be trapped in a loop. That is, if the story-world context 1 is used to retrieve action X from memory, and the postconditions of such an action does not modify context 1, there is a strong possibility that the system will retrieve again action X and it might be caught into a loop.

Fulfilling beliefs.- During the production of material MEXICA can generate events that might not fulfil certain beliefs about the writing topic, social restrictions, traditions, etc. (e.g. between the MEXICAS homosexuality was forbidden. So, a story that strictly follows the Mexica's costumes must avoid homosexual relationships). Also, MEXICA might produce illogical events (e.g. a princess who falls in love with an enemy who has just wounded her). Thus, all those actions that do not fulfil such social or logical requirements are eliminated from the set of events retrieved from memory.

### 3.2.2 Analysis of the Engaged State.

As a main characteristic, constraints (and not goals or predefined story structures) guide the production of material during the Engaged State. "A writing episode starts not with a single goal, but with a set of external and internal constraints... As the writing progresses, constraints provide the tacit knowledge to guide the writing process." (Sharples 1996, p. 142-143).

In order to describe properly the engagement process, it is necessary to introduce into the model the concept of filters. Filters are a set of routines which have a very important role in the production of appropriate material during engagement. Its main function is to remove those possible next actions retrieved from memory which do not satisfy the requirements imposed by the guidelines or general constraints. In other words, they constrain the set of possible next actions to those options that satisfy the guidelines and general constraints. Thus, filters are essential to produce appropriate outputs. Through them MEXICA assures that the recommendations set by the Reflective State are attended during engagement. In this way, requirements of novelty and interest are fulfilled. Also, filters guarantee that all possible next actions retrieved from memory will help the story in progress to flow. This characteristic seems to agree with human behaviour. For example, a person engaged in a daydreaming (typical example of the engaged

state) always retrieves actions that in some way or another allow the dream to develop. A similar thing occurs with author's beliefs about the world.

Filters do not perform any activity that could be considered as part of the Reflective State. They do not evaluate the closeness of an action to a goal state, explicitly explore a problem space, etc. (see Section 3.2.3 for a description of the main characteristics of the Reflective State). Filters only constrain the universe of possible next actions to those that are appropriate for the story. Without the use of filters MEXICA would end up producing a kind of brain-storm of stories, i.e. sequences of actions produced by association of ideas which do not necessarily fulfil the requirements of logic and coherence.

Once filters have been incorporated into the model, it is possible to establish the engagement cycle:

1. The consequences of an initial event produce an initial story-world context.
2. This context is used to match a structure in long-term memory (in the Abstract Representation) and retrieve the set of possible next actions associated to it.
3. The filters eliminate from such a set all those actions that do not satisfy the guidelines and general constraints.
4. The system selects between the remaining actions one as the next event in the tale. Thus, after it is performed in the story in progress, its postconditions modify the story-world context.
5. The new context is used to match another structure in memory and the cycle keeps on going.

These are the steps followed by MEXICA during engagement. Notice how during the production of material, actions are linked through the use of story-world contexts (i.e. a story-world context is used to retrieve an action, which produces a new context, which is used to retrieve another action, etc.) In this way, although each action in the system has associated a set of requirements (also known as preconditions) which must be fulfilled in order an action can be performed in a story, during engagement those requirements are ignored (see Section 3.2.3-B for an explanation of preconditions). Only during reflection does MEXICA verify if all actions' preconditions in the story in progress are satisfied. As a result of this situation, the action selected during engagement as the next event in the tale might not have all its preconditions satisfied. This characteristic gives an important flexibility to the system during the development of a story. That is, MEXICA is not restricted to only developing a tale in the direction of those actions whose preconditions are already satisfied.

### 3.2.3 Analysis of the Reflective State.

Based on Sharples' ideas studied in Section 3.1, two processes are considered in this research as essential components of the Reflective State:

- Explicit comparison of writer's content and rhetorical knowledge against the text generated during engagement.
- Deliberate knowledge exploration.

MEXICA makes use of such processes when it performs the following tasks:

- Evaluation of the material produced during engagement.
- Verification of the coherence of the text produced.
- Breaking an impasse triggered during engagement.

**A. Evaluation.**

During reflection MEXICA evaluates two aspects of the material produced during engagement: novelty and interest. A story is considered novel when it is not very similar to any of the tales in the file of Previous Stories. To perform this evaluation MEXICA compares the events occurring in the story in progress against those occurring in the Previous Stories. A story is considered interesting when it includes conflicts, elaboration, climax and resolution. To perform this evaluation MEXICA compares the Tensional Representation of the story in progress against the frames in the Previous Stories. As mentioned in Section 3.2.1-B, the frames (or Tensional Representations) of the Previous Stories are considered as models to follow.

**B. Verification of coherence (Preconditions).**

During engagement MEXICA might retrieve actions which do not ensue properly in the tale in progress (see Section 3.2.2 and the example in Section 3.2.4-B for an explanation of how this situation arises). For example, imagine the following sequence: “It was a nice day. The sun was shining and John was playing his guitar by the swimming pool. Quickly, he got up, found some disinfectant and applied it onto Paul’s wound...” This sentence or event is not coherent. It is necessary to explain or justify why John abruptly got up, reached for the disinfectant and so on. For that purpose preconditions are introduced into the model. Their function is to avoid a story in progress containing a sequence of actions that does not flow in a coherent way (it is not possible to cure someone unless that person is wounded or ill). In the present model, each Primitive Action (PA) has associated a set of preconditions (e.g. the precondition of the action A cures B is that B must be wounded or ill). During reflection MEXICA checks that all actions’ preconditions in the story in progress are satisfied. When the system detects unfulfilled preconditions, it explores the space defined by all the PAs and fetches an action whose postconditions satisfy such preconditions. Then, it inserts that action just before the event with the unsatisfied preconditions. Following this process, the previous example would look as follows: “It was a nice day. The sun was shining and John was playing his guitar by the swimming pool. Paul arrived early that day. While he was trying to reach a chair, he accidentally broke a glass cutting his hand. Quickly, John got up, found some disinfectant and applied it onto Paul’s wound...” Inserted actions can also have unsatisfied preconditions, which would cause the process to be repeated. Thus, whole episodes can be inserted to satisfy the preconditions of a single action. (Notice how in the previous example, the action where Paul broke the glass and cut his hand was enough to explain or justify why John went in search of the disinfectant. However, for that action to happen, it was necessary that John and Paul were situated by the swimming

pool at the same time. Thus, it was necessary to insert an extra action which explained how both of them happened to be together at that moment.)

In MEXICA, the user defines through a text file what preconditions are linked to each action. This is a valuable characteristic since preconditions influence the development of tales. As more preconditions are attached to an action, it becomes more difficult to find an event that satisfies them (i.e. the set of events available to satisfy the preconditions is reduced). As a result of this situation, logical but predictable sequence of events might be generated. On the other hand, if few preconditions are attached to an action, there is a bigger risk of producing illogical sequences, but there is more freedom to generate novel events. Thus, it is necessary to find an adequate balance.

Ensuing from this, one can conclude that the logical flow and coherence in a story does not depend on the Engagement-Reflection cycle itself but in the set of preconditions defined by the user. If an adequate definition of preconditions is given the model produces coherent sequences of actions. In the same way, if an inappropriate set of preconditions is defined the model generates unsatisfactory episodes. Thus, when MEXICA produces odd stories the user can modify the preconditions assigned to the problematic events in order to try to solve the problem.

In this research preconditions are explicitly designed to allow the user to experiment with them. This characteristic is important because MEXICA attempts to work as a research tool. So, the user can study the effects that preconditions have in the development of tales.

**C. Breaking an Impasse.**

It is possible that during engagement MEXICA declares an impasse; i.e. the story-world context of the story in progress cannot match any structure in long-term memory hence the production of material cannot continue. In this case, it is necessary to switch to the Reflective State to sort the problem out.

To illustrate how MEXICA solves the problem, the reader can imagine a writer who gets blocked while writing a story. In order to break the impasse, such a hypothetical author can try to remember and analyse how other writers have sorted out similar situations, and apply the same method or a variation of it to the story in progress. In the same way, when MEXICA is trying to break an impasse, it explores the conceptual space defined by the set of tales in Previous Stories and analyses what events have followed the action that triggered the impasse. For example, if action X triggers an impasse in the tale in progress, but in the Previous Stories action X has been followed by action Y, it is assumed that action Y can also be employed as the following action in the story in progress (of course preconditions are verified). What is expected is that the postconditions of action Y modify the story-world context in a way that actions can now be retrieved from long-term memory. Notice how during engagement MEXICA employs the story-world context to retrieve sequences of actions from long-term memory. By contrast, when MEXICA requires to break an impasse during reflection the system analyses the set of Previous Stories, identifies a particular action that can help to break the impasse, and retrieves it from long-term memory.

**D. Producing Guidelines.**

Since one of the main characteristics of this approach is the use of constraints to guide the production of material during engagement (i.e. the lack of goals or pre-defined story structures as a way to lead the production of material), it is necessary to establish a medium of communications between engagement and reflection. That is, during reflection the system must analyse and evaluate if the text generated is fulfilling the requirements established by content and rhetoric demands. So, during reflection, guidelines are set to guide the production of material during engagement. Some are generated based on built-in knowledge, and others on parameters defined by the user.

### 3.2.4 Novelty in the Computer Model.

Sharples suggests that novelty and appropriateness are necessary for creativity (Sharples 1996, p. 129). Appropriateness is achieved through the setting of the right constraints. Novelty is achieved when MEXICA generates tales that are different to the ones in the Previous Stories. In this research, three methods to create novel stories have been implemented: the first two are performed during engagement and the last one during reflection. In order to make clear the explanation of the first two methods, a summary of the process followed during engagement to develop a story is now presented. An initial action is performed producing a story-world context. The system looks in memory (in the Abstract Representation) for a structure that matches such a context and retrieves the set of possible next actions associated to it. One of those actions is selected as the next event in the story, a new story-world context is generated, and the cycle starts again. Thus:

1. The first method to generate novel stories consists of eliminating from the set of possible next actions retrieved from the Abstract Representation all those actions that have been used frequently in the Previous Stories. In this way, using uncommon actions, MEXICA tries to produce original tales.
2. From the explanation of the process followed during engagement one can clearly establishes a link between the story-world context, the structure in memory representing that context, and the set of possible next actions associated to it. So, the Abstract Representation acts as the knowledge necessary to establish logical ways of continuing a story. That is, part of the knowledge in MEXICA is represented by structures linking story-world contexts and sets of possible next actions to perform. (As explained in Section 3.2.1-B, all these structures come from information extracted from the Previous Stories.) Thus, the second method to produce novel tales consists of creating new knowledge by either linking contexts and sets of possible next actions not linked before, or by producing new contexts (i.e. circumstances or situations which do not exist in memory) and linking them to sets of possible next actions. The process works as follows: MEXICA searches in the Abstract Representation for a structure *similar* to the story-world context of the tale in progress (cf. with method 1 where the system matches a structure *equal* to the story-world context). That is, MEXICA looks in the Abstract Representation for a structure which shares some characteristics with the context of the story in

progress. Then, MEXICA selects as the next event in the tale in progress one of the options included in the set of possible next actions associated to the structure. In this way, the system links the actual story-world context to an action not associated to that context before. As a result of this process, MEXICA creates novel context-possible next actions pairs which allow producing sequence of actions not present in the Previous Stories.

3. The third method is performed when MEXICA tries to break an impasse or satisfy preconditions. If the story in progress lacks originality MEXICA selects an action not used frequently in the Previous Stories to break the impasse or satisfy the preconditions. In this way, inserting uncommon events in the tales in progress, MEXICA attempts to produce novel tales.

Thus, the whole process of producing novel tales works as follows. When MEXICA is developing a new story and it detects that the story in progress lacks originality, MEXICA applies the methods described above. During engagement it applies method 1; if it does not work (e.g. if all possible next actions retrieved from memory are eliminated by the filters) MEXICA applies method 2. If the second method also fails (i.e. if the system cannot find a structure similar to the story-world context) the story is abandoned. During reflection MEXICA always applies method 3. If it fails (i.e. if all available options do not satisfy the requirements of novelty) the story is abandoned.

The rest of this section is divided in three parts. Part A gives a clearer view of how engagement works and an example of how method 1 is employed. Part B offers an example of how method 2 works. Finally, part C describes the way method 3 is performed.

**A. Method 1: Using uncommon actions.**

In MEXICA a story is defined as a sequence of actions. The following is a representation of a story:

Story I: Act A, Act B, Act C ...

where Act A, Act B and Act C represent different events occurring in the story. A story also can be seen as a sequence of actions producing different contexts, i.e. the postconditions of action A modify the story world producing a context 1; the postconditions of action B modifies the story world (represented by context 1) producing context 2, etc. The following is a representation of a story in terms of actions and contexts:

Story I: Act A (Context 1), Act B (Context 2), Act C (Context 3) ...

Notice that Context 2 is the result of the story-world context before action B is performed (represented as Context 1) and the postconditions of action B. This can be represented as:

Context 2 = Context 1 + Postconditions of Act B.

Context 2 is not only the result of adding the postconditions of action A and action B. MEXICA performs an analysis of the actual context of the story-world and the postconditions of the last action performed, in

order to trigger inferred postconditions, eliminate redundant information, etc. Thus, story-world contexts are very dynamic structures. For example, the reader can imagine that the last example (Story I) is a tale about lovers, where John, Mary and Jenny are the main characters. If the postconditions of action A produce that Mary falls in love with John, and the postconditions of action B produce that Jenny also falls in love with John, MEXICA detects this situation and triggers an inferred postcondition indicating a love competition between Mary and Jenny. This can be represented as follows (where the phrase in bold represents the inferred postcondition):

Story I:
Act A (Context 1: Mary is in love with John),
Act B (Context 2: Mary and Jenny are in love with John. **Thus, there is a love competition between them**),
Act C (Context 3) ...

The set of tales in the file of Previous Stories can be represented as follows:

**Previous Stories:**
Tale I: Act A (Context 1), Act B (Context 2), Act C (Context 3) ...
Tale II: Act M (Context 1), Act N (Context 12), Act O (Context 13) ...
Tale III: Act X (Context 21), Act Y (Context 22), Act B (Context 23) ...
Tale IV: Act K (Context 31), Act B (Context 32), Act Y (Context 33) ...
Etc.

In this example, it is assumed that the postconditions of action A and action M are the same. That is the reason why the first action in Tale I and Tale II produces the same context (represented as Context 1). However, after action B is performed in Tale I MEXICA produces Context 2, while after action N is performed in Tale II a different context is generated (Context 12). That occurs because it is assumed that the postconditions of action B and action N are different. This can be represented as follows:

Context 2 = Context 1 + Postconditions of Act B
Context 12 = Context 1 + Postconditions of Act N
Where the postconditions of action B are different to the postconditions of action N

Based on the hypothetical file of Previous Stories, MEXICA produces the following Abstract Representation:

**Abstract Representation:**
Context 1 —> [Act B, Act N]
Context 21 —> [Act Y]

Context 2 —> [Act C]
Context 12 —> [Act O]
Etc.
(To make the example as simple as possible, only part of the Abstract Representation is shown).

Now, MEXICA can start to generate a story in the Engaged State. An initial action is selected (e.g. action A) whose postconditions produce Context 1. Now, based on the information in the Abstract Representation, the possible next actions to perform are action B or action N:

New Story: Act A (Context 1)
Possible next actions: Context 1 —> [Act B, Act N]

This information can be interpreted as follows: according to the constraints imposed by the story-world context, and based on the knowledge acquired from the Previous Stories, logical possible next actions to perform in the story in progress are action B or action N. Or in other words, using Context 1 as a cue MEXICA retrieves from memory action B and action N as possible next actions in the tale.
Now, MEXICA eliminates all those retrieved actions which are not useful (a non-useful action is that which does not satisfy the filters' requirements) and selects one (at random) between the remaining ones. Since MEXICA is trying to generate novel stories, for this example action B is eliminated by the filters and action N is selected as the next event in the tale (notice that action B has been used three times in the Previous Stories while action N has been used only once, i.e. action N is less common than action B. Thus, the filters eliminate action B). The story in progress can be represented as follows:

New Story: Act A (Context 1), Act N (Context 12)
Context 12 = Context 1 + Postconditions of Act N
Context 1 and the postconditions of action N produce Context 12 (see Tale II in the Previous Stories).

Now, MEXICA retrieves the possible next actions pointed by Context 12 (in this case action O), applies the filters, selects one and the process keeps on going.
This example illustrates in general terms the way method 1 works: when MEXICA detects that the story in progress is not novel enough, the guidelines restrict the use of actions that occur frequently in the Previous Stories. This helps to avoid producing tales which already exist in such Previous Stories. For instance, if in this example action B had been selected as the next action in the tale, the first events in the story in progress would have been identical to Tale I in the Previous Stories.
To simplify the explanation of method 1, some aspects of the process have been omitted. For example, the criterion to define what actions the filters must eliminate depends on how similar the story in progress is to any of the tales in the Previous Stories. That is, MEXICA distinguishes when the story in progress is a copy of a tale in the Previous Stories, and when it only resembles such a tale. Details of the process are given in Section 4.3.2.3.

**B. Method 2: Creating new Knowledge.**

MEXICA creates new knowledge by creating new contexts and linking them to sets of possible next actions, or by linking in novel ways contexts (which already exist) and sets of possible next actions. How can a new context be created? As explained earlier, all contexts in the Abstract Representation are formed by combining the actual story-world context and the postconditions of the last action performed.

Context 2 = Context 1 + Postconditions of Action.

If the system combines a context and the postconditions of an action which have not been combined in the Previous Stories, a new context is obtained. The problem is to find a novel context-action's postconditions combination that fulfils requirements of logic and coherence. That is, it is not possible to take any context and combine it with the postconditions of an action chosen at random; that would produce scenes lacking sense.

What MEXICA does is to find two contexts that are similar, i.e. two contexts which share some essential characteristics. Then, it assumes that the set of possible next actions associated to one of them can also be used by the other context. In this way, new coherent links of context-possible next actions are formed. For example, a new story can start with action X, which produces Context 21 (to illustrate and make clearer this example, the reader can consult the hypothetical Previous Stories and Abstract Representation employed in the example in part A of this Section):

New Story: Act X (Context 21)

Now, it is assumed that Context 21 is similar to Context 1; so, MEXICA assumes that the set of possible actions associated to Context 1 can also be used by Context 21:

Possible next actions: Context 1 —> [Act B, Act N]
Context 21 is similar to Context 1, so MEXICA assumes that
Possible next actions: Context 21 —> [Act B, Act N]

In this way, if Act B is selected as the next even in the story in progress MEXICA creates a sequence of actions which does not exist in the Previous Stories (i.e. the sequence Act X, Act B cannot be found in the Previous Stories). Action B is linked to Context 21 (this link is not present in the system). Finally, Context 21 and the postconditions of Action B creates a new context (context 32) which is not present in memory:

New Story: Act X (Context 21), Act B (**Context 32**)
Novel context —> Context 32 = Context 21 + Postconditions of Act B
This combination does not exist in memory.

This new context is not added automatically into long-term memory. After the story in progress is finished the user has the option to include it in the set of Previous Stories. If the user decides to take this option, the next time MEXICA creates a new tale, action B will be included in the set of possible next actions associated to context 21 and the new context (context 32) will be included as structure in memory (i.e. the knowledge in MEXICA will be increased).

At the moment it is not possible to find any context 32 in long-term memory. So, MEXICA looks for another context similar to it in order to be able to keep on developing the story. For this example, it is assumed that context 32 is similar to context 12. So, MEXICA assumes that action O is a coherent possible event in the tale in progress:

Possible next actions: Context 12 —> [Act O]
Context 32 is similar to Context 12, so MEXICA assumes that
Possible next actions: Context 32 —> [Act O]
Thus:
New Story: Act X (Context 21), Act B (**Context 32**), Act O (**Context 33**)

The combination of Context 32 and the postconditions of action O produce a new context (context 33):

Context 33 = Context 32 + Postconditions of Act O.

And the process keeps on going. The following example illustrates the same situation but using concrete characters. The reader can imagine that one of the tales in the Previous Stories includes the following sequence of actions (the phrases in brackets represent the context created by the last action performed):

**Previous Stories**:
Princess went with her slave to the forest
Enemy attacked and wounded the Princess. [Princess hated enemy. The life of the princess was at risk].
Princess' slave went to look for a doctor
Etc.

The second action produces a context where the princess hates the enemy, and where the life of the princess is at risk due to the enemy's attack. Thus, the following structure is created in memory:

**Abstract Representation:**
[X hated Y. The life of X was at risk] —> Z went to look for a doctor.

Where X represents the princess, Y the enemy, and Z princess' slave. Now, the reader can imagine that MEXICA starts to create a new tale and generates the following sequence of actions:

**New Story:**

Princess went horse riding in the forest.
The horse got scared and the princess fell down injuring her head [The life of the princess was at risk].

The consequence of princess' accident is that the life of the princess is at risk. Thus, MEXICA utilises that context to retrieve actions from memory. If MEXICA does not find in memory a context like this one, it starts looking for a similar context. Then —for this example— substituting X for princess it finds that the context [X hated Y. The life of the X was in risk] is 50% similar to the context [The life of the princess was at risk]. So, the action *Z went to look for a doctor* is retrieved and the story continues as follows:

Princess went horse riding to the forest.
The horse got scared and the princess fell down injuring her head [The life of the princess was at risk].
Someone went to look for a doctor

MEXICA instantiates "someone" with an appropriate character and the process keeps on going. During reflection MEXICA justifies how "someone" was at the right place at the right time to help the princess (those are the preconditions of the action "someone went to look for a doctor"). Thus, this is an example of how during engagement some actions whose preconditions have not been satisfied yet are included in the story in progress.
This section attempts to give a general idea of the process followed by MEXICA when it develops new stories. The process used by the system to find similar contexts is more complex that the one explained here. It consists of transforming the original contexts and/or searching in memory for a context which includes the original one. Also, an instantiation process is performed which plays a very important role in the creation of novel contexts (details of all these processes are given in Section 4.3)
In order to make the explanation as simple as possible, the examples used in this section illustrate the process followed by the system employing only one general story-world context. However, when MEXICA develops a story each character in the tale has its own context. That is, in MEXICA each character has its own perspective of the story-world reality, and it is used to retrieve possible next actions from memory. Details of all these processes are given in the following chapters.

**C. Inserting Novel Actions during Reflection.**

In the previous examples it has been assumed that MEXICA starts developing a story under engagement. After a certain number of actions are generated or after an impasse is declared, the system switches to reflection. MEXICA always starts verifying that all preconditions are satisfied. If it detects an anomaly, the system looks in the set of Primitive Actions (PAs) for all events which satisfies the required preconditions and which have not been used frequently in the Previous Stories, and selects one between the available options.
When an impasse is declared MEXICA analyses the Previous Stories looking for alternatives to break it. That is, MEXICA studies how similar situations have been resolved in the past. Then, between the options

found, the system selects to break the impasse one that has not been used frequently in such Previous Stories.

### 3.2.5 Operation Modes.

Stories created by MEXICA are the result of the interaction between the Engaged and Reflective States. However, part of the purpose of this research is to develop a flexible system that allows the user to experiment with different aspects of the model. With this in mind, MEXICA has been designed to work in four operation modes that permit enabling or disabling different characteristics of the system. They are referred as: Engaged State 1 (E1), Engaged and Reflective States 1 (ER1), Engaged State 2 (E2), Engaged and Reflective States 2 (ER2).

When MEXICA works under the E1 or E2 operation modes, the system only makes use of the processes included in the Engaged State. That is, all routines which operate under reflection are omitted. In this way the user can analyse the effects of leaving out reflection in a story, the kind of tales that the system is capable to create under engagement, etc.

The user also has the option of "forcing" MEXICA to produce tales without the use of filters. The E1 operation mode avoids the use of all routines in the Reflective State and the use of filters. In contrast, the E2 operation mode avoids only the use of the routines included in the Reflective State, i.e. stories are created making use of the filters. Again, this allows observing the effects of filters in the development of stories. Thus, the only difference between E1 and E2 operations modes is the use of filters.
Under the ER1 operation mode MEXICA creates stories as a result on the interaction of the Engaged and Reflective States but it excludes the use of filters. ER2 makes use of all the processes included in the system.

| | | |
|---|---|---|
| Engaged State 1 (E1) | No Filtering Process | No Reflective State. |
| Engaged State 2 (E2) | Filtering Process | No Reflective State |
| Engaged and Reflective States 1 (ER1) | No Filtering Process | Reflective State. |
| Engaged and Reflective States 2 (ER2) | Filtering Process | Reflective State |

### 3.2.6 Conclusions.

In this research a *story* is defined as a sequence of actions which:

- Are logical and coherent.
- Includes degradation-improvement processes (conflict, complication and resolution).

A *logic and coherent sequence of actions* is that where the preconditions of all actions in the sequence are satisfied.

Following Sharples, in MEXICA *creativity* consists of producing novel and appropriate narratives. A narrative is considered novel when it is not similar to any of the tales in the Previous Stories. A narrative is considered appropriate when it satisfies the requirements of coherence and degradation-improvement processes established for a story.

*MEXICA is a computer model of a cognitive process based on Sharples' account of writing. Its main goal is to produce novel and appropriate short stories as a result of an engagement-reflection cycle.*

During reflection a deliberate knowledge exploration is performed as well as an assessment to evaluate if the material produced during engagement fulfils writer's knowledge and beliefs about the theme, the writing topic and writing goals. In MEXICA the Reflective State simulates this process. When the system breaks an impasse or satisfies preconditions it explores either the knowledge represented by the Concrete Representation (Previous Stories) or the group of Primitive Actions (PAs). In the same way, during reflection MEXICA tests if the material produced during engagement satisfies requirements of novelty and interest.

Engagement consists of producing a chain of ideas guided by constraints; i.e. no goals or predefined story structures are employed in the process. In MEXICA, the Engaged State simulates such a process: an action produces a story-world context that is used to retrieve a new action, which modifies the story-world context provoking a new action to be retrieved and so on. As specified by Sharples' account, in MEXICA constraints guide engagement by restricting to appropriate events the universe of possible actions to be performed in a story. Filters play an important part of this process: together with the guidelines, they establish a dynamic communication between the Reflective State and the Engaged State. So, the analytical part of the model can influence the production of material by setting constraints. Filters also restrict the use of those events that do not satisfy social conventions, etc. and assure (again by constraining events) the flow of the story in progress. Filters do not perform any deliberate knowledge exploration or explicit evaluation of the material retrieved from memory (the main characteristics of reflection); they only restrict the use of those events that do not satisfy a set of requirements. Thus, filters match the concept of engagement used in this work.

*The core element of the creative process in MEXICA is the production of novel story-world contexts. This characteristic allows the system to develop stories in surprising directions.*

MEXICA's output depends on the Previous Stories and the set of PAs. However, the creative process implemented in MEXICA permits constructing situations in the story in progress which were not present in the system before. That is, MEXICA's creative process allows new structures to be incorporated in memory that represent original knowledge. Since such knowledge is the essential material used to build new stories, and it can be combined in multiple ways, the creative process in MEXICA is very flexible and allows leading the story in surprising directions.

In general terms, the Engaged State generates the novel situations while the Reflective State maintains coherence between the story in progress and those novel situations. Since in this research creativity is formed by novel and coherent outputs, MEXICA clearly illustrates the importance that the interaction of engagement and reflection plays in the creative process.

*MEXICA also works as a research tool, i.e. it allows the user to experiment with different parts of the model.*

MEXICA has been designed to offer to the user all the facilities necessary to manipulate and experiment with different aspects of the model. For example, preconditions —whose role is to assure the coherence in a story— are defined, and can be modified at any moment, by the user. In the same way, more than twenty other parameters are controlled by the user. However, such flexibility can mean that MEXICA generates inappropriate outputs without noticing it. For instance, in the case of preconditions, if they are not properly defined by the user but all actions' preconditions in the story in progress are satisfied, the resulting odd text will be evaluated as adequate by the system. That is, a story can be completely coherent for MEXICA but illogical from a human point of view. Thus, an evaluation of MEXICA's output must contemplate this situation. That is, an inadequate definition of preconditions probably will result in an unnoticed odd output. If MEXICA were a program exclusively developed to write good stories, the production of "strange" tales could be a problem. But MEXICA is a computer model of a cognitive process designed to give to the user all the facilities to experiment with different parts of the model. Thus, the generation of odd tales are expected outputs (also, it must be taken into consideration that in some cases the judgement of what is an odd tale depends on one's own experience, cultural backgrounds, etc.) When a user finds a story too bizarre, such a story can easily be corrected by modifying actions' preconditions. That is, in MEXICA preconditions have been explicitly designed to allow the user to experiment with them. That is the reason the user can modify preconditions at any moment. The same occurs with many other parameters that control important aspects of the system and can be manipulated by the user.

## 3.3 Summary.

This chapter is divided in two sections. The first describes the core parts of Sharples' account of the writing process: importance of constraints, generation and analysis of text, similarities between design problems and writing, writers and their environment, and writing as creative design: the Engagement-Reflection cycle.

Sharples claims that what distinguishes novelty from creativity is the setting of the right constraints. Therefore, their study is indispensable for a comprehension of creativity. He calls up in his account different theories: knowledge telling and knowledge transforming (Scardamalia and Bereiter 1987), creativity and cognition (Gelernter 1994, Boden 1992), etc. Similarities between writing and design are pointed out (e.g. the lack of explicit goals to drive the activity, the use of primary generators, etc.) And the

importance that tools, external representations, media and resources have in the writing process is analysed. The main aspects of his account are summarised as follows:

1. Writing starts not with a single goal but with a set of external and internal constraints.
2. Constraints provide the tacit knowledge to guide the writing process.
3. The cognitive engine of writing is formed by cycles between engaged writing (guided by constraints) and deliberate reflection.

Engagement involves the continuous production of material on an external medium, while reflection involves reviewing, contemplation and planning.

The second section of this chapter describes the main elements of the computer model topic of this research: types of constraints, the Engaged and Reflective States (preconditions, postconditions, evaluation, guidelines, etc.), novelty in the computer model and operation modes. MEXICA is a computer program where such a model has been implemented. The differences between Sharples' account and the computer model are pointed out and a map between the theory and the computer model is established. Four types of constraints are included in the system: Context Constraints, Knowledge Constraints (Abstract, Tensional and Concrete Representations), Guidelines Constraints and General Constraints. MEXICA produces novel and interesting stories through cycles of engagement and reflection. During engagement the production of material is guided by constraints rather than explicit goals or predefined story-structures. During reflection MEXICA evaluates the story in progress, verifies preconditions, breaks impasses and set the guidelines. The system includes three methods to produce novel stories: using uncommon actions (in two different ways) and creating new knowledge. MEXICA has been designed with the idea of allowing the user to experiment with different aspects of the computer model. Thus, four operation modes (and an important number of parameters) which control different parts of the Engagement-Reflection cycle can be set by the user. Finally, the nature of the Engagement-Reflection processes in MEXICA is explained and terms like story and creativity defined. Thus, MEXICA is a computer model based on the cognitive process described by Sharples' account of the writing process.

# Chapter IV

# How MEXICA Works

The system can be described in terms of two main processes: the first creates all data-structures in long-term memory and the second, based on these structures, creates new stories.
The first structure created in long-term memory is called Primitive Actions Structure; it encodes all the information defined in the file of Primitive Actions. The rest of the structures are created by transforming the file of Previous Stories into the Concrete, Abstract and Tensional Representations. The Concrete Representation can be seen as a copy in memory of the file of Previous Stories. The Abstract Representation encodes the knowledge necessary to bring into working memory plausible actions to continue the story in progress. Finally, the Tensional Representation registers the behaviour of a variable called Tension to the Reader, which is used to produce interesting stories. Both, the Primitive Actions and the Previous Stories are defined (i.e. built) by the user.

The process of developing new stories consists of a cycle between the Engaged and Reflective States. During engagement, an action is performed producing a specific story-world context. Such a context is used to match in long-term memory structures representing similar situations. These structures have associated a set of possible next actions, which are brought into working memory. There, one of them is selected as the next action in the story. This action is performed in the story producing a new story-world context and the cycle starts again.
If the cycle is interrupted (e.g. by an impasse) the system switches to the Reflective State. During reflection all preconditions are verified, impasses broken, and the material produced is evaluated either to set the guidelines and return to the Engaged State or to finish the story. When the story is finished, MEXICA performs a final analysis to add a few finishing touches to the tale.
In this chapter, all these processes are explained in detail.

## 4.1 Primitive Actions.

The design of the system is based on operators, preconditions and effects. In MEXICA operators are called Primitive Actions; thus, Primitive Actions are a set of actions that any character can perform in the story and whose consequences produce some change in the story-world. Primitive Actions are defined by the user in a text file by specifying the name of the action, the number of characters who participate in it and the set of preconditions and effects associated with the action. A complete explanation of the syntax to define Primitive Actions can be found in Appendix A The maximum number of characters allowed in one action are three, and most of them follow the structure *actor1 acts-on actor2*, i.e. actor1 executes an action towards actor2, e.g. EAGLE_KNIGHT ATTACKED ENEMY or PRINCESS CURED JAGUAR_KNIGHT. However, actions in which actors act on each

other can also be defined, e.g. EAGLE_KNIGHT FOUGHT ENEMY (both characters are fighting to each other). Actions involving three characters are special cases and they are explained in section 4.2. When defining actions, letters are used to represent characters. For example, the following string represents the action of character A kissing B:

ACTION
A KISSES B

All the primitive actions used to test the present model have been defined in the past tense, e.g. A LOVED B, A WENT_TEXCOCO_LAKE, (a list with some of the Primitive Actions used to test the prototype can be found in Appendix C). The user is free to define the primitive actions in the most convenient way since the internal representation and instantiation process are independent of such definition.

Each time the program starts MEXICA creates in long-term memory the Primitive Actions Structure. Such a structure contains all the information the user defined in the file of Primitive Actions.

### 4.1.1 Postconditions.

The effects that Primitive Actions produce in the story-world are known as postconditions. There are three types of possible postconditions that can be used in MEXICA:
1) Emotional Links between characters.
2) Tensions in the story.
3) Changes in the physical position of the characters in the story-world.
Each of these is now described in detail.

#### 4.1.1.1 Emotional Links.

It is beyond the scope of this work to make a detailed analysis of emotions. However, they are essential elements in any short story. For the purpose of implementing the present model, a simple representation of Emotional Links between characters has been incorporated in the system. Dyer (1987) describes some computer models of emotions. He affirms that “all affects can be represented simply in terms of a positive or negative state of arousal...” Based on that idea in MEXICA three types of Emotional Links have been defined.

For practical reasons all types of emotions are implemented in discrete terms with a value in the range of -3 to +3. Type 1 represents a continuum between love and hate. In this way, an emotion of intensity -3 and type 1 represents hate, while an emotion of intensity +3 and type 1 represents love. The remainders are possible values between these two poles.

| To hate | | | | | | To love |
|---|---|---|---|---|---|---|
| -3 | -2 | -1 | 0 | +1 | +2 | +3 |

Emotions of type 2 represents a continuum between being in love with and feeling hatred towards. In the present work, love is interpreted as brotherly love, while to be in love is interpreted as amorous love. Finally, type 3 has been defined with the intention of allowing the user to include another Emotional Link according to his/her necessities. That is, when defining Primitive Actions the user can include an Emotional Link of type 3; it will represent what the user requires.

The following example illustrates the use of Emotional Links as postconditions. If a warrior is ill or wounded and a lady cures him, it is natural that he will develop very positive emotions towards the lady. In this way, when defining the action A CURED B, postconditions might include that B develops an Emotional Link of type 1 intensity +3 towards A.

ACTION
A CURED B
POSTCONDITIONS
B(+3,1): A

Notice in the last example the notation used to represent the postcondition B developed an Emotional Link of intensity +3 and type 1 towards A. From now onwards, the same notation will be used in all the examples involving Emotional Links: first it is specified the character who develops the Emotional Link, followed in brackets and separated by a coma by the intensity and type of Emotional Link, followed by a colon and ending with the character towards whom the link is developed[1].

Postconditions also allow establishing Emotional Links between characters participating in an action and their friends or family in the story, i.e. between characters participating in an action and others characters who previously have established a positive Emotional Link towards them. This second group of characters (friends, family, etc.) is referred as Linked Characters. In order to establish such an Emotional Link it is necessary that the Linked Characters are located in the same position as the actors in the event. For example, an action like PRIEST CURED JAGUAR_KNIGHT causes not just jaguar knight but all his friends (i.e. all Linked Characters) to develop a positive Emotional Link towards the priest. This situation is defined in the declaration of primitive actions as follows:

ACTION
A CURED B
POSTCONDITIONS
B(+3,1): A
LB(+3,1):A

Where LB represents all those characters linked previously to character B. In this way, the second postcondition can be read as all those characters who have a positive Emotional Link towards character B and are in the same location as character B, also establish an Emotional Link of intensity +3 and type

1 towards character A. Finally, MEXICA allows the user to introduce a variation of this situation. If the priest cures jaguar knight, the intensity of the emotional response of jaguar knight's friends towards the priest depends on how strong their relationship is. That is, jaguar knight's fiancé would establish a stronger emotional response than someone who is just fond of him. This situation can be represented in MEXICA. If instead of specifying a concrete intensity for Linked Characters the symbol of percentage is used, e.g. LB (%,1):A, then the intensity of the Emotional Link triggered by the postcondition between LB (Linked Characters) and the character A depends on the intensity of the Emotional Link between LB and the character B, and the intensity of the Emotional Link between character B and character A. In this way, if character B is very grateful towards character A, someone who is just fond of character B establishes a less intense Emotional Link towards character A that someone who is in love with character B. This situation is defined in terms of primitive actions as follows:

ACTION
A CURED B
POSTCONDITIONS
B(+3,1): A
LB(%,1):A

MEXICA uses a table, called Percentage Table, to obtain the value of the intensity of the Emotional Link when it is defined in terms of the percentage symbol.

| **LB->B** | **B->A** | **LB->A** |
|---|---|---|
| +3 | -3 | -3 |
| +3 | -2 | -2 |
| +3 | -1 | -1 |
| +3 | 0 | 0 |
| +3 | +1,+2+3 | (B->A)-1 |
| +2 | -3,-2 | -2 |
| +2 | -1 | -1 |
| +2 | 0,+1 | 0 |
| +2 | +2,+3 | (B->A)-1 |
| +1 | -3,-2,-1 | -1 |
| +1 | +3 | +1 |
| +1 | 0,+1,+2 | 0 |

(B->A)-1 means to decrement by one the value of the intensity between character B and character A.

The table shows how the value of the intensity of the Emotional Links between LB and character A depends on the value of the intensity of the Emotional Link between LB and character B, and the value of the intensity of the Emotional Link between the character B and the character A. Also, it is important to notice that the value of such intensity does not depend on the type of Emotional Link established.

[1] Although the notation used to define Emotional Links in the prototype differs from the one in the example, for reasons of clarity the second has been adopted through this text.

As an example to illustrate the use of the Percentage Table the reader can imagine a princess is in love with jaguar knight, i.e. she has established the following Emotional Link: princess(+3, 2):Jaguar_Knight. Now, if the jaguar knight has an accident and the priest cures him, according to the primitive action defined above, two new Emotional Links are established: Jaguar_Knight(+3,1):priest, and princess(%,1):priest. Then, ensuing from the Percentage Table the following value is obtained:

| princess->Jaguar_Knight | Jaguar_Knight->priest | princess->priest |
|---|---|---|
| +3 | +3 | (+3)-1 = +2 |

In this way the princess establishes the Emotional Link princess(+2,1):priest which makes sense since probably she is very grateful to the priest for saving the life of her lover.

MEXICA allows characters to establish different Emotional Links towards each other; e.g., character B can have an Emotional Link of intensity +3 type 2 towards character A and at the same time have an Emotional Link of intensity -2 type 1 towards such a character A. In this case, if MEXICA is calculating the intensity of an Emotional Link defined in terms of the percentage symbol, and either the previously Linked Characters to B or character B have different Emotional Links towards A, the system needs to decide which of such Emotional Links is the one that will be used to obtain the value of the intensity from the table. The rule is simple: the one with the highest absolute value of intensity is selected. This was decided on the assumption that strong feelings overcome weak ones. If both Emotional Links have the same absolute value, one is selected randomly.
Linked Characters are only allowed in postconditions of type Emotional Links. Notice that Linked Characters are just those characters who have established a positive Emotional Links towards other one.

### 4.1.1.2 Tensions.

One of the key elements in any short story is the tension produced by the author to the reader through the use of different tools or techniques. It is beyond the scope of this work to analyse tensions and fiction, but it is assumed that a tension in a short story arises when a character is murdered, when the life of a character is at risk, when the health of a character is at risk (e.g. when a character has been wounded), when a character is made a prisoner, when a character feels clashing emotions towards other one, and when two different characters are in love with a third one producing a love competition. Six different types of tension represent these situations: Actor Dead, Life at risk, Health at risk, Prisoner, Clashing Emotions and Love Competition. It is not suggested that those are the only situations that can produce tension in a reader, or even that always these situations will produce it. They have just been defined in order to be able to implement and test the present computer model.
There are two different ways to trigger tensions. Actor Dead, Life at risk, Health at risk and Prisoner are activated directly by postconditions. For example, if in a story the enemy attacks the tlatoani, a

tension will be produced because the life of the tlatoani is at risk. This situation can be defined in terms of Primitive Actions as follows:

ACTION
A attacked B
POSTCONDITIONS
Lr (B):A+

Notice again the way the postcondition indicating that the life of character B is at risk due to the presence of character A has been defined. From now onwards this notation will be used in all examples involving tensions: first a mnemonic representing the tension to be triggered is specified, followed in brackets by the character who is the victim, followed optionally by a colon and the character who is responsible of triggering the tension, followed optionally by the addition symbol. The addition symbol indicates that the tension will be active only while character A and B are in the same location; it would not make sense in a short story to keep the tension Life at Risk active if character A attempts to attack character B and then s/he runs away.

When the addition symbol is omitted the tension triggered by the postcondition is kept active, whether or not A and B are in the same location, until other postcondition deactivate it. For example, if character A pushes character B to a river, the life of character B is at risk regardless if character A runs away or not. Finally, when the second character is excluded from the definition of the postcondition, e.g. Lr(B), it is assumed that nobody is responsible that the life of the character B is at risk and the tension is kept active until other postcondition deactivates it. To illustrate this case the reader can picture an event where character B falls accidentally in a river. The mnemonics used to represent tensions are: Ad for Actor Dead, Lr for Life at Risk, Hr for Health at Risk and Pr for Prisoner. Appendix C shows examples of declarations of Primitive Actions.

The second method to trigger tensions is now explained. Clashing Emotions and Love Competition belong to a special class of postconditions known as Inferred Postconditions. They arise when MEXICA detects that the conditions that activate them are present in the story. Thus, each time an action is performed in the story MEXICA verifies if a tension must be triggered. A tension due to Clashing Emotions is produced when a character establishes two Emotional Links of any type but opposite intensity towards other character. To illustrate this situation, the reader can imagine a princess who falls in love with an enemy. A tension due to love competition is produced when two different characters are in love with a third one. For example, consider a story with the following actions:

EAGLE_KNIGHT WAS_IN_LOVE_WITH PRINCESS
JAGUAR_KNIGHT WAS_IN_LOVE_WITH PRINCESS

The first event triggers the Emotional Link Eagle_Knight (+3,2):princes and the second one activates Jaguar_Knight (+3,2):princess. Then, MEXICA detects that two different characters are in love with the princess and it triggers a tension of Love Competition.

Finally, there are three other tensions: Life Normal, Health Normal and Prisoner Free. They are used to deactivate those tensions triggered directly by postconditions. The mnemonics to identify them trough the examples are Ln, Hn, Pf respectively. In the same way as the previous tensions, the user defines them as consequences in the primitive actions. For example, to deactivate the tension produced when the health of a character is in risk (Hr), the following action can be defined:

ACTION
A CURED B
POSTCONDITIONS
Hn(B):A

#### 4.1.1.3 Positions.

The story-world in MEXICA has eight different positions or locations: Texcoco Lake, Popocatepetl Volcano, Tlatelolco Market, Palace, Tenochtitlan city, Chapultepec Forest, Temple and Jail. Two other special locations have also been defined: Nowhere which is used to locate dead characters, and b_position that is used to situate a character in the same position as another character. In MEXICA all characters that participate in an action must have the same position in the story-world in order to perform such an action.

The set of active postconditions that a character has at any specific time in the story is known as the Context of the character. During the developing of the story each time an action is executed, each character's context is updated. In MEXICA, the Context determines what Emotional Links and Tensions characters are aware of in the story, and plays a crucial role in the generation of material during the Engaged State.

### 4.1.2 Preconditions.

Preconditions specify the requirements that need to be fulfilled in order that a character can perform an action. However, as explained in Chapter III, preconditions have a very particular characteristic in the present model: they are just checked during the Reflective State. During the Engaged State MEXICA produces material without taking them into account. The user specifies preconditions when Primitive Actions are declared; they can be of two types: Tensions or Emotional Links. There is a predefined or implicit precondition for all Primitive Actions; it requires that when an action is performed, all characters participating in it must be in the same place in the story-world. The following is an example of a declaration of a Primitive Action including preconditions.

ACTION
A CURED B
PRECONDITIONS
Hr(B):*
A(+1,*):B
POSTCONDITIONS
Hn(B):A
B(+3,1):A

Notice that the syntax used to define the tension in the precondition is slightly different to the one used previously. The reason is that preconditions allow using the start symbol ('*') which means "any character in the tale". In this way, the precondition in the example can be read as: In order for A to cure B it was necessary that the health of B was previously put at risk by any other character in the story (this also includes the possibility of a none-character.) There is one important restriction to point out: when a tension is used as a precondition, the star can only be used to represent the character who is responsible for triggering the tension (i.e. the second character in the definition); the victim of the tension (i.e. the first character in the definition) cannot be represented by a star.
The star symbol has also another function. When it is used in the definition of an Emotional Links as a preconditions, the star stands for "any type of Emotional Link"; so, the precondition in the example can be read as: In order for A to cure B it was necessary that A has an Emotional Link of any type towards B.

Preconditions represent the requirements that must be satisfied in order an action can be performed. In the present research it is assumed that if an Emotional Link is defined as a precondition, the same Emotional Link but with a stronger intensity also matches the precondition. That is, if the precondition for an action is A(+1,*):B, the precondition is satisfied if the character A has an Emotional Link of intensity +1, +2 or +3 of any type towards B. If the precondition for the action is A(-2,*):B, it is fulfilled if the character A has an Emotional Link of intensity -2 or -3 of any type towards B. In this way, the range of valid values goes from the value specified in the precondition to +3 or -3.
So, in the example of the definition of the action A cured B, the range of valid values goes from +1 to +3. In this way, the precondition can finally be read as: In order for A to cure B it was necessary that A has an Emotional Link of any type and intensity greater or equal to +1 towards B.
It is important to stress that this interpretation of the intensity just applies for Emotional Links as preconditions; under other circumstances it would make no sense.

During the Reflective State MEXICA verifies that all preconditions in the new story have been fulfilled, and, if necessary, actions are inserted in the new story in order to fulfil them. Only those characters participating in the action are allowed intervening in the preconditions; so, Linked Characters are not permitted.

### 4.1.3 Text Generation.

The words and phrases that form a story are a vital part of it. However, it is out of the scope of this work to make any research related to natural language generation. Thus, in order to produce better outputs, MEXICA includes a routine that permits linking text to Primitive Actions. In this way, it is possible to embellish the stories produced by the system. The method works as follows. The user defines as part of the Primitive Actions a text related to the event it represents. When the story is finished, all Primitive Actions are substituted by their texts to generate the final version of the tale. The following is an example of a Primitive Action including the text option:

ACTION
A CURED B
PRECONDITIONS
Hr(B):*
A(+1,*):B
POSTCONDITIONS
Hn(B):A
B(+3,1):A
TEXT
With the help of some magic plants @A cured @B.

The text is formed by a string of characters and three possible variables symbolised as @A, @B and @C. These variables represent characters A. B and C in the Primitive Action. Thus, if the action in this example is instantiated as PRINCESS CURED JAGUAR_KNIGHT, the variable @A is substituted by PRINCESS and the variable @B by JAGUAR_KNIGHT resulting in the following text: “With the help of some magic plants princess cured Jaguar_knight.” MEXICA permits defining any number of texts in a single Primitive Action and when the story is finished, the system selects the text to be used at random between the available options. If no text is defined MEXICA employs the name of the Primitive Action; e.g., if no text is defined for A CURED B, MEXICA includes in the final version of the story the phrase “princes CURED Jaguar_knight”.

## 4.2 Previous Stories.

Previous stories provide the basic material from which all new stories are created. Consequently, any outcome from MEXICA depends on their number and the way they are organised. In MEXICA, the Previous Stories are represented as a set of short stories. The following is an example:

STO
EAGLE_KNIGHT ACTOR
JAGUAR_KNIGHT ACTOR
EAGLE_KNIGHT WAS_IN_LOVE_WITH PRINCESS
JAGUAR_KNIGHT WAS_IN_LOVE_WITH PRINCESS
EAGLE_KNIGHT WERE_FRIENDS HUNTER
HUNTER HATED PRINCESS
PRINCESS WENT_TEXCOCO_LAKE

HUNTER FOLLOWED PRINCESS
HUNTER KILLED PRINCESS
JAGUAR_KNIGHT WAS_TOLD EAGLE_KNIGHT KILLED PRINCESS
JAGUAR_KNIGHT KILLED EAGLE_KNIGHT
HUNTER REALISED JAGUAR_KNIGHT KILLED EAGLE_KNIGHT
HUNTER LOOKED_FOR_AND_FOUND JAGUAR_KNIGHT
HUNTER KILLED JAGUAR_KNIGHT
END

The user defines in a text file all previous stories. The syntax to define them is explained in Appendix B. Notice from this example how a story can be understood as a chain of primitive actions, and how the first two actions have neither preconditions nor postconditions; they are used just to introduce the characters in the story. Their real use will become evident through the following sections. Notice as well the events JAGUAR_KNIGHT WAS_TOLD EAGLE_KNIGHT KILLED PRINCESS and HUNTER REALISED JAGUAR_KNIGHT KILLED EAGLE_KNIGHT. These are special kind of primitive actions called Compound Actions; their main purpose is, for the former, to make characters to believe things which have not occurred in the tale, and for the latter, to allow characters to realise about other events happening in the story.

Previous Stories are transformed into structures in long-term memory, which are used to produce new tales. This process is done action by action; i.e. MEXICA reads an action from the text file, updates all characters' contexts in working memory, updates long-term memory, and then reads the following action in the file and repeats the same cycle until all pervious stories are processed.
Although all actions in the file are read in sequence, when MEXICA detects that a new story is starting it cleans all characters' contexts and resets variables, i.e., each of the Previous Stories is processed independently.

### 4.2.1 Introducing New Characters in the Story.

Characters become alive in the story the first time they are mentioned, i.e. the first time they participate in a Primitive Action. Their location is set according to the following rule: when all characters participating in an action are introduced for the first time in the story (i.e. they have just becoming alive), they are placed in a default location chosen previously by the user. When at least one of the characters in the action is already alive in the tale, new characters are situated in the same position as the one alive.

In this way, if for example the first action in a story is WARRIOR WAS_IN_LOVE_WITH LADY and the default location is set by the user to Texcoco Lake, MEXICA assigns a context to the warrior and to the lady and sets their location to the default value Texcoco Lake. If the next action is EAGLE_KNIGHT WAS_IN_LOVE_WITH LADY, a context is assigned to the new character eagle knight and he is located in the same place as lady, i.e. at the lake.

Although the three characters are in the same location, because a character becomes alive in the story the first time s/he is mentioned, eagle knight is not aware of the warrior's Emotional Link towards the princess. However, the warrior and princess do know about eagle knight's Emotional Links towards her, and that triggers in their context as an inferred postcondition a tension due to love competition (see Section 4.2.2.2 for inferred postconditions). This situation is represented in the following lines in terms of characters' contexts.

CONTEXT ***
***Time=>1  Action: warrior WAS_IN_LOVE_WITH lady
Character:WARRIOR. Pos:Texcoco Lake. Status:Alive
Emotional Links => Warrior(+3,2):princess.
Tensions=> none.

Character:LADY. Pos: Texcoco Lake. Status:Alive
Emotional Links=> Warrior(+3,2):princess.
Tensions=> none.

CONTEXT ***
***Time=>2  Action: eagle_knight WAS_IN_LOVE_WITH lady
Character:WARRIOR. Pos:Texcoco Lake  Status:Alive
Emotional Links=> Warrior(+3,2):princess
Eagle_Knight(+3,2):princess
Tensions=>  Lc(Warrior):Eagle_Knight

Character: LADY  Pos: Texcoco Lake  Status:Alive
Emotional Links=> Warrior(+3,2):princess
Eagle_Knight(+3,2):princess
Tensions=>  Lc (Warrior):Eagle_Knight

Character:EAGLE_KNIGHT Pos:Texcoco Lake Status:Alive
Emotional Links=> Eagle_Knight(+3,2):princess.
Tensions=> none.

If this situation is not convenient for the story, it can be avoided by including as a first action EAGLE_KNIGHT ACTOR. The Primitive Action ACTOR has neither preconditions nor postconditions; its only function is to introduce a character to the tale. Thus, what it produces is that eagle knight is assigned a context when the story starts and then from the beginning he is able to become aware of all the events occurring around him.

### 4.2.2 Updating Working Memory.

Working memory is updated in two main stages: 1)The preconditions triggered by the action performed are joined to characters' contexts; 2)The consequences that such preconditions produce in characters' contexts (i.e. inferred postconditions) are analysed and updated.

#### 4.2.2.1 Joining Postconditions.

The process of joining postconditions to characters' contexts involves three steps: 1)Getting the characters participating in the action, 2)Getting the postconditions that the action triggers and 3)Joining such postconditions to the characters' context. So, each time MEXICA reads an action from previous experiences, it obtains and transforms to a suitable representation the name of the action and the characters participating in it. These characters are denominated the Actors in the Action. If any of these characters does not exist in the story, a context is assigned to them. After this, MEXICA obtains a copy of the postconditions and instantiates them with the actors in the action. Finally, the postconditions are joined to the characters' contexts.

Postconditions always have a main or principal actor:

-When the postcondition is of type Position, the main actor is the character who changes location.

-When the postcondition is of type Emotional Link, the main actor is the character who develops or establishes the link towards other one (e.g. in the case of princess(+3,2):Eagle_Knight, the main character is the princess).

-When the postcondition is of type Tension, the main actor is the character who is the victim in the situation (e.g. for Lr(princess):enemy, the main actor is the princess).

This concept of main actor is important when updating characters' contexts.

Thus, depending on the type of postcondition to be added to the context, MEXICA runs one of three possible routines: Joining Position (change in the location), Joining Emotional Links or Joining Tensions.

A. Joining Position.

The field Position in the main actor's context is set either to a specific location (e.g., Texcoco Lake, Tenochtitlan City, etc.) or to the location of the second character in the action (b_Pos) depending on what was specified in the postcondition. The second option (b_Pos) is useful for actions like A followed B, where the postcondition specifies that the main actor (character A) must change his/her position to the position of the second character in the action (character B).

B. Joining Emotional Links.

This process consists of joining the list of Emotional Links triggered by the action to the context of all those characters in the story who are in the same location that the characters in the action. For example, if a tale has three characters, e.g. jaguar knight, princess and eagle knight, they all have the same location, and the action JAGUAR_KNIGHT FELL_IN_LOVE_WITH PRINCESS occurs, the postcondition Jaguar_Knight(+3,2):princess is joined to the context of the three of them (including Eagle_Knight who did not participate in the action).

There are two possible variants to this process. When the action performed is compound (compound actions are REALISED or WAS_TOLD, see section 4.2), the Emotional Links are added just to the

context of the character who is performing it; e.g. with the action JAGUAR_KNIGHT REALISED PRIEST CURED PRINCESS, all the Emotional Links triggered by the action CURED are added just to the context of the character jaguar knight.

The second variation of the process occurs when the main actor in the postcondition is a Linked Character (see Linked Characters in Emotional Links in section 4.1.1.1). In this case, MEXICA looks in the context of all those characters who have the same location that the actors in the action, for the Linked Characters. When MEXICA finds a context with such Linked Characters, it joins the postcondition to that context. For instance, in the example some lines above where JAGUAR_KNIGHT FELL_IN_LOVE_WITH PRINCESS, jaguar knight is a Linked Character to the princess, and three of them (jaguar knight, princess and eagle knight) are aware of this link. Let us suppose that the action WARRIOR MUGGED PRINCESS occurs. One of the postconditions for such an action is that all characters linked to the princess hate the warrior; so, the Emotional Link Jaguar_Knight(-3,1):Warrior is triggered. This Emotional Link is joined as a postcondition to the context of the jaguar knight, the princess and the eagle knight. That is, because three of them were in the same location, and three of them knew about the link between jaguar knight and the princess, three of them become aware that jaguar knight hates the warrior. However, the warrior does not get that postcondition, i.e. he is not aware that jaguar knight hates him because he did not know about the previous link.

C. Joining Tensions.

This process works as the same as for joining Emotional Links but it does not include Linked Characters. That is, those tensions triggered by the action as postconditions are joined to the context of the characters located in the same place that the actors in the action; for compound actions, tensions are joined to the context of the character performing the compound action.

### 4.2.2.2 Analysing Consequences (Inference Procedures).

Characters' contexts are very dynamic structures that are integrated, not just for the postconditions triggered by actions, but also for postconditions triggered and/or eliminated by inference procedures. That is, through these procedures MEXICA adds or deletes Emotional Links and/or Tensions to characters' contexts. Members added through this process are known as inferred postconditions. So, after characters' contexts have been updated with the last action in the tale, MEXICA analyses the consequences of such an action (runs inference procedures) in all characters' contexts. This section explains this analysis.

A. Analysing Emotional Links.

There are three potential situations related to Emotional Links that can trigger inferred postconditions. They are Clashing Emotions, Love Competition and Potential Danger. A clashing emotion is produced when a character establishes two or more Emotional Links of any type but opposite sign towards other character. For example, if an enemy kidnaps the princess and later he risks his life to save her from the attack of a tiger, she will probably develop a very negative feeling from the first action, and at the same time a very positive from the second one. When MEXICA detects that both feelings are present, an inference process triggers a tension due to clashing emotions which is joined to the context of all characters who are aware of the dual emotion.

A love competition is produced when MEXICA detects that two different characters have an Emotional Link of type 2 intensity +3 (which represents to be in love with) towards the same character. For example, if the tlatoani and the eagle knight fall in love with the same lady, a tension due to love competition is triggered and joined to the context of those characters that are aware of this situation. As explained in the example in section 4.2.1, if (for example) the tlatoani is not aware that the eagle knight is also in love with the lady, the tension due to love competition is just joined to the context of the eagle knight.

A tension due to potential danger is triggered when a character establishes an Emotional Link of any type and intensity -3 towards other one, and both of them are in the same location. Again, the tension is just joined to the context of those characters who are aware of the conditions to trigger the tension.

As part of the inference processes and in order to avoid an unmanageable amount of Emotional Links between characters, MEXICA simplifies them. It works as follows. An Emotional Link is classified by its type and by the sign of its intensity (positive or negative). Thus, if two characters have established two or more Emotional Links of the same type and the same sign, just the one with the highest intensity is kept and the rest are eliminated. This is done under the assumption that strong feelings override weak ones when they belong to the same type, e.g. if character A is fond of B but later character A falls in love with character B, the second Emotional Link overrides the first one.

B. Analysing Tensions.

For every action performed in a tale, MEXICA corroborates that the conditions which keep tensions active are still present in the context; if an action modifies such conditions, the tensions are deleted. There are four situations that need to be verified:

1)Presence-Conditioned Tensions.- As indicated in Section 4.1.1.2, during the declaration of primitive actions tensions can be conditioned through the use of the symbol '+' to be active while the characters participating in the action are in the same location. If one (or both) of the characters changes his/her position or one or both of them die, the tension is deleted from the context of all those characters who knew about it and who are aware that they have changed their location. For example, for the story

PRINCESS WENT_POPOCATEPTL_VOLCANO_WITH JAGUAR_KNIGHT

ENEMY ATTACKED JAGUAR_KNIGHT
PRINCESS RAN_BACK_TO_CITY
JAGUAR_KNIGHT FOUGHT ENEMY
ENEMY RAN_AWAY

the princess was aware that the life of the jaguar knight was at risk due to the presence of the enemy because she was with them during the attack (see the postconditions for A ATTACKED B in Appendix C). However, because she changed her position, when the enemy ran away her context is not updated (the tension triggered by the action ATTACKED is not deleted) and she keeps on thinking that the life of jaguar knight is at risk due to the presence of the enemy. The contexts of jaguar knight and enemy are updated and such a tension is eliminated from the contexts.

2)Normal Tensions.- There is a special group of postconditions used to deactivate tensions triggered previously by actions in the tale (see Section 4.1.1.2). They are called Normal Tensions although they are not really tensions, i.e. instead of incrementing the value of the variable Tension to the Reader they decrement it by deactivating tensions previously triggered by other actions. Normal Tensions are essential in order to produce those processes of degradation and improvement described in section 3.2.1-B. There are three kinds of Normal Tensions: Life-normal (Ln), Health-normal (Hn) and Prisoner-free (Pf). The syntax used to define them as postconditions in a Primitive Action is the same as the one explained before to define tensions. For example, in the action

ACTION
A cured B
POS
Hn(B):A

the postcondition can be read as the health of character B is normal again thanks to character A. This implies that the tension Hr(B):* was active before the action A CURED B was executed. So, when a Normal Tension is triggered MEXICA looks in all characters' contexts (who are in the same position as the characters in the action) for a tension to deactivate. A Normal Tension of type Hn always deactivates a tension of type Hr; Ln always deactivates a tension of type Lr; and Pf always deactivates a tension of type Pr. Once a Normal Tension has deactivated the old tension it also deactivates itself, that is, they are not kept in the characters' context. For this reason Normal Tensions can be used just as postconditions.

3)Dead-character Tensions.- Once this tension is triggered it always remains active; however, it can provoke other tensions to be eliminated. The purpose of Dead-Character Tension is to make others characters aware that someone in the tale died. When a character dies, all the Emotional Links where s/he was the main actor and all tensions where s/he participates are deleted from the context of all characters who are aware of his dead. For example, if jaguar knight and eagle knight were in love with a lady causing a Love Competition tension, and one of them dies, the tension is eliminated. Notice that MEXICA does not eliminate any of the Emotional Links that other characters have towards the dead

actor; that is, although a character is dead her/his friends and family keep their Emotional Link towards such a character.
When a character dies MEXICA also cleans his/her context, i.e. it deletes all Emotional Links and Tensions, sets the status to Dead and position to Nowhere.

4)Love Competition Tensions.- When MEXICA detects a Love Competition tension, it is necessary to corroborate two situations: 1)the characters engaged in the love competition are still alive and both are still in love with the same character; 2)the loved character is still alive, i.e. it is not possible that an Emotional Link towards a dead character produces a Love Competition tension.

5)Clashing Emotions Tensions.- MEXICA verifies that the main character in a tension of Clashing Emotions is still alive and that s/he is still having these opposite Emotional Links towards other character.

6)Potential Danger Tensions.-MEXICA verifies that the main character in a tension of Potential Danger is still having an Emotional Link of any type and intensity -3 towards other character, and that both of them are still in the same location.

MEXICA also has a way of simplifying tensions: If two different actions trigger the same tension between two characters, the system keeps just one of them.

### 4.2.3 Loading Long-Term Memory.

When MEXICA starts it creates in long-term memory the Primitive Actions Structures and transforms Previous Stories into three different structures: Concrete Representation, Abstract Representation and Tensional Representation.

#### 4.2.3.1 Primitive Actions Structures and Concrete Representation.

The Primitive Actions Structures can be described as a copy in memory of the file of the Primitive Actions created by the user. The Concrete Representation is formed by linking the Primitive Actions Structures in the same way that Previous Stories are organised; i.e., the Concrete Representation can be described as a copy in memory of the text file of Previous Stories.

#### 4.2.3.2 Abstract Representation.

The Abstract Representation is built in two steps. The first consists of generalising the context of the first character participating in the action, i.e. all concrete characters are substituted by variables; this new representation is called atom. During the second step MEXICA searches memory to find out if the

features represented by the new atom have been already encoded by another atom created previously. If that structure already exists the new atom is deleted; otherwise, it is allocated in the memory-area reserved for the Abstract Representation.
The main purpose behind the Abstract Representation is to gather together all those actions in Previous Stories that are preceded by the same context. In this way, using characters' context as a guide, MEXICA can link actions in a coherent way. Different contexts can lead to the same actions; or in other words, there are different paths to arrive to the same action. This seems to be in accordance with the studies of Cognitive Psychology in Elaborations and the alternative retrieval routes they produce (Anderson 1990 p.181).

When MEXICA generalises a context, it replaces all concrete characters in the Emotional Links and Tensions with variables, obtaining a representation very similar to the one used for specifying postconditions. For example, having the tension Lr(Tlatoani):Enemy after it has been generalised it is represented as Lr (A):B, where A stands for tlatoani and B for enemy. So, each character in the story is represented in the atom by a different variable, and the same variable is used through the whole atom to represent the same character.

The following is an example that shows how characters' contexts change through a story and specially how atoms are created. The reader must imagine that MEXICA is processing the file of Previous Stories which just contains the following story.

STO
PRINCE WENT_TEXCOCO_LAKE
PRINCE HAD_AN_ACCIDENT
PRIEST FOUND_BY_ACCIDENT PRINCE
PRIEST REALISED PRINCE HAD_AN_ACCIDENT
PRIEST CURED PRINCE
PRINCE WENT_PALACE
FISHERMAN MUGGED PRIEST
PRINCE REALISED FISHERMAN MUGGED PRIEST
PRINCE LOOKED_FOR_AND_FOUND FISHERMAN
PRINCE MADE_PRISIONER FISHERMAN
END.

The characters' contexts for the first three actions are[2]:

*** CONTEXT`S REPORT STORY No.1
*** Time => 1 Action: prince WENT_TEXCOCO_LAKE
Charac: PRINCE Pos: Texcoco Lake Status: Alive

*** Time => 2 Action: prince HAD_AN_ACCIDENT
Charac: PRINCE Pos: Texcoco Lake Status: Alive
Tensions => Hr(prince)

[2] For reasons of clarity, some of the information produced by the Context's Report has been suppressed or modified in this example.

*** Time => 3 Action: priest FOUND_BY_ACCIDENT prince
Charac: PRINCE Pos: Texcoco Lake Status: Alive
Tensions => Hr(prince)

Charac: PRIEST Pos: Texcoco Lake Status: Alive

The first action just introduces the character prince in the story; his context includes neither Emotional Links nor tensions. The second action's postcondition triggers a tension of type Life at risk which is registered in the prince's context. The third action introduces the priest in the tale. Notice that, because the priest was not in the same location as the prince was when he had his accident (as a matter of fact the priest did not exist in the tale at that moment), he is not aware that the life of the prince is at risk. However, the compound action at time 4 makes the priest to realise about this situation and it is registered in his context

*** Time => 4 Action: priest REALISED prince HAD_AN_ACCIDENT
Charac: PRINCE Pos: Texcoco Lake Status: Alive
Tensions => Hr(prince)

Charac: PRIEST Pos: Texcoco Lake Status: Alive
Tensions => Hr(prince)

Now, let us examine the atoms. Because the prince's context in action one does not include any Emotional Link or Tension, no atom is created from it. Prince's context in action number two produces the following atom:

** Atom
Tensions=> Hr(a)
Emotional Links=> NIL
Possible Next Actions=> NIL

Notice that the character “a” substitutes the character prince. The Abstract Memory is empty and MEXICA allocates the atom in it. Notice that the list of possible next actions points to nil; that is, MEXICA has not read yet action three from the file of Previous Stories, so it cannot assign a value to such a list. To solve the problem, MEXICA keeps the address in memory of such an atom; then, when it reads action three, the list of possible next actions in the atom is updated with the right action.

** Atom
Tensions=> Hr(a)
Emotional Links=> NIL
Possible Next Actions=> b FOUND_BY_ACCIDENT a

Notice how the character prince has been substituted by the letter "a" in the representation of the tension and in the possible next actions. So, there is a correlation between the characters in the Emotional Links and Tensions, and the characters in the list of Possible Next Actions. This correlation is important in order to obtain the correct interpretation of the atom. For instance, the atom in this

example encodes that when the health of a character in a story is at risk, a coherent possible next action to happen is that someone else finds by accident such a character.

Action number three introduces the priest into the story and locates him by the prince. Notice that this action does not alter prince's context. Now, MEXICA follows the process described earlier to update the Abstract Representation: it generalises prince's context and looks in memory for an atom equal to it. Because the context did not change between actions two and three, MEXICA finds that the only atom in memory is equal to the one just created. So, it deletes the new atom and again keeps the address in memory of the old atom to updated it when the next action is read.
Because the context of the priest does not include any Emotional Link or Tension, no atom is created from it. When action four is read, MEXICA updates the list of possible next actions in the atom.

*** Atom
Tensions=> Hr(a)
Emotional Links=> NIL
Possible Next Action=>
b FOUND_BY_ACCIDENT a
b REALISED a HAD_AN_ACCIDENT

In this way the atom encodes that when the health of a character in a story is at risk a coherent possible next action to happen is, either that someone finds by accident the wounded character or that someone realises that the wounded character had an accident.
After action four is executed, the context of the prince is not modified and the context of the priest becomes equal to the prince's context. So, no atom is added to the Abstract Representation and after action five is read the Abstract Representation looks as follows:

*** Atom
Tensions=> Hr(a)
Emotional Links=> NIL
Possible Next Action=>
b FOUND_BY_ACCIDENT a
b REALISED a HAD_AN_ACCIDENT
b CURED a

Finally action five produces a change in the characters' context, a new atom is added to memory, and the process continues until the story ends.

In order to make it easy to understand, the atom presented in the example is very simple. However, atoms can become very complicated with large numbers of Emotional Links, Tensions and characters involved. In MEXICA, special attention is given to the correlation between characters in the atoms, as was mentioned above. If a new atom which has the same Emotional Links and Tensions as an old atom in memory is created, but the correlation between characters is different in such atoms, they are not considered as equals and the new atom is allocated in memory. This distinction allows encoding actions with semantic differences as different structures. For example, if the first action in a story is

WARRIOR TRIED_TO_KISS PRINCESS, the tale changes completely if the second actions is PRINCESS PUNCHED WARRIOR or if the second action is WARRIOR PUNCHED PRINCESS. MEXICA produces different atoms when such sequences are found in different tales.

Atoms are the core element for the production of material during the Engaged State They allow MEXICA to write stories without the use of specific-goals or predefined story-structures as the main way to drive development of the story.

### 4.2.3.3 Tensional Representation.

For every action in a tale MEXICA calculates and stores the tension produced in the story in a variable called Tension to the Reader. The Tensional Representation is a vector that records the different values over time of this variable. In other words, each time an action is executed a variable named Tension to the Reader is updated with the value of the tension accumulated in the tale, and such a value is stored in a vector called Tensional Representation. The Tensional Representation permits representing graphically a story in terms of the tension produced in the reader. When MEXICA writes a new story it can use the Tensional Representation of the Previous Stories as frames to evaluate the story in progress (see Section 4.3.2.3-B). This evaluation is used to set some guidelines. From now onwards, all situations that produce tension in the reader are referred to as Tensions.

The value of Tension to the Reader at time=t depends on the kind and number of tensions active at that moment. The user can assign a value between zero and fifty to each of the situations that produce tension. By default the system sets a value of 10 to Love Competition. A value of 20 to Health at risk, Life at risk, Prisoner, Clashing Emotions and Potential Danger. And a value of 30 to Dead Characters.

MEXICA examines all characters' contexts to determine which tensions must be taken into account when calculating the value of the Tension to the Reader. That is, the fact that a tension is found in a character's context does not imply that it must be included in such a calculation. For example, if characters A, B and C are in the same location and character B has an accident, the tension Hr(B) is joined to the context of three of them. However, it does not mean that the Tension to the Reader will be incremented three times. The characters' contexts represent what actors are aware of. In this way, the Tension to the Reader must not be incremented just because a character is aware of a particular tension that involves other characters. In MEXICA, such a variable is incremented only when the characters involved in the tension are aware of it. In the previous example MEXICA increments the Tension to the Reader only when it finds in the context of character B the tension Hr(B).

So, the tension Health at Risk is triggered when a character (e.g. character B) has an accident or is wounded by someone. When MEXICA finds in the context of character B the tension Hr(B):* the value of the Tension to the Reader is incremented by 20. If any other character is aware of this

situation, the Tension to the Reader is not further incremented. The same process is used for Life at risk, Prisoner and Clashing Emotions.

To illustrate this situation, the characters' contexts after action four from the example in last section are examined again. In this case, the tension Lr(Prince) is found in the context of the two characters participating in the tale

*** Time => 4 Action: priest REALISED prince HAD_AN_ACCIDENT
Charac: PRINCE Pos: Texcoco Lake Status: Alive
Tensions => Hr(prince)

Charac: PRIEST Pos: Texcoco Lake Status: Alive
Tensions => Hr(prince)

After MEXICA examines the prince's context, because the main character in the tension is the prince, the Tension to the Reader is assigned a value of 20. However, when MEXICA examines the priest's context, the Tension to the Reader is not further incremented because the main character in the tension is not the priest but the prince; that is, the priest is just aware that the health of the prince is at risk. So, the final value of the Tension to the Reader at time=4 remains 20.

A similar process is followed to calculate the tension due to Love Competition. If character A and character B are in love with character C, a tension is triggered due to the competition between them. If MEXICA finds in the context of character A such a Love Competition (i.e. if character A is aware of it), the Tension to the Reader is incremented by ten; the same happens when examining B's context. So, if both characters are aware of the competition the Tension to the Reader is incremented by 20; if one of them is aware of it, the tension is just incremented by 10. If any other character is aware of this situation, the Tension to the Reader is not further incremented.

Potential Danger arises when character A has an Emotional Link of any type and intensity of -3 towards character B, i.e. A(-3,*):B, and both of them are in the same location. Thus, when MEXICA finds in the context of character A the tension due to Potential Danger, the Tension to the Reader is incremented by 20. If any other character is aware of this situation, the Tension to the Reader is not incremented.

Finally, if character A kills another character, MEXICA increments the Tension to the Reader when it finds in the context of character A the tension Character Dead. If any other character is aware of this situation, the Tension to the Reader is not incremented. There is an exception to this process; if enemy is the dead character the tension is not incremented. This is under the assumption that the enemy’s death does not produce a problem to anybody.

To summarise, to calculate the Tension to the Reader MEXICA examines all characters' contexts. When a tension is found in the context of a character that participates in it, in any of the ways described

in this section, the Tension to the Reader is incremented. Once it has been calculated, MEXICA stores the value of the Tension to the Reader in the Tensional Representation of the story. This process if repeated for each action in the tale.

## 4.3 Creating a New Story.

All new stories in MEXICA start with the user specifying the initial action, the characters participating in it and a starting location that becomes the default location for the story. When developing a new tale MEXICA can work in four Operation Modes (see Section 3.2.5).

1)Engaged State 1 (E1).
2)Engaged State 2 (E2).
3)Engaged and Reflective States 1 (ER1).
4)Engaged and Reflective States 2 (ER2).

When running under E1 or E2 operation modes, MEXICA works exclusively within the Engaged State. By contrast, when running under ER1 or ER2, the Engaged and Reflective States work together in order to produce a new story. When running under E2 or ER2 operation mode the guidelines and filters are active. When MEXICA is running under E2 operation mode run-time requirements are set by default values, while when running under the ER2 such requirements are set by the guidelines produced during the Reflective State. In this way, the guidelines set during the Reflective State influence the production of material during the Engaged State.

| | | |
|---|---|---|
| Engaged State 1 (E1) | No Filtering Process | No guidelines. |
| Engaged State 2 (E2) | Filtering Process | Guidelines set by default. |
| Engaged and Reflective States 1 (ER1) | No Filtering Process | No guidelines. |
| Engaged and Reflective States 2 (ER2) | Filtering Process | Guidelines set during the Reflective State |

The interaction between the Engaged and Reflective States is controlled by three factors. The first one is a parameter modifiable by the user that establishes the initial state (either Engaged or Reflective) under which the system starts to run. (From now onwards this parameter is referred as Initial State.) Depending on the content of characters' contexts and the knowledge in memory, the Initial State can have an important influence in the developing process (see examples in Chapter V).
The second factor is a constant, also modifiable by the user, which indicates the number of actions that MEXICA must generate under the Engaged State before switching to the Reflective State to evaluate the material produced. From now onwards this parameter is referred as CtEg-Rf (Constant Engaged-Reflective). When the constant is set to one MEXICA works with a strong tendency towards the Reflective State, i.e. it analyses and evaluates every action produced in the tale. On the other hand, if

the constant is set with a high value (e.g. 10) MEXICA works with a strong tendency towards the Engaged State, i.e. it produces a lot of material before switching to the Reflective State. Since MEXICA is a system developed to study the interaction between the Engaged and Reflective States, the possibility to manipulate the cycle in this way is an important characteristic of the system.
The third factor which influences the interaction between the two states arises when no more material can be produced, i.e. when an impasse is declared. In this case MEXICA switches to the Reflective State to try to break the impasse. Once it is broken MEXICA switches back to the Engaged State.

During the Engaged State, possible next actions are retrieved using characters' contexts to construct the structures to match atoms in memory. In MEXICA all characters' context participate in this process; i.e., MEXICA retrieves a set of possible next actions using the context of the first characters in the tale, retrieves another set of possible next actions using the context of the second character in the tale and so on. Then, after all options are in working memory one is selected as the next event in the story.

During the Reflective State impasses are broken, the material produced is evaluated, guidelines prepared and preconditions verified and fulfilled. When the story is finished, the final analysis takes place.

### 4.3.1 Engaged State.

The retrieval of information from memory and selection of the next action constitutes the basic cycle during the Engaged State. MEXICA uses dynamic structures —known as Associative Structures— as samples (or probes) to match atoms in memory and retrieve the set of possible next actions associated to them. Associative Structures are built from characters' contexts. These structure are referred as dynamics because, if no atom can be matched, they modify their own organisation (i.e. they transform themselves) to try to match another atom.
The logic behind dynamic structures works as follows. When no match is possible between an Associative Structure and an atom in memory, MEXICA attempts to find other alternatives by modifying the structure. That is, by modifying the Associative Structure MEXICA is changing the requirements to match an atom. So, new options no available in the previous search are accessible now. As long as the Associative Structure conserves after each transformation the core characteristics of the characters' contexts, MEXICA is able to retrieve coherent possible next actions following this procedure.
The maximum number of transformations allowed is three; thus, Associative Structures can be of three types. The first is identical to the character's context from where it was built and is referred as Associative Structure I (ASI). The second is the result of the first transformation and is referred as Associative Structure II (ASII). Finally, the third one is the result of the last transformation and is referred as Associative Structure III (ASIII).

In this way, instead of recalling equal episodes from previous stories and adapting them to the actual story, MEXICA recognises similar context-situations; this characteristic gives it a greater flexibility. Associative Structures are not indexes to access a particular area in memory but structures that can be matched against different patterns in memory. Associative Structures do not relax constraints but modify its organisation.

There is another important process related to retrieving possible next actions. When scanning long-term memory MEXICA tries to match the Associative Structure against an atom. If it fails, before transforming the Associative Structure an attempt is made to find another atom which contains the Associative Structure; that is, MEXICA tries to find an atom in which is possible to find as part of its organisation the Associative Structure. From now onwards this process is referred as ACAS-Process (Atom Containing the Associative Structure).

To explain it with a simple example, the reader can picture a person who is looking in a library (the memory) for an article that describes the sacred rituals of the Mexicas (the Associative Structure). If this person does not find it but instead come across a small book (an atom) which describes not just the Mexicas' rituals but also the Mayas and Olmecas' ones, i.e. a book which contains as part of its structure the article, probably this book will satisfy all the requirements the person was expecting the article to satisfy. However, it is necessary to establish some limits to this process. If instead of finding such a book this person gets a twenty volume encyclopaedia that describes all the pre-Hispanic civilisations (Mexicas, Mayas, Zapotecas, Chichimecas, Olmecas, etc.) where the Mexicas occupies volumes I and II, probably it will be too much.

To avoid this situation MEXICA requires the matched atom to be equal to the Associative Structure in a minimum percentage. From now onwards this percentage is referred as ACAS-Constant. So, in order an Associative Structure can match an atom, the atom must be equal to the Associative Structure in at least ACAS-Constant percent. MEXICA has three different ACAS-Constants, one for each type of Associative Structure; i.e., ACAS-Constant I is used with the ASI, the ACAS-Constant II with the ASII and the ACAS-Constant III with the ASIII. They are definable parameters; in this way the user can decide which percentage is associated to each of the Associative Structures.

It is expected that when the ACAS-Constant is set to a low value unusual actions are brought to working memory increasing the originality of the story. However, unusual actions also increase the risk of producing sequences of events with a lack of coherence, i.e. events with a weak link to the actual context in the story. On the other hand, a high value of the ACAS-Constant leads MEXICA to retrieve actions well connected with the story in progress, but which are very predictable. So, it is necessary to find a value that balances properly this situation.

The whole process of retrieving possible next actions can be summarised as follows:

1)Create from characters' contexts an Associative Structure I.

2)Scan memory (Abstract Representation) to match the Associative Structure against an atom.

3)If no match is possible, try to find an atom that contains as part of its organisation the Associative Structure (ACAS-Process).

4)If no match is possible the Associative Structure is transformed (to ASII or ASIII) and the cycle starts in step two until an atom is matched or two transformations are made.
This process is repeated for each of the characters in the story; that is, all actors in a tale contribute (or at least try to contribute) with a set of possible next actions.

The retrieval of possible next actions through dynamic structures and the ACAS-Process is one of the most important characteristics in MEXICA. The following sections describes in detail how the Associative Structures are created and transformed, how the search in long-term memory is performed, how actions are instantiated and selected.

#### 4.3.1.1 Bringing Possible Next Actions to Working Memory.

The process to create the Associative Structure works as follows. When MEXICA is analysing the context of a particular character, e.g. character A:
1) All Emotional Links and Tensions in the context of character A are generalised and joined together to form what is known as Associative Structure I (ASI). A search in long-term memory is launched to try to match the ASI with an atom.
2) If it is not possible to match an atom the first transformation occurs. It consists of eliminating from the ASI all Emotional Links where character A does not participate, and all Tensions —except Life at Risk and Health at risk— where character A does not participate. In other words, this new structure contains all Emotional Links where character A participates, all Tensions where character A participates, and all Life at Risk and Health at Risk Tensions (independently of who participates in them) found in ASI. The new structure created is named Associative Structure II (ASII).
3) If it is not possible to match an atom the second transformation occurs. It consists of eliminating from the Associative Structure II all Emotional Links; i.e., just those Tensions where character A participates and all Life at Risk and Health at Risk Tensions (independently of who participates in them) are kept. The new structure created is named Associative Structure III (ASIII).

The same process is repeated for all characters in the tale. For example, having the following context:

CONTEXT ***
Charac: WARRIOR Pos: Texcoco Lake Status: Alive
Emotional Links=>
Warrior(-3,1):enemy
Eagle_Knight(-3,1):enemy
Tensions => Lr(Warrior):enemy

The first Associative Structure is created by copying all the Emotional Links and tensions which form the character's context.

Associative Structure I
Emotional Links=>

Warrior(-3,1):enemy
Eagle_Knight(-3,1):enemy
Tensions => Lr(Warrior):enemy

If no possible next actions are retrieved from memory, the first transformation occurs:

Associative Structure II
Emotional Links=> Warrior(-3,1):enemy
Tensions => Lr(Warrior):enemy

If no possible actions are retrieved from memory, the second transformation is made:

Associative Structure III
Tensions => Lr(Warrior):enemy

There is a requirement to fulfil when the search is done using an ASIII. All retrieved possible next actions must be fully instantiated; those that do not fulfil this condition are eliminated (see Section 4.3.1.2 for examples of uninstantiated possible next actions brought to working memory). This restriction attempts to minimise the possibility of bringing actions that are unrelated to the story in progress to working memory.

Once the Associative Structure has been created, MEXICA starts the search in long-term memory. It works as follows. Atoms in memory are organised according to their attributes (i.e. number and type of Emotional Links and Tensions); so, MEXICA tries to find one that shares with the Associative Structure the same properties. If it succeeds, MEXICA attempts to correlate the characters in the atom and the characters in the Associative Structure; if the atom and the Associative Structure share the same attributes but the characters cannot be correlated, MEXICA looks for another atom which can fulfil both requirements. This correlation between characters is important to link properly the actors in the tale in progress and the characters in the set of possible next actions in the atom (see also the explanation of the importance in the relation between characters in the atom and the possible next actions in Section 4.2.2.1).
If the process succeeds, the actors in the list of possible next actions pointed by the atom are substituted with the characters in the Associative Structure and then transferred to working memory, where finally they are instantiated. For example, the reader can imagine that a story in progress has produced the following context:

CONTEXT ***
Charac: PRINCESS Pos: Texcoco Lake Status: Alive
Emotional Links=> princess(+3,2):Jaguar_Knight
Tensions => NIL

MEXICA generalises the context to create the Associative Structure

Associative Structure:
Emotional Link=> A(+3,2):B
Tension=> NIL

and a map which correlates the characters in the context and the Associative Structure is formed (this map had not been mentioned before to avoid complicating previous explanations).

princess <-> A
Jaguar_Knight <-> B

Now, MEXICA matches the Associative Structure with an atom in memory

Atom
Emotional Link=> C(+3,2):D
Tension=> NIL
Possible Next Action=> D married C

and based in the correlation between characters described earlier it creates a map between the actors in the Associative Structure and the atom.

A <-> C
B <-> D

With the help of this map, the characters in the possible next actions are substituted with the characters in the Associative Structure.

Possible Next Actions: (D married C) -> Possible Next Actions: (B married A)

Finally, the possible next action is transferred to working memory where, with the help of the map between the characters in the context and the Associative Structure, the possible next action is instantiated.

Possible Next Action: (Jaguar_Knight married princess)

If no atom is found which can match the Associative Structure, MEXICA changes tactic; this time it looks for an atom where the Associative Structure can be found as part of the atom's organisation. That is, it tries to match an atom using the ACAS-Process. For example, having the following Associative Structure

Associative Structure I:
Emotional Link=> A(+3,2):B
Tension=> NIL

an atom that contains as part of its organisation the Associative Structure is

Atom
 Emotional Link=> C(+3,2):D
 Tension=> Hr(D)
 Possible Next Action=> C cured D

If such an atom is found, MEXICA extracts from it all those elements equal to the ones in the Associative Structure and attempts to correlate the characters between them. Again, if it succeeds the characters in the list of possible next actions pointed by the atom are substituted by the characters in the Associative Structure and transferred to working memory; once there, the possible next actions are instantiated with the characters in the tale.

When MEXICA is trying to match an atom using an Associative Structure I, by default it requires that such an ASI constitutes at least 50% of the atom. In other words, at least 50% of the atom must be equal to the Associative Structure I. This percentage is known as the ACAS-Constant I. When MEXICA is trying to match an atom using an ASII, such percentage is set by default to 70%; this percentage is known as ACAS-Constant II. And when MEXICA is trying to match an atom using an ASIII the percentage is set to 90%; this percentage is known as ACAS-Constant III. If this minimal percentage is not reached or the characters cannot be correlated, MEXICA looks for another atom that can fulfil the requirements. (All these percentages are modifiable by the user.)

When a set of possible next actions has been brought to working memory, through a process described in following sections MEXICA eliminates those actions which are not useful for the story. If all possible next actions are left out, MEXICA starts a new search in long-term memory to try to find another atom that can offer more possible next actions.

The ability to transform the Associative Structure (dynamic structures) and the ACAS-Process are two of the most important characteristics in MEXICA; they provide the flexibility required to create unexpected sequences of actions. Notice that in the case of the dynamic structures MEXICA is not relaxing constrains but transforming the structure. This transformation can be done in different manners without affecting the way the procedure to retrieve possible next actions from memory works. In MEXICA's prototype the three heuristics just explained are implemented; however, other ways to build such structures are also suggested (see Future Work in Chapter VI).

This section can be summarised in the following sentences: an Associative Structure is formed and a search in memory executed. If the search fails MEXICA tries to match an atom using the ACAS-Process. If it also fails a second Associative Structure is formed and a new search launched. If the search is not successful MEXICA tries to match an atom through the ACAS-Process. If it fails again a third Associative Structure is formed and another attempt is made. If it does not work a final attempt is tried using the ACAS-Process. A search fails when an atom which shares with the Associative Structure the same characteristics cannot be found in memory. A search also fails when the characters in an atom cannot be correlated with the characters in the Associative Structure. When some material is obtained, MEXICA transfers it to working memory.

A last comment. MEXICA performs the process just described for each of the characters in the tale. That is, each character's context is used to match an atom. In order to bring different possible next actions to working memory MEXICA never matches the same atom twice. That is, if two characters' contexts are equal they are forced to match different atoms.

#### 4.3.1.2 Selecting the next action.

When MEXICA is running under E1 operation mode, the next action in the story is chosen randomly between the options in the set of possible next actions brought from long-term memory. Only a simple process to avoid repeating the same action twice in a row in a tale is carried out.
During the E2 operation mode, before selecting the next action all options brought from long-term memory are filtered in order to eliminate those that not contribute to do story development. Then, the next action is selected randomly between the remaining alternatives.
Before an action can be filtered and/or selected it must be completely instantiated.

A. Instantiating Characters.

Although MEXICA creates the maps described in the previous section to establish correlation between characters, sometimes possible next actions can arrive into working memory without being instantiated. For example, the action VIRGIN HAD_AN_ACCIDENT produces the following context.

CONTEXT ***
Charac: VIRGIN Pos: Texcoco Lake  Status: Alive
Emotional Link => NIL
Tensions=> Hr(Virgin)

The Associative Structure that arises from it is

Associative Structure
 Emotional Links=> NIL.
 Tensions=> Hr(A)

and a map that correlates Virgin and A is created. Now, let us imagine that the following is the atom matched in memory.

Atom.
 Emotional Links=> NIL
 Tensions=> Hr(C)
 Possible Next Actions=> D cured C

Thus, MEXICA creates another map which correlates A and C. However, when the characters in the possible next action are substituted, MEXICA does not find and a equivalent actor for character D.

Possible Next Actions: (D cured C) -> Possible Next Actions (? cured A).

And the same happens when MEXICA tries to instantiate in working memory the possible next action using the first map.

Possible Next Actions: (? cured A) -> Possible Next Actions: (? cured Virgin).

That is, an uninstantiated action arrives in working memory.

Under the E1 or ER1 operation mode, to solve this problem MEXICA creates a set of potential candidates to instantiate the action and selects one of them at random. The way this set is created is now described. All characters in MEXICA except those participating in the context from where the Associative Structure used to retrieve the actions was formed, are used to build the set. For instance, in the last example all characters in MEXICA would be included in the set of candidates except the Virgin.

The reason why those characters are excluded (or banned) for participating in the set is now explained. All characters in the context are included in the first map; so, all characters in the context are represented when the second map is created. An uninstantiated action arrives when there is no correlation between the actors in the second map and the actors in the possible next actions, which implies a lack of correlation between the actors in the context and the actors in the possible next actions. So, if the actors in the context have already failed to be instantiated, they are considered as inadequate and banned to be included in the set of candidates to instantiate the possible next actions.

However, in order to make the system more flexible MEXICA allows some variations to this rule. A parameter modifiable by the user known as Forbidden Characters prevents some of the characters in the context from being banned. It works as follows. When Forbidden Characters is set to Active MEXICA bans all characters in the context (as just explained).

When Forbidden Characters is set to Half-Active MEXICA just bans the character who holds the context from where the Associative Structure which matched the atom was created. In the last example, the only character banned would be Virgin.

When Forbidden Characters is set to No-Active MEXICA does not ban characters, i.e. all characters are allowed being included in the set of potential candidates to instantiate the action.

Finally, in order to instantiate the action there is one last requirement. If the action includes the postcondition A(+3,2):B (i.e. that A fells in love with B) the system verifies that characters A and B are not the same, and that both of they are not males or females. If this requirement is not satisfied the system looks for other characters (following the same procedure) to instantiate the action.

Thus, under the E1 or ER1 operation modes MEXICA selects randomly a character from the set of candidates. When MEXICA is running under the E2 or ER2 operation mode the problem is approached in a different way. The system tries to avoid the random procedure by using other three alternatives.

First, as was commented before, each character in the story contributes with a set of possible next actions. In another words, each characters' context is used to retrieve from long-term memory possible next actions. So, MEXICA tries to replace those uninstantiated actors with the character who holds the context. For example, if the context of character A retrieves uninstantiated actions, MEXICA tries to instantiate them using character A.
However, there are two situations that can prevent this procedure from success: when character A has been banned (as explained in the previous paragraph) or when there is more than one character not instantiated.

In this case MEXICA tries a second option: it tries to use the rest of the characters in the tale to instantiate the actions. With this heuristic MEXICA is trying to apply that rule taught in courses of theatre and improvisation, that Johnstone (1989) refers to as reincorporating. To avoid lack of structure and coherence when improvising a story, characters used previously in the tale are reincorporated.
In order to give all characters in the tale an opportunity to be used to instantiate the action, each time MEXICA reincorporates a character it verifies if the resulting action makes the story flow (see part B in this section for a definition of an action which flows). If it does not flow MEXICA tries again to instantiate the action using a different character.
This procedure fails if the rest of the characters in the tale are banned, if all instantiated actions do not flow, or if some characters remain uninstantiated in the action.

Before explaining the third option, the concept of group class is introduced. In MEXICA, as a support for the procedures to instantiate characters, all characters are divided in what has been called group class. Group classes are organised as follows:

[tlatoani, prince]
[princess]
[Eagle_Knight, Jaguar_Knight, priest]
[lady, Virgin, ]
[Farmer, Hunter, Fisherman, Trader, Warrior, Artist]
[Slave]
[enemy]

The main idea behind group class is to be able to substitute one character for an equivalent one. That is, in MEXICA two characters are considered as equivalent when they belong to the same group class. This classification is arbitrary and just useful during the instantiation process.

Now, the third alternative is explained. It requires that at least one of the characters in the action has already been instantiated and it works as follows. MEXICA studies (in the Concrete Representation) the way the uninstantiated action has been used in Previous Stories; it tries to find an instance where an actor with the same group class as the known character participates. If it is found, the other character in such an instance is used to instantiate the action.

For example, jaguar knight and priest belong to the same group class. So, if the uninstantiated action X CURED PRIEST arrives in working memory, and in the Concrete Representation the action LADY CURED JAGUAR_KNIGHT is found, MEXICA detects that jaguar knight and priest belongs to the same group class and uses lady to instantiate the action resulting in LADY CURED PRIEST.
This alternative fails when none of the characters in the action are instantiated, or if none equivalent actors are found in the Concrete Representation.

When all previous alternatives fail, MEXICA uses the random procedure described earlier to instantiate the action. A final comment. If after an action is instantiated it results that the characters participating in it are located in different positions, automatically MEXICA situates both of them in character A's position. Later, during reflection, the system justifies how character B moves to character A's position.

B. Filters.

MEXICA is provided with a group of routines called Filters that eliminate all those actions not useful to the story. Filters are divided in two groups according to the way they establish what actions are not useful. In the first group, the characteristics of not useful actions are encoded in the program; i.e. the programmer defines them. In the second group, those characteristics are established by MEXICA at run time; i.e. depending on the features of the story in progress MEXICA decides which actions are not useful during the developing of the story.

The first group is constituted by routines that:

1. Delete all those possible actions that are equal to the last action performed in the story.
2. Verify that just those actors who are alive in the story participate in a possible next action.
3. Check that an action in a story flows. By definition an action flows if, after performing it, the Emotional Links or Tensions in any of the characters' context changes or if the Tension to the Reader changes. In this way, boring sequences of actions like JAGUAR_KNIGHT WENT_POPOCATEPTL_VOLCANO, JAGUAR_KNIGHT WENT_TLATELOLCO_MARKET, JAGUAR_KNIGHT WENT_TEXCOCO_LAKE, END, are avoided.
4. Eliminate no representative actions. The concept of no representative action is now explained. When MEXICA is developing a story a new character can be introduced in the tale at any moment. The context of this new character will include just the postconditions of the action used to introduce it in the story. And this can be a problem if the remainder characters' contexts include long list of Emotional Links or Tensions. That is, when MEXICA retrieves possible next actions from long-term memory it uses all available characters' contexts to create the Associative Structures. The context of the new character lacks important information about previous actions in the story; so, the possible next actions retrieved from it might include events not connected at all with the story in progress. To avoid this situation MEXICA detects and eliminates them through the following process. MEXICA analyses all characters' contexts to determine which of them has the greater number of elements (the number of elements is obtained adding the number of

Emotional Links and the number of Tensions in a context). This number is used as a reference; so, all characters' context which number of elements is less than the reference divided by two are classified as no representative contexts. And all actions brought to working memory from a no representative context are classified as no representative actions, therefore eliminated.

5. Eliminate illogical actions. If character A has strong positive Emotional Links towards character B (i.e. A(+2,*):B or A(+3,*):B), and the action performed triggers strong negative Emotional Links in B towards A (i.e. B(-2,*):A or B(-3,*):A), that actions is considered as illogical and eliminated by the filters. In other words, if the PRINCESS is in love with JAGUAR_KNIGHT (strong positive Emotional Links) and in the next action PRINCESS performs an action that produces that JAGUAR_KNIGHT hates her (e.g. PRINCESS ATTACKS JAGUAR_KNIGHT) that actions is considered as illogical. By contrast with the previous routines in this group that always are active, the user can activate or deactivate this filter through a parameter known as Logical Action. This option is included because sometimes, with the help of the Reflective State, sequences of illogical actions can be transformed into good stories (see the story in Section 5.3).

The second group of filters is constituted by routines which verify that the story in progress is observing certain constrains; these constrains are denoted Guidelines for the Story. They are set either by some procedures during the Reflective State when MEXICA is running under the Engaged and Reflective States 2 operation mode, or by default values when MEXICA is running under the Engaged State 2 operation mode. Details of the process followed to assign their values to the guidelines is explained in Section 4.3.2.3

The guidelines try to produce an increment or decrement in the Tension to the Reader by restricting the requirements to select the next action in the tale. Also, they establish a minimum percentage of novelty that any action must satisfy. In MEXICA the novelty is defined by the number of times an action has been used in Previous Stories. If an action does not fulfil the guidelines' requirements, it is deleted.

So, the basic cycle during the Engaged State consists in creating Associative Structures from character's contexts and retrieving from long-term memory sets of possible next actions. A filtering and selecting process is applied to them. If none of the options is suitable as a possible next action MEXICA tries again to get a new sets of possible next actions. When is not possible to retrieve any new option, an impasse is declared.

### 4.3.2 Reflective State.

During the Reflective State MEXICA performs four main tasks: it checks (and solves) preconditions, breaks an impasse produced during the Engaged State, evaluates the story in progress and produces guidelines to the Engaged State. Once the story is completed, MEXICA performs the final analysis. Each of these tasks is now described.

#### 4.3.2.1 Checking Preconditions.

MEXICA verifies that the preconditions of all the actions in the story in progress are satisfied. This procedure is necessary because during the Engaged State preconditions are not checked at all. The process consists of four steps:
1)Clear all characters' context in the story (i.e. delete all their Emotional Links and Tensions) and get the first action in the story ready for inspection.
2)Verify that all its preconditions are satisfied. If they are not satisfied, an action to fulfil them is inserted in the story and the cycle starts again in step number one.
3)When all the preconditions in the action are satisfied the characters' contexts is updated with the postconditions triggered by the action.
4)Take the following action in the story and repeat the cycle from step number two.

Step number two is divided in two parts:
a)Verify that the characters participating in the action are in the same location.
b)Verify that the characters' contexts satisfy the action's preconditions.

In other words, preconditions can be unsatisfied because the characters participating in the action are not in the same location or because characters' contexts do not include the Emotional Links or Tensions necessary to satisfy the action's preconditions. The first situation is known as Location Problem and the second as Context Problem.

The Location Problem is solved as follows. Most actions have two characters; MEXICA has established as a rule that all characters participating in an action must have the same location as the second one (the same applies for actions with three characters). If MEXICA detects an action with Location Problems, an event is inserted to move the first character to the location of the second. For example, if character A is located in the Palace and character B in the temple, the action A FOLLOWED B will present a location problem. In this case MEXICA inserts the action B WENT_PALACE before the action FOLLOWED in order to sort out the problem.

The Context Problem is solved as follows. When the actual context in the story does not satisfies the preconditions of the action, MEXICA checks two possible situations: either if an action which fulfils the preconditions has already been performed in the story but the right characters are not aware of it (remember that not all characters are aware of the same things), or if an action which satisfies the preconditions has not occurred at all in the story.
In the first case MEXICA solves the problem by inserting the compound action REALISE together with the action that satisfies the preconditions. For example, in the sequence PRINCESS HAD_AN_ACCIDENT, PRIEST CURED PRINCESS, MEXICA inserts the compound action

PRIEST REALISED PRINCESS HAD_AN_ACCIDENT to solve the problem (the priest must be aware that the princess is injured in order to cure her).

In the second case MEXICA looks for all actions whose consequences fulfils the preconditions and selects one at random; if no action can be found the story is abandoned. If one or more characters in the unsatisfied action do not exist in the story, MEXICA first introduces them in the tale through the action ACTOR; then, it inserts the action to satisfy the preconditions. For example, to satisfy the preconditions of WARRIOR ATTACKED HUNTER, MEXICA inserts the action HUNTER MUGGED WARRIOR; if the character Warrior does not exist, MEXICA first insert the action WARRIOR ACTOR and then HUNTER MUGGED WARRIOR.
MEXICA avoids inserting an action to justify itself. That is, if the postconditions of ACTION X satisfy its own preconditions, MEXICA avoids inserting ACTION X to justify itself. The reason for this restriction is that such situation can lead to an endless loop. For example, if the precondition of A PUNCHED B is A(-2,*):B and its postcondition B(-2,1):A, PUNCHED can satisfy itself endlessly. In other words, the precondition of PRINCESS PUNCHED PRIEST is princess(-2,*):priest which could be satisfied with the action PRIEST PUNCHED PRINCESS. Now, PRIEST PUNCHED PRINCESS can also be satisfied with PRINCESS PUNCHED PRIEST, and so on.

When MEXICA inserts an action to satisfy preconditions, it always checks that such an action flows and satisfies the Novelty Guideline; however, the Tensional Guidelines are not verified (see Section 4.3.2.3 for an explanation of the Novelty and Tensional Guidelines). The reason is now explained. When checking preconditions MEXICA examines the whole story in progress and inserts actions wherever they are necessary: at the beginning, in the middle or at the end of the story. The Tensional Guidelines indicates a desired tendency in the behaviour of the Tension to the Reader. But it is a desired behaviour for the future actions in the tale, not for the previous ones. So, it is not point to have active the Tensional Guidelines.

### 4.3.2.2 Breaking an Impasse.

MEXICA tries to break an impasse by "copying" the way actions have been used in Previous Stories. The process consists of the following steps:
1)Obtain from the Concrete Representation all those actions that have followed in Previous Stories the deed which triggered the impasse.
2)Eliminate all options that are inadequate to break the impasse and select one action between the remaining ones.
3)Join the action to the end of the tale in progress and switch back to the Engaged State.

When the actions which have followed the one which triggered the impasse are obtained, MEXICA creates a map where the relation between characters in such actions and the one which produced the impasse is kept; this map helps later to instantiate properly the event chosen to break the impasse.
For example, if the action TLATOANI KISSED LADY triggers an impasse, MEXICA looks for all actions which have followed SOMEONE KISSED SOMEONE-ELSE. Let us imagine that in the Previous Stories exists the sequence EAGLE_KNIGHT KISSED PRINCESS, PRINCESS PUNCHED EAGLE_KNIGHT; so, MEXICA chooses the action SOMEONE PUNCHED SOMEONE-ELSE. However, in order to preserve the coherence of the original sequence is necessary to maintain the relation between the characters; thus, MEXICA creates a map where it is registered that the character who performed the action of kissing is the one who is punched, and the character who received the action of being kissed is the one who punches. In this way MEXICA obtains LADY PUNCHED TLATOANI.

Sometimes, however, it is not possible to fully instantiate all characters. For instance, if in the last example the sequence in the Previous Stories is changed to EAGLE_KNIGHT KISSED PRINCESS, JAGUAR_KNIGHT GOT_JEALOUS_OF EAGLE_KNIGHT, MEXICA will obtain the uninstantiated action SOMEONE GOT_JEALOUS_OF TLATOANI. This situation arises because it is not possible to establish a map to link all characters as in the last example.
MEXICA solves this problem by instantiating the actors as follows. First, it tries to substitute the unknown character with one of the other actors in the tale (i.e. it tries to reincorporate characters); thus, it instantiates the action with the first actor in the tale. To check that it makes the story moves, MEXICA verifies that the instantiated action flows. If it does not satisfies this condition, MEXICA takes the next character in the tale and repeats the same steps until it finds an action that flows or there are no more characters to try with.
If it is not possible to instantiate the action following this procedure, MEXICA tries a second option. It checks if in the Previous Stories exists an event where such an uninstantiated action has as one of its actors the known character. That is, following the last example MEXICA verifies if in a previous story there is an action where someone gets jealous of tlatoani. If it is found, this other character is used to instantiate the action.
If it fails, the same process is repeated again but this time MEXICA looks for an action in which is possible to find an actor with the same Group Class as the known character. Following the previous example, MEXICA looks for an action where someone gets jealous of an actor with the same Group Class as tlatoani. If it is found, this other character is used to instantiate the action.
If this process also fails, MEXICA instantiates the action with any actor who has participated in such an uninstantiated action in Previous Stories.

In order to get rid of all the actions that are inadequate to break the impasse, an elimination process is run. In MEXICA an action is considered inadequate when it includes two uninstantiated characters, when it includes a dead character, when it does not flow or when it does not satisfy the Novelty

Guideline. The Tensional Guidelines are not included in this process because the Tension to the Reader is considered as no important when MEXICA is trying to break an impasse.
Actions with two uninstantiated characters are eliminated because they have a big chance to introduce incoherent actions in the tale. That is, the procedures described earlier in this section to instantiate characters cannot be used when more than one character is uninstantiated. Thus, the only option left is to select characters randomly, which probably will produce an incoherent event. So MEXICA prefers to eliminate this type of actions.
Notice that if an action which does not flow is used to break an impasse, a new impasse will be declared since the characters' contexts used to retrieve possible next actions from long-term memory remain without any change.

Once all non-useful actions have been eliminated a selective process starts. This process divides all the remaining options into two categories: those that were fully instantiated and those that needed to pass through the instantiation procedures. The former provides a set of actions that can be integrated easily in the tale in progress; i.e. because they were fully instantiated from the beginning, actions in this category just include characters that are already participating in the tale. This avoids introducing actors "out of the blue" who might produce inconsistencies. The latter category includes actions that might present such a problem.
In this way, the selective process chooses randomly an action from the set of options belonging to the first category. If such a set is empty, a random action is selected from the second group. If both sets are empty (i.e. if the elimination process eliminated all actions) MEXICA tries a last option: equivalent actions.
The heuristic Equivalent Action looks in the Concrete Representation for an action equivalent to the one that produced the impasse and then follows the same steps described for the previous heuristic. That is, it gets all those actions that in previous stories have followed the equivalent action, deletes all those which are not useful and selects one of the remaining ones. In MEXICA two actions are considered equivalent if they share a percentage of equal postconditions; this percentage (known as Equivalent Constant) is modifiable by the user although by default it is set to 50%. If all the alternatives brought through the equivalent action are not useful to break the impasse, MEXICA looks for another equivalent action until either finds an action to break the impasse or no more equivalent actions can be found.
If both heuristics fail an unbreakable impasse is declared and the story is abandoned. Otherwise, MEXICA joins the selected action to the end of the tale in progress and verifies preconditions. If the preconditions are not satisfied the story is abandoned.

#### 4.3.2.3 Evaluating the story.

MEXICA performs two kinds of evaluations. One verifies that the material produced is not too similar to any of the Previous Stories. The other compares the Tensional Representation of the tale in progress

against the set of Tensional Representations produced by Previous Stories; then, it uses the most similar as a frame to evaluate the material produced. The results of these evaluations are used to set the guidelines.

Guidelines.
Novelty:
Permanent Tension:
Temporal Tension:

The guidelines are divided into two groups: the Novelty Guideline and the Tensional Guidelines. The latter group is formed by two elements: the Permanent Tension and the Temporal Tension. All them are explained in detail in the following paragraphs.

When MEXICA starts it assigns default values to all the guidelines. If it is running under the E2 operation mode, the guidelines are never modified. If it is running under the ER2 operation mode, each time MEXICA evaluates the story in progress the guidelines are updated according to the result of the evaluation.
This section explains how the value of the guidelines is calculated and assigned. The function of the guidelines is to establish a criteria to eliminate no useful actions during the filtering process in the Engaged State. So, references to that process are frequently made.

A. Novelty.

During the evaluation of novelty MEXICA verifies if the material produced during the Engaged State resembles too much any of the tales in the Previous Stories. The system has a parameter that determines the percentage of similarity authorised to exist between two tales; if that percentage is exceeded, a request is sent through the guidelines to the Engaged State for more original sequence of events. This percentage is called Novelty-Percentage, has a default value of 50% and is modifiable by the user. So, if more than 50% of the story in progress is equal to some of the Previous Stories, a request for more original actions is sent to the Engaged State through the Novelty Guideline.

To evaluate novelty MEXICA divides the story in progress into sequences; one sequence is defined as a group of two consecutive actions. For example, the following story in progress

STO
START
PRINCESS WENT_TEXCOCO_LAKE
PRINCESS HAD_AN_ACCIDENT
JAGUAR_KNIGHT REALISED PRINCESS HAD_AN_ACCIDENT
JAGUAR_KNIGHT CURED PRINCESS
PRINCESS FELL_IN_LOVE_WITH JAGUAR_KNIGHT

can be divided into five sequences.

| | |
|---|---|
| Sequence 1 | PRINCESS WENT_TEXCOCO_LAKE<br>PRINCESS HAD_AN_ACCIDENT |
| Sequence 2 | PRINCESS HAD_AN_ACCIDENT<br>JAGUAR_KNIGHT REALISED PRINCESS HAD_AN_ACCIDENT |
| Sequence 3 | JAGUAR_KNIGHT REALISED PRINCESS HAD_AN_ACCIDENT<br>JAGUAR_KNIGHT CURED PRINCESS |
| Sequence 4 | JAGUAR_KNIGHT CURED PRINCESS<br>PRINCESS FELL_IN_LOVE_WITH JAGUAR_KNIGHT |
| Sequence 5 | PRINCESS FELL_IN_LOVE_WITH JAGUAR_KNIGHT<br>NIL |

MEXICA analyses how many of these sequences can be found in Previous Stories. If one of such Previous Stories includes more than 50% of the sequences (the default value of the Novelty-Percentage), the story in progress is classified as lacking originality. If all the sequences can be found in a Previous Story, the story in progress is classified as a copy. This classification is used to assign a value to the Novelty Guideline.

MEXICA includes four parameters called Novelty Constants. Their function is to establish a criteria to evaluate the novelty of an action. Two of them, known as the Medium and Strict Novelty Constants, are modifiable by the user. By default they are set with the values of 75% and 15% respectively. The other two parameters, known as the Low and Medium Novelty Constants, have a fixed value of 0% and 50% respectively.

They work as follows. After MEXICA has created all the structures in long-term memory it verifies how many Primitive Actions have been used at least once, and how many times each of them has been employed in the Previous Stories. The relation between these two quantities provides the average number of times an action has been employed.

MEXICA links that average number with the High Novelty Constant. For example, let us imagine that such an average number is five. So, MEXICA considers that any action used in Previous Stories five or less times satisfies the requirement of high novelty.

Now, knowing that five is equal to 50% (the value of the High Constant Novelty) MEXICA calculates how many times an action can be used to satisfy the Strict Novelty Constant (15%). The result is obtained through the following equation:

x=(Strict Novelty Constant*average number) / Medium Novelty
x=(15% * 5) / 50%
x= 1.5 = 2
(Obviously the result is rounded)

So, any action used 2 or less times in the Previous Stories satisfies the requirements of strict novelty. The same process is followed for the Medium Novelty Constant. The Low Novelty Constant is set to zero, i.e. any action satisfies its requirement.

The Novelty Guideline can be set with four different values: Strict, High, Medium or Low. When it is set to Strict the filters eliminate all those actions which do not satisfy the criteria established by the strict novelty requirement. The same applies when the Novelty Guideline is set to High or Medium. When it is set to Low, no action is deleted. The default value assigned to the Novelty Guideline is Low.

If after the evaluation MEXICA classifies the story as a copy, the Novelty Guideline is set to Strict for one action. After that it is re-set to High. That is, just the first following next action in the story has to satisfy the Strict requirements; the rest have to satisfy the High requirements.
Something analogous occurs when the story is classified as lacking originality. The Novelty Guideline is set to High and after one action, it is reset to Medium.

This is the way MEXICA verifies novelty. It is a simple, effective and flexible process (e.g. the user can decide how strict the requirements are through the Novelty Constants).
Each time a story is developed MEXICA produces a report. In that reported it is indicated the number of times each sequence has been used previously, and the result of the evaluation. In this way, the user has access to a detailed information of the novelty of the story in progress.

A final point regarding novelty. MEXICA gives the user the option to decide if the system starts the development of the tale under the Engaged or Reflective State. The analysis of the evaluation of novelty allows foreseeing some of the possible consequences of choosing an initial state.
If MEXICA starts the development of the tale under the Engaged State, the Novelty Guideline is set with the default value (Low). So, the filters delete no actions due to novelty problems, even if MEXICA is copying a Previous Story. This situation lasts until MEXICA switches to the Reflective State and performs the evaluation process. By contrast, if MEXICA starts the story under the Reflective State, MEXICA performs immediately an evaluation process. If the initial action is included in one of the Previous Stories, the Novelty Guideline is set to Strict even if the story in progress is formed just by one event (the initial action). In some cases, this unnecessary rigidity can lead to an impasse.
In the following chapter this kind of situation is analysed.

B. Tensional Representation.

The evaluation of the Tensional Representation is divided into four stages: the first and second perform two different comparison processes. The third, based on such comparison, selects a Tensional Representation as a frame. Finally the fourth stage, with the help of such a frame, evaluates the story in progress and sends guidelines to the Engaged State.

The first process contrasts the transition of Tension between actions (qualitative comparison). The second, the value of the tension at each point in the vector of Tensional Representation (quantitative

comparison). The objective of these processes is to obtain the most similar Tensional Representation to the one of the tale in progress.

In order to explain the first comparison process the concept of Transitional Table is now introduced. In MEXICA, stories are sequence of events which occur at discrete times; that is, the first event occurs at time=1, the second at time=2, etc. A Transitional Table encodes the way the Tensional Representation changes between an action at time=t and the following action at time=t+1 for all events in a story. For example, if a tale has the following Tensional Representation [0, 5, 10, 10, 25, 15, 0] (i.e. the tension at t=1 is zero, at t=2 is 5, at t=3 is 10, etc.) its Transitional Table is [up up same up down down] (i.e. the tension from t=1 to t=2 goes up; the tension from t=2 to t=3 goes up, the tension from t=3 to t=4 is the same, etc.).

Thus, during the first process MEXICA compares the Transitional Table of the story in progress against the Transitional Table of each of the Previous Stories. This process works as follows. The Nth element of the Transitional Table of the story in progress is compared against the Nth element of one of the Transitional Tables in the Previous Stories, where N goes from 1 to the number of elements in the shortest of such tables. If in both tables the Nth elements have the same value one point is added to a variable called Result; this variable is used to calculate the similarity between them. If one of such elements has the value "same" and the other the value "up" or "down" zero points are added. Finally, if one has the value "up" and the other "down", one point is subtracted from Result. Thus, after comparing the story in progress against all the Previous Stories, the most similar tale will be that with the highest result.

| Table 1 | Table 2 | Result |
|---|---|---|
| Up | Up | 1 |
| Down | Down | 1 |
| Same | Same | 1 |
| Up | Same | 0 |
| Same | Up | 0 |
| Down | Same | 0 |
| Same | Down | 0 |
| Up | Down | -1 |
| Down | Up | -1 |

For example, let us suppose that the Previous Stories contains two tales with the following Tensional Representations: Story1 [0 0 5 10 15 25 25 0] and Story2 [0 15 10 15 25 25 0]. And that the Tensional Representation of the tale in progress is [0 5 10] (just three action have been produced for this new story). Now, the result of the first comparison between the story1 and the tale in progress is 1.

| Story 1 | New Tale | Result | Final Result |
|---|---|---|---|
| Same | Up | 0 | 1 |
| Up | Up | 1 | |
| Up | | | |

| | | | |
|---|---|---|---|
| Up<br>Up<br>Same<br>Down | | | |

and the result between the story 2 and the tale in progress is 0.

| Story 2 | New Tale | Result | Final Result |
|---|---|---|---|
| Up | Up | 1 | 0 |
| Down | Up | -1 | |
| Up | | | |
| Up | | | |
| Same | | | |
| Down | | | |

In this way, for this example the Tensional Representation of the tale in progress is more similar to the one in story1 than to the one in story2.

MEXICA performs a second comparison, this time to identify which of the Tensional Representations in the Previous Stories is the most alike to the one of the tale in progress. For this process MEXICA calculates the absolute difference in the value between the Nth element in the Tensional Representation of the story in progress and the Nth element of the Tensional Representation of one of the Previous Stories. The result of each operation is added to obtain a global result. The same process is repeated between the tale in progress and each of the tales in the Previous Stories. The comparison that produces the lowest global result indicates which Tensional Representation is the most similar to the one of the tale in progress. For instance, following with the previous example, after performing the second comparison process MEXICA obtains as a result that the Tensional Representation in story1 and story2 are equally similar to the one of the story in progress.

| | |
|---|---|
| New Tale<br>Story 1<br>Result | [ 0 5 10]<br>[ 0 0 5 10 15 25 25 0]<br>0 5 5 = **10** |
| New Tale<br>Story 2<br>Result | [ 0 5 10]<br>[ 0 15 10 15 25 25 0]<br>0 10 0 = **10** |

The third stage starts when MEXICA groups the Tensional Representations of those stories which obtained the highest value in the first comparison, and those which obtained the lowest value in the second comparison.

First comparison = [Story1]
Second comparison = [Story1 Story2]

Finally, the frame that is used to evaluate the story and produce the guidelines for the Engaged State is selected randomly, from a set resulting from the intersection between the elements obtained from the first comparison and those obtained from the second one.

Frame = [Story1] ^ [Story1  Story2]
**Frame = Story1**

If this set is empty, a frame is selected randomly from the group of Tensional Representations obtained from the first comparison.

MEXICA is now able to evaluate the tale in progress. Between all the options from the Previous Stories, the frame selected is just the most similar to the Tensional Representation of the story in progress; i.e., important differences can still exist between both of them. In MEXICA all knowledge about story-telling is represented in long-term memory; thus, MEXICA "taste" for a good story is based on the way Previous Stories were constructed. That is, for MEXICA an interesting story is that which resembles the Tensional Representation of a tale in the Previous Stories. Thus, although it does not attempt to copy the Tensional Representation selected as a frame,  MEXICA uses it as a reference; when the story in progress strays too much from this reference MEXICA tries to push the story back. This procedure allows MEXICA to produce novel but well organised stories in terms of Tensional Representation.

Thus, the evaluation consists in comparing how similar the Transitional Table of the story in progress is to the Transitional Table of the frame. If it is not similar in at least 50% the tale in progress is classified as a story lacking interest; otherwise, the story is seen as producing enough interest to the reader. Of course, this percentage —known as Transitional Table Percentage— is modifiable by the user.
This classification is important for the filters. They eliminate actions based on the requirements established by the Novelty and Tensional guidelines. But in the case of the Tensional Guidelines is necessary to define which of them, the Permanent or the Temporal, will indicate to the filters the criteria to follow.
If the story in progress is classified as producing enough interest, the filters follow the requirements specified by the Permanent Tension until another evaluation process is executed. If the story in progress is classified as lacking interest, the filters follow the requirements specified by the Temporal Tension just during one selective process. After that, they follow the requirements established by the Permanent Tension until another evaluation process is executed.
The difference in the criteria established by each of the Tensional Guidelines will become evident in the following lines. However, it must be mentioned that under E2 operation mode just the Temporal Tension is utilised.

The Permanent Tension indicates if the intensity of the tension in the frame will raise, decrease or be the same the next time that MEXICA evaluates the story. Its function, in combination with the variable

Chances (see some paragraphs later), is to provide the Tensional Representation of the story in progress with a general direction to follow in order to produce interesting stories.

The possible values for the Permanent Tension are: tendency-up, tendency-down, neutral, end-story. When the Permanent Requirement is set to tendency-up, all those actions which produce a decrement in the value of the variable Tension to the Reader are eliminated by the filters from the group of possible next actions. When it is set to tendency-down, all those actions which produce an increment in the value of the variable Tension to the Reader are eliminated by the filters from the group of possible next actions. When it is set to neutral no action is eliminated. Finally, when it is set to end-story MEXICA ends the story in progress. By default the Permanent Tension is set to tendency-up.

The process of calculating the value of the Permanent Tension works as follows. Having T representing the number of actions produced so far in the story in progress and CtEg-Rf representing the constant which indicates the number of actions to be produced before switching from the Engaged to the Reflective State (i.e. before having another evaluation process again), MEXICA obtains the difference between the value of the tension in the frame at T + CtEg-Rf and at T; if the result is positive MEXICA sets the permanent requirement to tendency-up, if the result is negative the guideline is set to tendency-down, otherwise it is set to neutral. For instance, in the previous example the story1 was selected as a frame for the story in progress. Their Tensional Representations are

New Tale [0 5 10]
Story1 [0 0 5 10 15 25 25 0]

By default CtEg-Rf is set to 3 and for this example T is also set to 3. Thus, the value of the frame at T+CtEg-Rf is 25 and at T is 5

Story1(T+CtEg-Rf) = 25
Story1(T)= 5

In this way, the requirement is set to tendency-up. If the value of T+CtEg-Rf is bigger than the number of actions in the frame, the last element in such a frame is used to perform the operation. If the number of elements in the story in progress and the frame are equal, the guideline is set to end-story and MEXICA finishes the tale.

There is a special variable related to the Permanent Tension called Chances. Its function is to allow some actions, which do not satisfy the requirements of the Permanent Tension, being selected as the next event in the tale. It works as follows. When MEXICA retrieves possible next actions from long-term memory the filtering process is executed; so, all those possible next actions that do not fulfil the requirements of the Permanent Tension are deleted. However, if the variable Chances has a value greater than zero, e.g. 2, MEXICA does not delete two of those actions which do not satisfy the

Permanent Tension's requirements, giving them the opportunity of being selected as the next event in the story.
Each time MEXICA does not delete an action because there are some Chances left, the value of such a variable is decrement by one.
As commented earlier, MEXICA does not attempt to copy the Tensional Representation of Previous Stories; it just uses it as a general frame to guide the story. Through the use of the variable Chances new Tensional Representations (different to the ones in the Previous Stories) can be created.

The process of calculating the value of the variable Chances is now explained. The constant CtEg-Rf determines how frequently MEXICA switches to the Reflective State to evaluate the story in progress. MEXICA establishes that —as a maximum— half of the actions retrieved between two evaluation processes cannot fulfil the requirements of Permanent Tension. In this way, Chances is equal to the value of CtEg-Rf divided by two (Chances=CtEg-Rf/2). If CtEg-Rf is an odd number greater than one Chances is decrement by one, i.e. Chances = (CtEg-Rd/2) - 1.

The Temporal Tension is used when the story in progress is classified as lacking interest. Its function is to try to ensure that the Tensional Representation of the story in progress becomes more similar to the frame.
The possible values for the temporal requirement are: Up, Down or Hold. When it is set to Up the filters eliminate all those possible next actions which decrement the value of the Tension to the Reader. When it is set to Down the filters eliminate all those possible next actions which increment the value of the Tension to the Reader. When it is set to Hold the filters eliminate all those possible next actions which modify the value of the Tension to the Reader.
The process to calculate its value is now explained. Imagine that the story in progress has produced T actions. If the intensity of the tension in the frame at T+1 is greater than the value of the Tension to the Reader in the story in progress at T, MEXICA sets the Temporal Tension to Up. If the intensity of the tension in the frame at T+1 is less than the value of the Tension to the Reader in the story in progress at T, MEXICA sets the Temporal Tension to Down. If the intensity of the tension in the frame at T+1 is equal to the value of the Tension to the Reader at T, MEXICA sets the Temporal Tension to Hold. For example, if the story in progress and the frame has the following values:

| | |
|---|---|
| Story in progress | [0 10 20] |
| Frame | [0 10 20 40 20] |

MEXICA sets the Temporal Tension to Up since the intensity of the tension in the frame at T=4 is 40 while the intensity of the Tension to the Reader in the tale in progress at T=3 is just 20.
To avoid copying the Tensional Representation of the frame, the Temporal Tension is active just for one action; afterwards, the Permanent Tension turns active.

If the number of actions in the frame is equal to the number of actions developed so far, MEXICA finishes the story. In MEXICA, a Tensional Representation cannot operate as a frame if it does not contain at least the same number of actions as the story in progress; this condition is necessary in order to be able to produce the guidelines. If all Previous Stories are shorter than the story in progress, i.e. if all Tensional Representations in long-term memory are smaller than the one of the story in progress, MEXICA does not know how to continue the story, and the permanent guideline is set to end-story.

A final point about the evaluation process. Each time that MEXICA switches to the Reflective State the story in progress is evaluated, and each time it is evaluated a new process to select a frame is executed. Thus, if the tale in progress now has different characteristics a new frame is selected. That is, MEXICA might use more than one Tensional Representation from completely different stories as a frame during the development of a tale. This allows the system to create novel Tensional Representations.

### 4.3.3. Ending a Story.

The Engagement-Reflection cycle ends (i.e., the story is finished) when:

1. All characters in the story are dead.
2. When an unbreakable impasse is declared.
3. When the number of actions in the story in progress is bigger than the number of actions in all the frames (see Section 4.3.2.3-B).
4. When the maximum number of actions allowed in a story is reached. The maximum number of actions allowed in a story is a parameter definable by the user called Maximum Actions.

Another criterion consists in ending a tale when a degradation-improvement cycle is completed. This alternative permits the user to experiment with stories that include one or several of such cycles. The user activates this option through a parameter named Zero Tension (by default it is not active). However, there is a potential problem with it: stories with a very short degradation-improvement cycle are boring (see the boring stories in Section 6.1.3). A parameter named Tensional Increments is used to control this problem. It works as follows. Before ending the story the system verifies if the variable Tension to the Reader has increased its value N times in a row, where N is the value of the parameter Tensional-Increments (by default Tensional-Increments is set to 2 although it accepts values between 1 and 100). The logic behind it is that if the Tension to the Reader grows in multiple occasions, it is more difficult to produce a boring tale. Thus, if the Tension to the Reader in the story in progress increases its value Tensional-Increments times in a row and the parameter Zero-Tension is active, the next time that the value of the Tension to the Reader is equal to zero (i.e. when the degradation-improvement cycle is completed) the story is ended.

### 4.3.4 The Final Analysis.

Once a story is finished —i.e., when the engagement-reflection cycle ends due to any of the reasons explained above— the system performs a final analysis of it. That is, MEXICA revises the material produced to add a few finishing touches to the story.

The purpose of this analysis is to make clear the motivation that characters in the story have to act in a particular way. Thus, the story becomes more coherent. To achieve this goal, MEXICA examines the story to determine where it is possible to insert either actions representing characters' goals or actions that explicitly represent tensions between characters. This process is divided in two parts.

**A. Detecting Life at Risk, Health at Risk, or Prisoner.**

The first part of the process consists in identifying if, at any moment in the story, there is a character whose life is at risk, or whose health is at risk or is a prisoner. If MEXICA finds a character that satisfies these characteristics, e.g. character B, the system keeps on examining the story to investigate if someone else saves, cures or rescues such a character B. If MEXICA finds this other character, the system has found a situation where it can insert a character's goal. For example, imagine the following story: *the princess went to the forest and the enemy kidnapped her. Jaguar knight realised about the kidnapping. He followed and killed the enemy. He rescued the princess and she fell in love with him.* In this story, the princess becomes a prisoner after the kidnapping. MEXICA detects this situation and finds that some actions later the knight rescues the princess. That is, MEXICA establishes a link between someone kidnapping the princess and jaguar knight rescuing the princess. Thus, the system inserts an action, just after the knight realises about the kidnapping, where the goal to rescue the princess is set. The final story looks as follows: *the princess went to the forest and the enemy kidnapped her. Jaguar knight realised about the kidnapping. Jaguar knight knew that princess' life was at risk and that jaguar knight had to do something about it. He followed and killed the enemy. He rescued the princess and she fell in love with him.*

The extra action introduces the goal of saving the princess, which makes clearer jaguar knight behaviour. It also permits introducing some suspense in the story by delaying the kidnapping resolution. In general, these kind of additional actions improve the story.

When MEXICA detects a situation like the one just explained, it inserts the following standard Primitive Action:

```
ACT
Life_Risk_1 2 ;  Character A is the  hero.  Character  B is the victim.
TEXT
@A knew that @B's life was at risk and had to do something about it.
```

Where character A saves B. This Primitive Action does not include preconditions or postconditions. Its function is to represent the moment when character A decides to save character B. As with all the other Primitive Actions, MEXICA substitutes this Primitive Action with its associated text to produce the final version of the story. The user can modify the given text or add new ones.

The same process occurs when the system detects that the health of a character (e.g. character B) is at risk MEXICA analyses the story and if some other character cures character B the following standard Primitive Action is inserted:

ACT
Health_Risk_1 2 ; Character A is the hero. Character B is the victim.
TEXT
@A knew that @B could die and that @A had to do something about it.

And finally, MEXICA uses the same method when it detects that character B is kidnapped and someone else rescues such a character B. In this case, the following standard Primitive Action is inserted:

ACT
Pr_Free_1 2 ; Character A is the hero. Character B is the victim.
TEXT
Although it was very dangerous @A promised to Quetzalcoatl —The God between the Gods— to rescue @B.

**B. Detecting Love Competition and Clashing Emotions.**

This part of the process detects if —in any of the characters in the story— the tension Love Competition or Clashing Emotions becomes active. When this occurs, MEXICA inserts an action to make explicit these tensions. In this way, the story gets a special drama. The following is an example of a story: *Eagle knight rescued princess. The tlatoani felt an enormous gratitude for the knight and rewarded him. Suddenly, tlatoani was informed that eagle knight was responsible for the murder of many children during the last expedition. Tlatoani decided to exile eagle knight forever.* After MEXICA performs the final analysis, the story looks as follows: *Eagle knight rescued princess. The tlatoani felt an enormous gratitude for the knight and rewarded him. Suddenly, tlatoani was informed that eagle knight was responsible for the murder of many children during the last expedition. Tlatoani was emotionally tied to eagle knight but tlatoani could not accept eagle night's behaviour. What should tlatoani do? Tlatoani decided to exile eagle knight forever.*
When MEXICA detects a Clashing Emotion it inserts a standard Primitive Action just after the event that triggered the tension:

ACT
CLASH_EMOTION_1 2
TEXT
@A was emotionally tied to @B but @A could not accept @B's behaviour. What should @A do?

MEXICA distinguishes three different types of Clashing Emotions. The first has been just described. The second occurs when character A has Clashing Emotions towards character B, but previously character B had already developed Clashing Emotions towards character A. For example, continuing with the story above, the tlatoani develops the first type of Clashing Emotions when he realises that the knight is a murder. When the knight realises that he has been exiled by the tlatoani (the man who rewarded him), the

knight develops the second type of Clashing Emotions. In the first type, the Clashing Emotion is triggered by the contradictory and disappointing knight's behaviour (he is a hero but also a murder). In the second type, the Clashing Emotion is triggered by tlatoani's reaction to knight's behaviour. Detecting and making explicit these subtle differences improve the quality of the stories.
When MEXICA detects the second type of Clashing Emotions it inserts the following standard Primitive Action:

ACT
CLASH_EMOTION_2 2
TEXT
@A was shocked by @B's actions and for some seconds @A did not know what to do.

The third case occurs when a character has Clashing Emotions towards itself. For example, imagine a warrior that has an accident. A man arrives and cures him. Suddenly the warrior realises that the man is an enemy and kills him. Thus, the warrior develops clashing emotions towards himself. In this case MEXICA inserts the following standard Primitive Action:

ACT
CLASH_EMOTION_3 1
TEXT
@A was emotionally devastated and confused, and was not sure if what @A did was right.

MEXICA uses the same process described above to insert actions when it detects a Love Competition between characters. Thus, in this case, it inserts the following standard Primitive Action:

ACT
Love_Competition_1 2
TEXT
@A and @B were in love with the same person, and none of them would give up.

Like in the case of Clashing Emotions, different types can be distinguished. For example, when one of the characters is aware of the Love Competition but the other not (e.g. when a knight is in love with a lady but he does not know that other knight also wants her). When the characters involved in the Love Competition belong to the same social class (it is not the same when two knights are competing for the love of a woman, and when a knight and a farmer are competing for the same woman), etc.

## 4.4 Learning in MEXICA.

The learning mechanism in MEXICA is simple. Knowledge in long-term memory mainly comes from the set of Previous Stories; so, when a new tale is developed by MEXICA the user can add it to the file of Previous Stories. In this way, all the information produced by the new tale is incorporated into the structures in long-term memory each time MEXICA loads the Previous Stories. This is important because an impasse occurs when an (unusual) context cannot match an atom; so, if the impasse is

overcome, the next time the file of Previous Stories is loaded into memory such a context is transformed in a new atom with its associated set of possible next actions. In this way, when in the future MEXICA faces a similar situation the impasse will be avoided. What happens when an impasse cannot be broken? Because Previous Stories are encoded in a text file the user has the opportunity to provide some examples which illustrate how to break the impasse.

## 4.5 User Interface.

The user interface consists of a set of windows, which either open menus, run processes, display the new tale on the screen or allow the user to modify different parameters in the system.

A. Setting up Variables.

MEXICA has twenty three parameters, which can be manipulated by the user. They are all assigned default values when the system starts, so they do not have to be modified. However, if the user decides to experiment with all the different options, the possibility of changing them is always present. Table 4.1 shows a list of all parameters modifiable by the user ordered alphabetically. Such table includes the name of the parameter, the section where the reader can find an explanation of their function, the default value assigned to them and a brief description of their role.

| Parameter | Section | Default Value | Description |
|---|---|---|---|
| ACAS-Constant I, II, III | 4.3.1 | 50%, 70% and 90% | Minimum percentage required to match an atom through the ACAS-Process. |
| CtEg-Rf | 4.3 | 3 | Number of actions produced during the Engaged State before switching to the Reflective State. |
| Equivalent Constant | 4.3.2.2 | 50% | Minimum percentage required to consider an action equivalent to another one. |
| Forbidden Characters | 4.3.1.2-A | Half-Active | Prevent some of the characters in the context from being banned. |
| Initial State | 4.3 | Engaged State | Indicates the state under which MEXICA starts to develop a tale. |
| Logical Action | 4.3.1.2-B | Not active | Activates or deactivates the constraints for logical actions. |
| Maximum Actions | 4.3.3 | 20 | Maximum number of actions allowed in a new story. |
| Medium Novelty Constant | 4.3.2.3-A | 75% | Minimum percentage necessary to satisfy the requirement of Medium Novelty. |
| Novelty-Percentage | 4.3.2.3-A | 50% | Maximum percentage of similarity authorised to exist between two tales. |
| Operation Mode | 4.3 | ER2 | Active Operation Mode for the developing of a tale. |
| Strict Novelty Constant | 4.3.2.3-A | 15% | Minimum percentage necessary to satisfy the requirement of Strict Novelty. |
| Tension Dc | 4.2.3.3 | 30 | Tension produced due to a Dead Character. |
| Tension Hr, Lr, Pr, Ce, Pd | 4.2.3.3 | 20 | Tension produced due to Health in Risk, Life in Risk, Prisoner, Clashing Emotions or Potential Danger. |
| Tension Lc | 4.2.3.3 | 10 | Tension produced due to Love Competition. |
| Tensional Increments | 4.3.3 | 2 | Number of times that the variable Tension to the Reader must increment its value in a row to activate the parameter Zero Tension. |
| Transitional Table Percentage | 4.3.2.3-B | 50% | Minimum percentage required to classify a story as producing enough interest. |
| Zero Tension | 4.3.3 | Not active | When this parameter is active the story ends the next time that the Tension to the Reader has a value equal to zero. |

**Table 4.1 Parameters definable by the user (notice that rows 1 and 13 include more than one parameter).**

B. Displaying the new Story.

MEXICA has the option of displaying on the screen the latest story created.

C. Saving a New Story

The user can incorporate the latest story created by the system to the Previous Stories. In this way, new members are added to the Concrete, Abstract and Tensional Representations in long-term memory and MEXICA can utilise them to produce new tales. The process consists in appending the new story to the text file of Previous Stories.

D. Re-loading Previous Stories.

Each time MEXICA starts all structures in long-term memory are created. When the user adds new tales to the file of Previous Stories through the option of saving a new story, they are not immediately incorporated to such structures. It is necessary to reset the program or re-load the Previous Stories. That is, the option of re-loading the Previous Stories runs again the process that constructs all structures in long-term memory; in this way, without leaving the program, the structures produced by such new tales are included in memory.

E. Printed Reports.

MEXICA generates three reports (some examples can be found in Appendixes E and F). The first traces step by step the way Previous Stories are processed; it is very useful to study and analyse the way characters' contexts behave and therefore the way atoms are created in long-term memory. It also includes the graphic of the Tensional Representation of all Previous Stories. The second is a map of the Abstract Representation, which includes all atoms and their position. Finally, the third traces the development of a new tale. For questions of space, only examples of the second and third report are presented in thesis. However, notice that the first and third reports are the same; the only difference is that the former reports the Previous Stories and the latter the story in progress.

# Chapter V

# Analysis of MEXICA's Output

This chapter analyses some of the stories created by MEXICA. It is organised as follows. Sections 5.1 and 5.2 introduce an example where the reader can trace step by step the development of a story called *The princess who cured the jaguar knight* (the titles of all stories created by MEXICA have been assigned by the author of this work). Section 5.3 presents an analysis of this story. Section 5.4 examines the outcomes obtained when different parameters in the system are modified. Section 5.5 examines the development of a story called *The kidnapped Tlatoani* under ER2 operation mode, and analyses the consequences of modifying the operation mode to ER1. Finally, Section 5.6 discusses inadequate tales produced by MEXICA.

In order to make the explanation clearer, all reproductions of the report produced by MEXICA during the developing of a tale are printed in bold characters **like these**. In this chapter, all references to the parameter ACAS-Constant I are made only as ACAS-Constant.

## 5.1 *The princess who cured the jaguar knight.*

The following is an example of a story created by MEXICA:

JAGUAR_KNIGHT WAS AN INHABITANT OF THE GREAT TENOCHTITLAN. PRINCESS WAS AN INHABITANT OF THE GREAT TENOCHTITLAN. TLALOC —THE GOD OF THE RAIN— WAS ANGRY AND SENT A STORM. THE HEAVY RAIN DAMAGED THE OLD WOODEN BRIDGE. WHEN JAGUAR_KNIGHT TRIED TO CROSS THE RIVER THE BRIDGE COLLAPSED INJURING BADLY JAGUAR_KNIGHT'S HEAD. PRINCESS KNEW THAT JAGUAR_KNIGHT COULD DIE AND THAT PRINCESS HAD TO DO SOMETHING ABOUT IT. PRINCESS HAD HEARD THAT THE TEPESCOHUITLE WAS AN EFFECTIVE CURATIVE PLANT. SO, PRINCESS PREPARED A PLASMA AND APPLIED IT TO JAGUAR_KNIGHT'S WOUNDS. IT WORKED AND JAGUAR_KNIGHT STARTED TO RECUPERATE! JAGUAR_KNIGHT REALISED THAT PRINCESS'S DETERMINATION HAD SAVED JAGUAR_KNIGHT'S LIFE.
DURING THE LAST WAR PRINCESS'S FATHER HUMILIATED ENEMY'S FAMILY. NOW, IT WAS TIME OF REVENGE AND ENEMY KIDNAPPED PRINCESS. THEY WENT TO THE FOREST WHERE ENEMY TIED PRINCESS TO A HUGE ROCK. EXACTLY AT MIDNIGHT ENEMY WOULD CUT PRINCESS UP. ALTHOUGH IT WAS VERY DANGEROUS JAGUAR_KNIGHT DECIDED TO DO SOMETHING IN ORDER TO LIBERATE PRINCESS. FOR SOME MINUTES JAGUAR_KNIGHT PRAYED TO QUETZALCOATL —THE FEATHERED SNAKE, THE GOD BETWEEN THE GODS— AND ASKED FOR WISDOM AND BRAVENESS. NOW JAGUAR_KNIGHT WAS READY TO FIND OUT ITS FATE.
PRINCESS WAS REALLY ANGRY FOR WHAT HAD HAPPENED AND AFFRONTED ENEMY. ENEMY'S FRAME OF MIND WAS VERY VOLATILE AND WITHOUT THINKING ABOUT IT ENEMY CHARGED AGAINST PRINCESS. MEANWHILE JAGUAR_KNIGHT DECIDED TO START A SEARCH FOR ENEMY. AFTER HARD WORK AND DIFFICULT MOMENTS JAGUAR_KNIGHT COULD FINALLY FIND ENEMY. JAGUAR_KNIGHT, FULL OF ANGER, TOOK A DAGGER AND ATTACKED ENEMY. JAGUAR_KNIGHT THREW SOME DUST IN ENEMY'S FACE. THEN, USING A DAGGER JAGUAR_KNIGHT PERFORATED ENEMY'S

CHEST. IMITATING THE SACRED CEREMONY OF THE SACRIFICE, JAGUAR_KNIGHT TOOK ENEMY'S HEART WITH ONE HAND AND RAISED IT TOWARDS THE SUN AS A SIGN OF RESPECT TO THE GODS.
JAGUAR_KNIGHT WALKED TOWARDS PRINCESS. FULL OF ADMIRATION FOR ALL THE BRAVENESS THAT PRINCESS HAD SHOWN IN THOSE HARD MOMENTS JAGUAR_KNIGHT LIBERATED PRINCESS! ALTHOUGH AT THE BEGINNING PRINCESS DID NOT WANT TO ADMIT IT, PRINCESS FELL IN LOVE WITH JAGUAR_KNIGHT. PRINCESS WAS KISSING JAGUAR_KNIGHT WHEN SUDDENLY PRINCESS RECOGNISED JAGUAR_KNIGHT'S TATTOO. IT WAS THE SAME AS THE ONE USED BY THE FRATERNITY WHICH HAD MURDERED PRINCESS'S FATHER SOME MONTHS AGO. AT ONCE ALL THOSE TERRIBLE MEMORIES WERE PRESENT AGAIN. PRINCESS HAD AMBIVALENT THOUGHTS TOWARDS JAGUAR_KNIGHT. ON THE ONE HAND PRINCESS HAD STRONG FEELINGS FOR JAGUAR_KNIGHT BUT ON THE OTHER HAND PRINCESS ABOMINATED WHAT JAGUAR_KNIGHT DID. PRINCESS FELT A DEEPLY ODIUM FOR JAGUAR_KNIGHT. INVOKING HUITZILOPOCHTLI, GOD OF THE DEAD, PRINCESS CUT JAGUAR_KNIGHT'S JUGULAR. THE BLOOD COVERED THE FLOOR. PRINCESS TOOK A DAGGER AND CUT PRINCESS'S THROAT. PRINCESS BLED TO DEATH WHILE TONATIU (THE GOD REPRESENTING THE SUN) DISAPPEARED IN THE HORIZON.

The tale is divided in three parts or episodes, each one coinciding with the three degradation-improvement processes found in the story (for a visual representation of such degradation-improvement processes see the graphic of the Tensional Representation at the end of Section 5.2). From now onwards, an episode is defined as the set of actions included in a degradation-improvement process.

The first episode ranges from the first action to the event where the princess cures jaguar knight. The first two actions introduce the main characters in the story. The event of the accident suffered by the knight constitutes the peak (the part with the highest value of the variable Tension to the Reader) in the episode. The function in the story of this episode is to establish an Emotional Link between the jaguar knight and the princess. In this way, when the enemy kidnaps the princess, the knight has a motive to go and rescue her.

The kidnapping action marks the beginning of the second episode, which ends when the princess falls in love with the knight. The kidnapping action introduces the antagonist in the story; in this example that role is played by the enemy. This episode can be subdivided in two sections. The first section includes the events where the enemy kidnaps the princess, the princess insults the enemy and he responds attacking her. The second section includes the events where the knight finds, attacks and kills the enemy, rescues the princess and the princess falls in love with him.

During the first section the Tension to the Reader is incremented (to make the story more interesting) not just by making the princess a prisoner of the enemy, but also by putting her life at risk when the enemy attacks her. The function of this first section is to drive the story towards the climax.

The second section starts by reintroducing the character jaguar knight in the story. The Tension to the Reader reaches one of its highest points in the story when the knight faces the enemy and decides to attack him. When the enemy is killed and the princess is rescued, all Tensions are released. This is followed by the action where the princess falls in love with the knight. Thus, this second section reaches the climax and releases all the tensions.

The third episode starts when the princess realises about knight's tattoo and finishes with the last action in the tale. The story takes an unexpected twist when the princess realises that the knight participated in

her father's murder. The story ends with the princess killing the man she loves and also killing herself. Thus, this episode introduces an abrupt new direction in the unfolding of the story, which leads towards an unforeseen end.

Although this story has three well identifiable parts —each one with a specific function in the story— and the role of the characters (e.g. antagonist-protagonist) is very clear, it is not the result of predefined plans or structures. This story is the result of an Engagement-Reflection process, which develops this tale by retrieving and linking sequences of actions. This process is explained in detailed in the following section.

## 5.2 Trace of the Story.

The initial action (supplied by the user) which originated this tale was PRINCESS CURED JAGUAR_KNIGHT. From it MEXICA sorted out what led to such an action and what happened after it. Each time MEXICA develops a new story a report called *New Story Context's Report* is created where all the details of the process are recorded.

***** NEW STORY CONTEXT`S REPORT**

**Initial State:EgS CtEg-Rf:3 ACAS-Constant:50% Guidelines.Chances:1**
**Forbidden Actors:Half Active Num_actions:34 times_used:85**
**Novelty=> Strict 15%(1) High 50%(2) Medium 75%(3)**
**Detection of end of cycle NO-active. Logical actions NO-active.**
**Operation Mode: Engaged and Reflective States 2**

The header of the report indicates the value of the most important parameters defined by the user to create the story. For instance, in this example MEXICA starts to develop the story in the Engaged State (EgS). The value of the constant which regulates the cycle between the Engaged and Reflective States (CtEg-Rf) is set to three, i.e. after every three actions the system switches from the Engaged to the Reflective State to verify preconditions and evaluate the story. The ACAS-Constant is set by default to 50%; the Chances in the guidelines are calculated to one and the forbidden actors are set to Half Active. The values of the Strict and Medium Novelty Constants are set to 15% and 75% respectively (by default the value of the High Novelty Constant is set to 50% and this parameter is not modifiable). The process to finish a story when an improvement-degradation cycle ends is set to NO-active, and the same occurs with the detection of illogical actions. And finally, MEXICA is running under the Engaged and Reflective States 2 (ER2) operation mode.

The header also includes information about the number of events occurring in Previous Stories; this information is utilised to evaluate the novelty of the story in progress. In this example, there are 37 different actions employed in Previous Stories and the total number of times that such actions have been used is 86. The ratio between these two values produces the average number of times that a Primitive Action has been performed; for this example such a value is two. This average number

represents a novelty of 50%, i.e. any Primitive Action which has been used two times in Previous Stories has a novelty of 50%.

In this way, when during the development of a tale the Novelty Guideline is set to High, MEXICA just selects actions which have been used previously in one or two occasions. When the Novelty Guideline is set to Strict, which in this example has a value defined by the user of 15%, MEXICA just selects actions that have been used previously in one occasion. Finally, when the Novelty Guideline is set to Medium, which in this example has a value defined by the user of 75%, MEXICA just selects actions which have been used previously in one or two or maximum three occasions.

The first action in the story produces the following context:

**CONTEXT *****
***** Time => 1 Action: princess CURED jaguar_knight Tension: 0**
**Charac: PRINCESS Pos: Texcoco Lake Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**

**Charac: JAGUAR_KNIGHT Pos: Texcoco Lake Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**

The first line indicates the (chronological) number of the action, the identifier of the action and the characters participating in it, and the value of the variable Tension to the reader represented in the report by the symbol **Tension**.

The first line in each characters' context indicates the name of the character, his/her position in the story-world, and his/her status. A list with all Emotional Links and Tensions that the character is aware of comes after it. In this example, the postconditions of the action A CURED B trigger an Emotional Link of intensity +3 and type 1 between the jaguar knight and the princess. That is, jaguar knight develops an Emotional Link towards the princess and the princess is aware of it. Now, MEXICA creates the Associative Structures from each of the characters' context to try to retrieve possible next actions from long-term memory.

**ASSOCIATIVE STRUCTURE *****
***** Time => 1 Action: princess CURED jaguar_knight Tension: 0**
**Charac: PRINCESS Pos: Texcoco Lake Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**

**Charac: JAGUAR_KNIGHT Pos: Texcoco Lake Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**

The information related to the Associative Structure is presented in the report in the same format as the information related to the characters' contexts; first, a line with general data about the character followed by a list of Emotional Links and Tensions. However, by contrast with the context, just those Emotional Links and Tensions used to form the Associative Structure are listed in this part of the

report. In the current example MEXICA is able to match for both characters, princess and jaguar knight, Associative Structures of type I; so, the characters' contexts and Associative Structures are currently the same.

The Associative Structure formed from the princess' context is matched against the following atom:

```
** Atom
EmoLin=>                A(+3,1):B

Possible Next Actions=> A WENT_PALACE
                        C MUGGED B
                        A WENT_HUNTING_WITH B
                        A HAD_AN_ACCIDENT
                        A REWARDED B
```

A map is created to establish a relation between the characters in such an Associative Structure and the atom; so jaguar knight is correlated with character A and princess with character B.

The Associative Structure formed from the jaguar knight's context is matched against the following atom:

```
** Atom
EmoLin=>                A(+3,1):C
                        B(+3,1):C

Possible Next Actions=> D KIDNAPPED C
```

MEXICA creates another map to correlate characters where jaguar knight is linked to A and princess to C.

The New Story Context's Report does not include a detailed description of the atoms matched as it is presented in this example; instead it prints general information about such atoms under the title of INDEXES.

**INDEXES *****
**PRINCESS: 0,1 ASI-100 JAGUAR_KNIGHT: 0,2 ASI-50**

This information includes the position in the Abstract Representation of the atoms matched, the type of Associative Structures used to match such atoms, and what percentage of the atom is equal to the Associative Structure (remember that an atom where the Associative Structure can be found as part of its organisation can be matched). Also, a list with all the possible next actions retrieved from long-term memory is printed.

For instance, in this example the Associative Structure created from the princess' context matches an atom in the position (0,1) (the Abstract Representation is organised as a matrix indexed by the number of Tensions and Emotional Links in the atom; thus, the atom is located in the position 0 Tensions, 1 Emotional Link). The Associative Structure used to match the atom belongs to type I (ASI) and the

atom is 100% equal to the Associative Structure (i.e. they are the same). All these information is encoded in the report as **PRINCESS: 0,1 ASI-100.**

In the same way, the Associative Structure created from the jaguar knight's context matches an atom in the position (0,2). The Associative Structure used to match the atom belongs to the type I (ASI) and 50% of the atom is equal to the Associative Structure (i.e. the Associative Structure constitutes 50% of the atom). All these information is encoded in the report as **JAGUAR_KNIGHT: 0,2 ASI-50**.

Notice that although the princess and jaguar knight's contexts are identical (and hence their Associative Structures) they match different atoms. The reason is that, in order to produce more alternatives, MEXICA avoids retrieving the same set of possible next actions twice.

Using the map to correlate characters described some lines earlier, all abstract characters in the list of possible next actions are substituted by the concrete characters in the princess' Associative Structure. This produces the following actions:

**PRINCESS possible next actions: ****
**JAGUAR_KNIGHT WENT_PALACE**
**ANYONE MUGGED PRINCESS**
**JAGUAR_KNIGHT WENT_HUNTING_WITH PRINCESS**
**JAGUAR_KNIGHT HAD_AN_ACCIDENT**
**JAGUAR_KNIGHT REWARDED PRINCESS**

Because character C in the first atom cannot be correlated with any of the characters in the Associative Structure, it is substituted with the symbol ANYONE which indicates that it has to be instantiated later.

MEXICA now substitutes the set of possible next actions retrieved from the jaguar knight's Associative Structure. Again, the first character in the set possible next actions (character D) cannot be linked to any character in the Associative Structure and it is substituted by the symbol ANYONE.

**JAGUAR_KNIGHT possible next actions: ****
**ANYONE KIDNAPPED PRINCESS**

In the next step MEXICA instantiates unknown characters and filters the set of possible next actions to eliminate those not useful for the story.

***** FILTER JAGUAR_KNIGHT WENT_PALACE NoFlow-**
**E$ instantiating JAGUAR_KNIGHT MUGGED PRINCESS ReiCha**
***** FILTER JAGUAR_KNIGHT WENT_HUNTING_WITH PRINCESS NoFlow-**
**E$ instantiating ENEMY KIDNAPPED PRINCESS PSt-**

The symbol **E$** in the report indicates that MEXICA is running under the Engaged State. The action JAGUAR_KNIGHT WENT_PALACE is eliminated because it does not flow. This is represented in the report by the symbol **NoFlow** at the end of the line. MEXICA instantiates ANYONE MUGGED PRINCESS with JAGUAR_KNIGHT MUGGED PRINCESS. The character jaguar knight was selected by reincorporating characters; this is indicated in the report by the symbol **ReiCha** at the end

of the line. The action JAGUAR_KNIGHT WENT_HUNTING_WITH PRINCESS is eliminated because it does not flow. And finally the action ANYONE KIDNAPPED PRINCESS is instantiated with ENEMY KIDNAPPED PRINCESS. The character enemy was selected based on the group class in Previous Stories. This is represented in the report by the symbol **PSt**.

So, after the processes for instantiating and filtering are executed, the sets of possible next actions looks as follows:

**PRINCESS possible next actions: ****
 **VIRGIN MUGGED PRINCESS**
 **JAGUAR_KNIGHT HAD_AN_ACCIDENT**
 **JAGUAR_KNIGHT REWARDED PRINCESS**

**JAGUAR_KNIGHT possible next actions: ****
 **ENEMY KIDNAPPED PRINCESS**

From these possible actions, MEXICA randomly selects the action ENEMY KIDNAPPED PRINCESS, and the following context is produced:

**CONTEXT *****
**** Time => 2 Action: enemy KIDNAPPED princess Tension: 40**
 **Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
 **Emotional Links =>**
 **JAGUAR_KNIGHT(+3,1):PRINCESS**
 **PRINCESS(-3,1):ENEMY**
 **JAGUAR_KNIGHT(-3,1):ENEMY**
 **Tensions =>**
 **Pr(PRINCESS):ENEMY**
 **Pd(ENEMY):PRINCESS+**

 **Charac: JAGUAR_KNIGHT Pos: Texcoco Lake Status: Alive**
 **Emotional Links =>**
 **JAGUAR_KNIGHT(+3,1):PRINCESS**
 **PRINCESS(-3,1):ENEMY**
 **JAGUAR_KNIGHT(-3,1):ENEMY**
 **Tensions =>**
 **Pr(PRINCESS):ENEMY**

 **Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
 **Emotional Links =>**
 **PRINCESS(-3,1):ENEMY**
 **Tensions =>**
 **Pr(PRINCESS):ENEMY**
 **Pd(ENEMY):PRINCESS+**

Each character’s context is updated in a different way. What follows is an explanation of what postconditions and inferred postconditions are added to each of the characters' context.

Princess' Context.- In the case of the princess, all action's postconditions are added to her context. That is, the field position is set to *Chapultepec Forest* (this is one of the postconditions of the action KIDNAPPED). The Emotional Link PRINCES(-3,1):ENEMY is triggered. Because the princess is

aware that jaguar knight is a linked character towards her (this is represented in her context by JAGUAR_KNIGHT(+3,1):PRINCESS), JAGUAR_KNIGHT(-3,1):ENEMY is also added to the princess' context. The tension Pr(PRINCESS):ENEMY is triggered too. Finally, MEXICA detects that the princess hates the enemy and that they are in the same position, so it triggers the inferred postcondition Pd(enemy):princess+.

Jaguar knight's Context.- Because jaguar knight was in the same location as the princess when she was kidnapped, the Emotional Link PRINCESS(-3,1):ENEMY and the tension Pr(PRINCESS):ENEMY are added to his context. Because he is a linked character towards the princess, the Emotional Link JAGUAR_KNIGHT(-3,1):ENEMY is also added to it. Notice that jaguar knight does not register the inferred postcondition Potential Danger (Pd). This is because MEXICA verifies inferred postconditions after the context has been updated; at that moment jaguar knight is in a different location to the princess or the enemy so the knight cannot register the inferred postcondition.

Enemy's Context.- This action introduces the enemy character into the story. His position is set to *Chapultepec Forest* and PRINCESS(-3,1):ENEMY and Pr(PRINCESS):ENEMY are added to his context as a result of the action's postconditions. Also, the inferred postcondition Pd(enemy):princess+ is triggered. Notice that the field Position in the enemy's context would be set to Lake (princess' location before the kidnapping) if the action did not include as a postcondition to locate the characters in the Chapultepec Forest (when a new character is introduced in the story, its location is set with the same value that the location of the other characters participating in the action). Also notice that, because the enemy is not aware of the Emotional Link between jaguar knight and the princess, the enemy's context does not include JAGUAR_KNIGHT(-3,1):ENEMY, i.e. the enemy does not know that the knight hates him.

The Tension to the reader after this action is performed rises to 40. The Tension Pr(PRINCESS):ENEMY in the princess' contexts contributes with 20 units and the Tension Pd(ENEMY):PRINCESS+ in the enemy's context contributes the other 20 units.

Now MEXICA forms new Associative Structures and tries to retrieve a new set of possible next actions from memory.

**ASSOCIATIVE STRUCTURE *****
***** Time => 2 Action: enemy KIDNAPPED princess Tension: 40**
**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Pd(ENEMY):PRINCESS+**

**Charac: JAGUAR_KNIGHT Pos: Texcoco Lake Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**

**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**

**Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**PRINCESS(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Pd(ENEMY):PRINCESS+**

**INDEXES ***
**PRINCESS: 3,7 ASI-50 JAGUAR_KNIGHT: 1,7 ASI-50 ENEMY: 2,1 ASI-100**

The report indicates that in position (3,7) an Associative Structure of type I formed from the princess' context matches an atom; 50% of such an atom is equal to the Associative Structure, i.e. the atom contains as part of its organisation such a structure. In position (1,7) an Associative Structure of type I formed from the jaguar knight's context matches an atom; 50% of such an atom is equal to the Associative Structure, i.e. the atom contains as part of its organisation the structure. Finally, in position (2,1) an Associative Structure of type I formed from the enemy's context matches an atom; 100% of such an atom is equal to the Associative Structure, i.e. they are identical.
The sets of possible next actions brought to working memory are:

**PRINCESS possible next actions: ****
**JAGUAR_KNIGHT ATTACKED ENEMY**

**JAGUAR_KNIGHT possible next actions: ****
**JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY**

**ENEMY possible next actions: ****
**ANYONE REALISED**
**ANYONE FOUND_BY_ACCIDENT ENEMY**
**ENEMY ATTACKED PRINCESS**

Now, the instantiation and filtering processes take place.

**** FILTER ANYONE REALISED**
**E$ instantiating PRINCESS FOUND_BY_ACCIDENT ENEMY ReiCha**
**E$ Instantiated action deleted ( NoFlow-); trying again.**
**E$ instantiating JAGUAR_KNIGHT FOUND_BY_ACCIDENT ENEMY ReiCha**

The action ANYONE REALISED is eliminated because the present prototype does not include a routine to manage compound actions during the Engaged State; the prototype is just able to work with compound actions during the Reflective State.
The action ANYONE FOUND_BY_ACCIDENT ENEMY is instantiated with the character princess. Princess was selected because she is already a character in the story and MEXICA is trying to reincorporate existing characters. This is indicated by the symbol **ReiCha** at the end of the line.

However, the action does not flow and MEXICA tries again to instantiate the action with another character in the story. Jaguar knight is chosen and this time the action flows (if jaguar knight finds by accident the enemy, i.e. if they are in the same location, the inferred Tension Potential Danger is triggered in the knight's context).

So, the sets of possible next actions look as follows.

**PRINCESS possible next actions: ****
 **JAGUAR_KNIGHT ATTACKED ENEMY**

**JAGUAR_KNIGHT possible next actions: ****
 **JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY**

**ENEMY possible next actions: ****
 **JAGUAR_KNIGHT FOUND_BY_ACCIDENT ENEMY**
 **ENEMY ATTACKED PRINCESS**

MEXICA selects randomly the action ENEMY ATTACKED PRINCESS producing the following context.

**CONTEXT *****
**** Time => 3 Action: enemy ATTACKED princess Tension: 60**
 **Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
 **Emotional Links =>**
 **JAGUAR_KNIGHT(+3,1):PRINCESS**
 **PRINCESS(-3,1):ENEMY**
 **JAGUAR_KNIGHT(-3,1):ENEMY**
 **Tensions =>**
 **Pr(PRINCESS):ENEMY**
 **Lr(PRINCESS):ENEMY+**
 **Pd(ENEMY):PRINCESS+**

 **Charac: JAGUAR_KNIGHT Pos: Texcoco Lake Status: Alive**
 **Emotional Links =>**
 **JAGUAR_KNIGHT(+3,1):PRINCESS**
 **PRINCESS(-3,1):ENEMY**
 **JAGUAR_KNIGHT(-3,1):ENEMY**
 **Tensions =>**
 **Pr(PRINCESS):ENEMY**

 **Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
 **Emotional Links =>**
 **PRINCESS(-3,1):ENEMY**
 **Tensions =>**
 **Pr(PRINCESS):ENEMY**
 **Lr(PRINCESS):ENEMY+**
 **Pd(ENEMY):PRINCESS+**

As a result of the postconditions, the Tension Lr(PRINCESS):ENEMY+ is added to the princess and enemy's contexts. Notice that all the Emotional Links triggered by the action (princess(-3,1):enemy and jaguar_knight(-3,1):enemy) already exists in the princess' context, so MEXICA does not duplicate them.

In the same way, the first Emotional Link in the postconditions is not duplicated in the enemy's context. However, with respect to the second one —that of the linked characters— because the enemy is not aware of the tie between the jaguar knight and the princess, his context does not register it.

Finally, because the jaguar knight is in a different location it does not register any of the postconditions triggered by the action.

Now MEXICA forms the Associative Structures and tries to retrieve possible next actions from memory.

**ASSOCIATIVE STRUCTURE *****
***** Time => 3 Action: enemy ATTACKED princess**
**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Pd(ENEMY):PRINCESS+**

**Charac: JAGUAR_KNIGHT Pos: Texcoco Lake Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**

**Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Pd(ENEMY):PRINCESS+**

**INDEXES *****
**PRINCESS: 10,15 ASIII-0 JAGUAR_KNIGHT: 1,7 ASI-50 ENEMY: 10,15 ASIII-0**

This time the Associative Structure formed from the princess' context cannot retrieve anything from memory. This is represented in the report by the symbol **ASIII-0** where the zero indicates that the structure did not match any atom. The Associative Structure of type I formed from the jaguar knight's context matched an atom in the position (1,7) which is 50% equal to it. Finally, the Associative Structure formed from the enemy's context also fails to retrieve anything from memory.

**PRINCESS possible next actions: ******

**JAGUAR_KNIGHT possible next actions: ******
**JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY**

**ENEMY possible next actions: ******

So, the only option available is used as the next action in the story. In this way, the story developed so far looks as follows.

*** NEW STORY:
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY

At this moment, the number of actions produced during the Engaged State is equal to the value of the constant which regulates the cycle between the Engaged and Reflective States (CtEg-Rf) which for this example has been set to three. So, MEXICA switches to the Reflective State to verify preconditions and evaluate the story.

***** Switching to Rf-S ...**
**R$ inserting JAGUAR_KNIGHT ACTOR Loc PRINCESS CURED JAGUAR_KNIGHT**
**R$ inserting PRINCESS ACTOR Pos PRINCESS CURED JAGUAR_KNIGHT**
**R$ inserting JAGUAR_KNIGHT HAD_AN_ACCIDENT Pre PRINCESS CURED JAGUAR_KNIGHT**
**R$ inserting PRINCESS AFFRONTED ENEMY Pre ENEMY ATTACKED PRINCESS**

**R$ Checking novelty: number of times a sequence happens in other stories**
**R$ Seq:1x1 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x0 Seq:6x0 Seq:7x0 Seq:8x0**
**R$ Adequate novelty: guideline set to LOW.**

**R$ Evaluating the Tensional Representations ...**
**R$ F1-R:4 F2-R:0 F3-R:5 F4-R:1 F5-R:3**
**R$ F6-R:3 F7-R:4**
**R$ Frame:3 PT:TDn Chances:1**

The symbol **R$** indicates the MEXICA is running under the Reflective State. To make the present explanation clearer, this section of the report is divided in three parts. The first is related to the process of checking preconditions, the second to the process of evaluating novelty, and the last one to the process of evaluating the Tensional Representation.

1)The first four lines contain information related to the process of checking preconditions.

**R$ inserting JAGUAR_KNIGHT ACTOR Loc PRINCESS CURED JAGUAR_KNIGHT**
**R$ inserting PRINCESS ACTOR Loc PRINCESS CURED JAGUAR_KNIGHT**
**R$ inserting JAGUAR_KNIGHT HAD_AN_ACCIDENT Pre PRINCESS CURED JAGUAR_KNIGHT**
**R$ inserting PRINCESS AFFRONTED ENEMY Pre ENEMY ATTACKED PRINCESS**

MEXICA detects that the preconditions of the first action in the tale PRINCESS CURED JAGUAR_KNIGHT are not fulfilled. Because jaguar knight intervenes in the preconditions and he is a new character (it is the first action in the story so there were no characters before) MEXICA inserts the actions PRINCESS ACTOR and JAGUAR_KNIGHT ACTOR to solve the location problem. This is indicated by the symbol **Loc** between the two actions in the first two lines.
MEXICA inserts the action JAGUAR_KNIGHT HAD_AN_ACCIDENT to satisfy the preconditions of PRINCESS CURED JAGUAR_KNIGHT. This is indicated in the report by the symbol **Pre** between

the two actions in the third line. Finally, the action PRINCESS AFFRONTED ENEMY is inserted to fulfil the preconditions of ENEMY ATTACKED PRINCESS.
Each time an action is inserted, MEXICA updates the characters' contexts with the consequences of such an action. In this way, when it switches back to the Engaged State all the contexts are properly updated. So, after all preconditions have been satisfied the story in progress looks as follows:

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
PRINCESS AFFRONTED ENEMY
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY

2)MEXICA now checks the novelty of the story in progress.

**R$ Checking novelty: number of times a sequence happens in other stories**
**R$ Seq:1x1 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x0 Seq:6x0 Seq:7x0 Seq:8x0**
**R$ Adequate novelty: guideline set to LOW.**

The second line in this part of the report indicates that the first sequence (i.e. the sequence JAGUAR_KNIGHT ACTOR / PRINCESS ACTOR) has occurred once in Previous Stories. This is represented by the symbol **Seq:1x1** where Seq:1 means *sequence one* and x1 means *appears once in previous stories*. The rest of the sequences have never occurred in the Previous Stories; this is indicated in the report by the symbol **x0** after the sequence number. In this way, the novelty of the story is classified as adequate and the guideline is set to Low.

3)Finally, MEXICA evaluates the Tensional Representation of the story in progress.

**R$ Evaluating the Tensional Representations ...**
**R$ F1-R:4 F2-R:0 F3-R:5 F4-R:1 F5-R:3 F6-R:3 F7-R:4**
**R$ Frame:3 PT:TDn Chances:1**

For this example there are seven tales in the file of Previous Stories, i.e. there are seven Tensional Representations or *frames* that MEXICA uses to compare the Tensional Representation of the story in progress with. (From now onwards all the Tensional Representations of the Previous Stories are referred as frames.) The result of the comparison of the first frame and the story in progress is four; this is represented in the report by the symbol **F1-R:4** where F1 means *comparing with the frame one* and -R:4 means *the result of the comparison is four*. The same applies for all the seven frames. The frame with the highest result is frame three, so MEXICA uses it to set the guidelines. Thus, the Permanent Tension is set to Tendency Down (TDn); because the frame and the Tensional Representation of the

story in progress are similar in more than 50%, the value of the Chances is not modified, i.e., it still has the value one.

Figures 5.1a to 5.1g show the frames of all the Previous Stories. Note that graphs are not drawn on the same scale (y-axis). Figure 5.2 compares the Tensional Representation of the story in progress against frame #2 (the frame with the lowest result) and frame #3 (the frame with the highest result).

**Fig. 5.1a Frame #1**

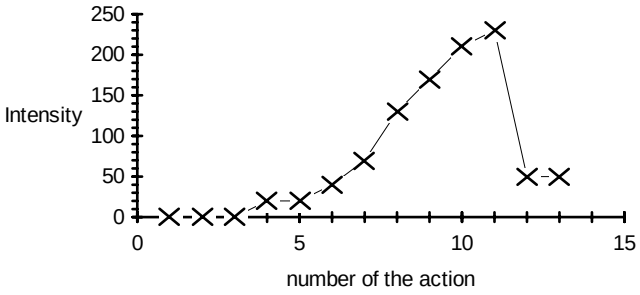



**Fig. 5.1b Frame #2**

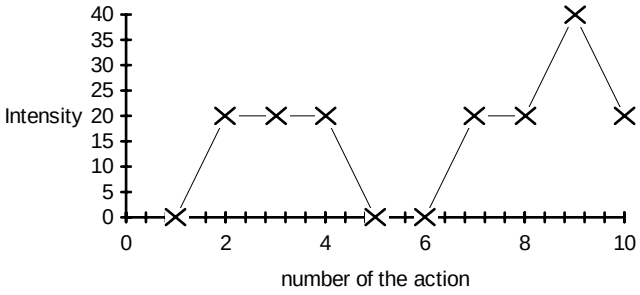



**Fig. 5.1c Frame #3**

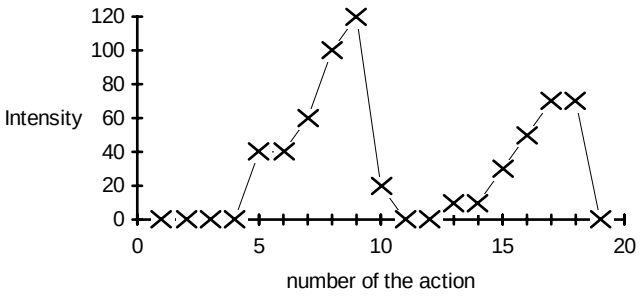


**Fig. 5.1d Frame #4**

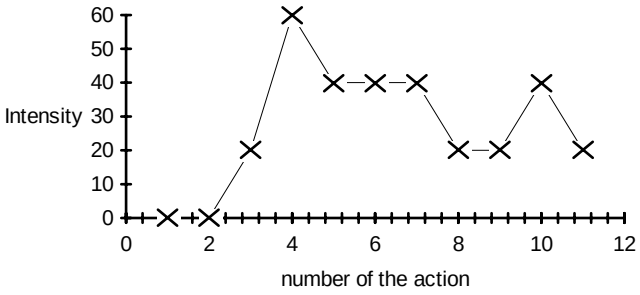



**Fig. 5.1e Frame #5**

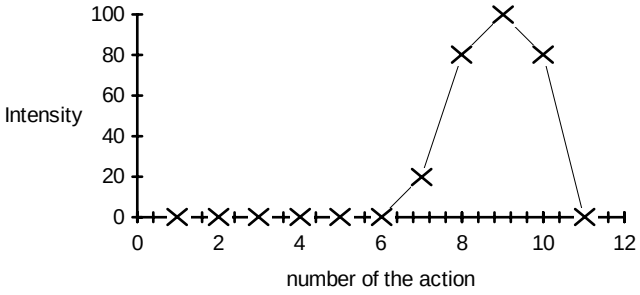



**Fig. 5.1f Frame #6**

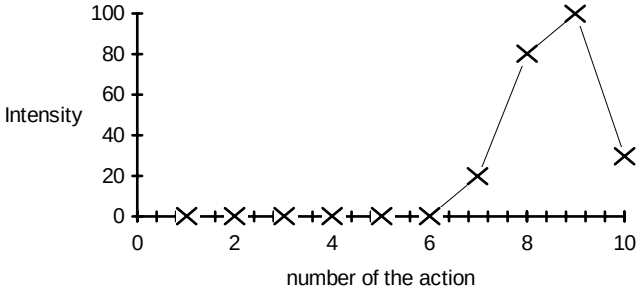


**Fig. 5.1g Frame #7**

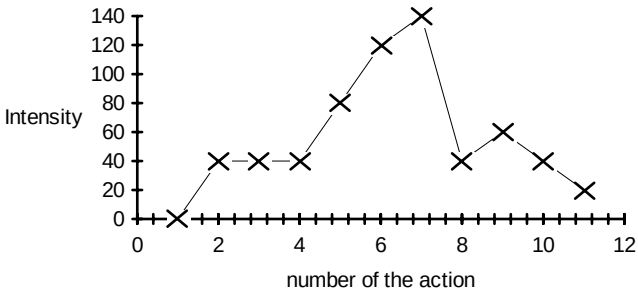
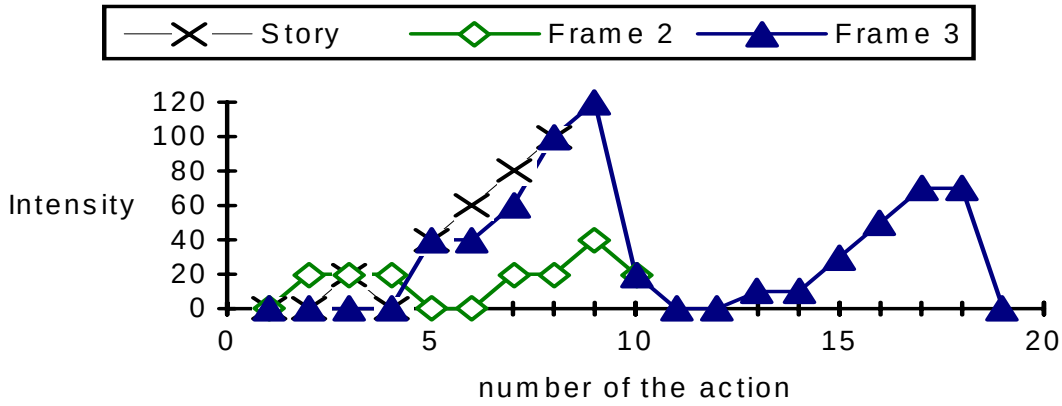



**Fig. 5.2 Comparing the Tensional Representations**




Once MEXICA finishes verifying preconditions and evaluating the story, it switches back to the Engaged State and updates the context with the last action selected.

***** Switching to Eg-S ...**
**CONTEXT *****
***** Time => 8 Action: jaguar_knight LOOKED_FOR_AND_FOUND enemy Tension: 100**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Pd(ENEMY):PRINCESS+**
**Pd(ENEMY):JAGUAR_KNIGHT+**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**ENEMY(-2,1):PRINCESS**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Pd(ENEMY):PRINCESS+**

**Pd(ENEMY):JAGUAR_KNIGHT+**
**Pd(PRINCESS):ENEMY+**

**Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**PRINCESS(-3,1):ENEMY**
**ENEMY(-2,1):PRINCESS**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Pd(ENEMY):PRINCESS+**
**Pd(PRINCESS):ENEMY+**

Notice that, because MEXICA inserted some actions to satisfy preconditions, the number representing the story-time in which the action LOOKED_FOR_AND_FOUND occurred has been updated to 8 (this is indicated in the report by **Time=>8**).

Here it is possible to observe how the actions inserted to satisfy the preconditions during the Reflective State have modified the characters' context. For example, the princess and the enemy added to their contexts the Emotional Link ENEMY(-2,1):PRINCESS triggered by the action PRINCESS AFFRONTED ENEMY. This new Emotional Link produces the inferred postcondition Pd(PRINCESS):ENEMY+ to be triggered increasing the Tension to the Reader.

Also, it is possible to see how MEXICA's routine to reduce Emotional Links works. The actions ENEMY KIDNAPPED PRINCESS and ENEMY ATTACKED PRINCESS trigger the same Emotional Link PRINCES(-3,1):enemy; to avoid an unmanageable number of elements in the context, MEXICA reduces it and just keeps one of them.

As a consequence of the action JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY the location of jaguar knight is set to Chapultepec Forest and the inferred postcondition Pd(ENEMY):JAGUAR_KNIGHT+ is triggered. Notice that the enemy's context does not register such inferred postcondition. The reason is that the enemy is not aware that the jaguar knight is a Linked Character to the princess, i.e. that jaguar knight also hates enemy because he kidnapped the princess. So, the enemy does not know of the potential danger of being in the same location as jaguar knight.

At this moment the value of the Tension to the Reader is 100. This value is calculated as follows. 60% comes from the tensions Pr(PRINCESS):ENEMY, Lr(PRINCESS):ENEMY+ and Pd(ENEMY):PRINCESS+ in the princess' context. 20% comes from Pd(ENEMY):JAGUAR_KNIGHT in the jaguar knight's context. Finally, the remaining 20% come from the tension Pd(PRINCESS):ENEMY+ in the enemy's context.

MEXICA creates new Associative Structures and tries to retrieve more possible next actions from memory.

**ASSOCIATIVE STRUCTURE *****
***** Time => 8 Action: jaguar_knight LOOKED_FOR_AND_FOUND enemy Tension: 100**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**

**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Pd(ENEMY):PRINCESS+**
**Pd(ENEMY):JAGUAR_KNIGHT+**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Pd(ENEMY):PRINCESS+**
**Pd(PRINCESS):ENEMY+**
**Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Pd(ENEMY):PRINCESS+**
**Pd(PRINCESS):ENEMY+**

**INDEXES *****
**JAGUAR_KNIGHT: 3,7 ASI-60 PRINCESS: 10,15 ASIII-0 ENEMY: 10,15 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ******
**JAGUAR_KNIGHT ATTACKED ENEMY**

**PRINCESS possible next actions: ******

**ENEMY possible next actions: ******

**E$ JAGUAR_KNIGHT ATTACKED ENEMY was not deleted because 1 chances left.**

The only option retrieved from memory is JAGUAR_KNIGHT ATTACKED ENEMY. But there is a problem with it; this option does not fulfil the tensional requirements set by the guidelines. Such requirements specify a tendency to go down in the value of the Tension to the Reader and the action ATTACKED increments such a tension. However, the guidelines also establish a chance (or flexibility) of one, so the action is not eliminated. This is indicated in the report by the line **E$ JAGUAR_KNIGHT ATTACKED ENEMY was not deleted because 1 chances left.**

**CONTEXT *****
***** Time => 9 Action: jaguar_knight ATTACKED enemy Tension: 140**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**ENEMY(-3,1):JAGUAR_KNIGHT**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(ENEMY):JAGUAR_KNIGHT+**
**Pd(ENEMY):PRINCESS+**
**Pd(ENEMY):JAGUAR_KNIGHT+**
**Pd(JAGUAR_KNIGHT):ENEMY+**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**

**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**ENEMY(-2,1):PRINCESS**
**ENEMY(-3,1):JAGUAR_KNIGHT**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Lr(ENEMY):JAGUAR_KNIGHT+**
**Pd(ENEMY):PRINCESS+**
**Pd(ENEMY):JAGUAR_KNIGHT+**
**Pd(PRINCESS):ENEMY+**
**Pd(JAGUAR_KNIGHT):ENEMY+**

**Charac: ENEMY Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**PRINCESS(-3,1):ENEMY**
**ENEMY(-2,1):PRINCESS**
**ENEMY(-3,1):JAGUAR_KNIGHT**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Lr(ENEMY):JAGUAR_KNIGHT+**
**Pd(ENEMY):PRINCESS+**
**Pd(PRINCESS):ENEMY+**
**Pd(JAGUAR_KNIGHT):ENEMY+**

The postconditions triggered by the action are added to all characters' contexts. The Tension to the Reader rises to 140 due to the tensions Lr(ENEMY):JAGUAR_KNIGHT+ and the inferred postcondition Pd(JAGUAR_KNIGHT):ENEMY+.

MEXICA creates the Associative Structures and searches memory.

**ASSOCIATIVE STRUCTURE ***
***** Time => 9 Action: jaguar_knight ATTACKED enemy Tension: 140**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**ENEMY(-3,1):JAGUAR_KNIGHT**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(ENEMY):JAGUAR_KNIGHT+**
**Pd(ENEMY):PRINCESS+**
**Pd(ENEMY):JAGUAR_KNIGHT+**
**Pd(JAGUAR_KNIGHT):ENEMY+**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Lr(ENEMY):JAGUAR_KNIGHT+**
**Pd(ENEMY):PRINCESS+**
**Pd(PRINCESS):ENEMY+**

**Charac: ENEMY Pos: Chapultepec Forest Status: Alive**

**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Lr(PRINCESS):ENEMY+**
**Lr(ENEMY):JAGUAR_KNIGHT+**
**Pd(ENEMY):PRINCESS+**
**Pd(PRINCESS):ENEMY+**
**Pd(JAGUAR_KNIGHT):ENEMY+**

**INDEXES *****
**JAGUAR_KNIGHT: 5,8 ASI-69 PRINCESS: 10,15 ASIII-0 ENEMY: 10,15 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ******
**JAGUAR_KNIGHT FOUGHT ENEMY**

**PRINCESS possible next actions: ******

**ENEMY possible next actions: ******

***** FILTER JAGUAR_KNIGHT FOUGHT ENEMY Ten(GLn:TnDn)-**

Like in the previous action, MEXICA just retrieves one possible next action from memory. It does not fulfil the requirements established by the guidelines and it is deleted since there are no chances left. The symbol **Ten(GLn:TnDn)-** at the right end of the line indicates that the actions was deleted because it did not fulfil the tensional requirement (Ten) and it shows that the guidelines (GLn) are set to tendency down (TnDn).

So, MEXICA tries again to retrieve possible next actions.

**Trying again *****
**INDEXES *****
**JAGUAR_KNIGHT: 6,8 ASI-64 PRINCESS: 10,15 ASIII-0 ENEMY: 10,15 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ******
**JAGUAR_KNIGHT KILLED ENEMY**

**PRINCESS possible next actions: ******

**ENEMY possible next actions: ******

This time MEXICA brings to working memory the action JAGUAR_KNIGHT KILLED ENEMY. As it can be observed in the context, almost all the tensions in the story are linked to the enemy; so, if the enemy dies all those tensions disappear decreasing the value of the Tension to the Reader. In this way, this action fulfils the requirements of Tendency Down established by the guidelines. Also notice that in MEXICA, when someone kills the character enemy, the Tension to the Reader is not incremented.

So, the action is selected producing the following context:

**CONTEXT *****
***** Time => 10 Action: jaguar_knight KILLED enemy Tension: 20**

**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

Associative Structures are created in order to try to retrieve some actions from memory. Since the enemy is dead, he no longer has a context.

**ASSOCIATIVE STRUCTURE ***
***** Time => 10 Action: jaguar_knight KILLED enemy Tension: 20**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**Tensions =>**
**Pr(PRINCESS):ENEMY**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Pr(PRINCESS):ENEMY**

**Charac: ENEMY Pos: NoWhere Status: Dead**

**INDEXES ***
**JAGUAR_KNIGHT: 2,7 ASI-56 PRINCESS: 10,15 ASIII-0 ENEMY: 0,0 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ****
**JAGUAR_KNIGHT RESCUED PRINCESS**

**PRINCESS possible next actions: ****

**ENEMY possible next actions: ****

MEXICA is able to retrieve just one option from memory. It fulfils the requirements established by the guidelines, so it is used as the next action in the story.

Taking this last action into account, the story created so far looks as follows:

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
PRINCESS AFFRONTED ENEMY
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS

MEXICA detects that three new actions have been joined to the story since the last time it switched to the Reflective State, so the system switches back to it again.

***** Switching to Rf-S ...**
**R$ Checking novelty: number of times a sequence happens in other stories**
**R$ Seq:1x1 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x0 Seq:6x0 Seq:7x0 Seq:8x1 Seq:9x0 Seq:10x1 Seq:11x0**
**R$ Adequate novelty: guideline set to LOW.**
**R$ Evaluating the Tensional Representations ...**
**R$ The frame number 2 is smaller than the story in progress.**
**R$ The frame number 6 is smaller than the story in progress.**
**R$ F1-R:3 F3-R:8 F4-R:1 F5-R:6 F7-R:7**
**R$ Frame:3 PT:TUp Chances:1**

In this occasion all preconditions in the story are fulfilled, so no action is inserted. Regarding novelty, just sequences one, eight and ten have occurred in Previous Stories. Thus, the story is classified as having an adequate novelty and the guideline is set to Low.

Regarding the Tensional Representation, the story in progress has reached eleven actions, i.e. it is bigger than tales number two and six in the file of Previous Stories. As a result, the Tensional Representations of such tales cannot be used any more as frames to be compared with the story in progress. This situation is indicated in the report by the line **R$ The frame number 2 is smaller than the story in progress** and the line **R$ The frame number 6 is smaller than the story in progress**. The following line in the report indicates which frames have been used to compare the story with and the result of the comparison.

Again, the most similar frame to the story in progress is number three which is the one used to set the Guidelines. This time, however, the Permanent Tension is set to Tendency Up (this is indicated in the report by **PT:TUp**).

Now MEXICA switches back to the Engaged State.

***** Switching to Eg-S ...**
**CONTEXT *****
***** Time => 11 Action: jaguar_knight RESCUED princess Tension: 0**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**

**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

As a consequence of this action the Tension Pr(PRINCESS):ENEMY is eliminated, and the Emotional Links PRINCESS(+3,1):JAGUAR_KNIGHT and JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT are added to both characters' context. This last Emotional Link represents a special case. One of the postconditions in the action RESCUED is that the Linked Characters to the princess establish an Emotional Link towards the character who rescued her (this is represented as LPRINCESS(%,1):JAGUAR_KNIGHT). In this case, the character that rescued the princess (i.e. jaguar knight) is also a linked character to her; so the consequence of the action is that jaguar knight develops a positive Emotional Link towards himself.

New Associative Structures are created and a search in memory launched.

**ASSOCIATIVE STRUCTURE ***
***** Time => 11 Action: jaguar_knight RESCUED princess Tension: 0**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

**INDEXES ***
**JAGUAR_KNIGHT: 1,9 ASI-60 PRINCESS: 1,10 ASI-55 ENEMY: 0,0 ASIII-0**

Two possible next actions are retrieved from memory.

**JAGUAR_KNIGHT possible next actions: ****
**PRINCESS REALISED**

**PRINCESS possible next actions: ****
**PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT**

**ENEMY possible next actions: ****

**** FILTER PRINCESS REALISED**

The filters eliminate the compound action and the remaining action works as the next action in the story.

**CONTEXT ***
**** Time => 12 Action: princess FELL_IN_LOVE jaguar_knight Tension: 0**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**PRINCESS(+3,2):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**PRINCESS(+3,2):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

This action triggers PRINCESS(+3,2):JAGUAR_KNIGHT. In this way, the princess has two different Emotional Links towards jaguar knight; on one hand she loves him (type 1) because he rescued her, and on the other hand she has fallen in love with him (type 2). Because the links are different types MEXICA does not reduce them.

The Associative Structures are created and the search in memory fired.

**ASSOCIATIVE STRUCTURE *****
***** Time => 12 Action: princess FELL_IN_LOVE jaguar_knight Tension: 0**
**Charac: JAGUAR_KNIGHT Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**PRINCESS(+3,2):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**JAGUAR_KNIGHT(+3,1):PRINCESS**
**PRINCESS(-3,1):ENEMY**
**JAGUAR_KNIGHT(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**PRINCESS(+3,2):JAGUAR_KNIGHT**
**JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

**INDEXES *****
**JAGUAR_KNIGHT: 1,9 ASI-70 PRINCESS: 2,11 ASI-54 ENEMY: 0,0 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ******
**PRINCESS REALISED**

**PRINCESS possible next actions: ******
**PRINCESS LOOKED_FOR_AND_FOUND ANYONE**
**PRINCESS KILLED ANYONE**

**ENEMY possible next actions: ******

***** FILTER PRINCESS REALISED**
**E$ instantiating PRINCESS LOOKED_FOR_AND_FOUND JAGUAR_KNIGHT ReiCha**
**E$ Instantiated action does not flow ( NoFlow-); trying again.**
**E$ instantiating PRINCESS LOOKED_FOR_AND_FOUND LADY PSt-**
***** FILTER PRINCESS LOOKED_FOR_AND_FOUND LADY NoFlow-**
**E$ instantiating PRINCESS KILLED JAGUAR_KNIGHT ReiCha**

Three possible next actions are brought to working memory. The first is a compound action, which is deleted by the filters. The second is instantiated by MEXICA reintroducing one of the characters from the story. However, the action does not flow because the princess and the jaguar knight are already in the same location. So, MEXICA tries to instantiate the action copying the way it has been instantiated in Previous Stories using the class group; however, again the action does not flow and it is deleted by the filters. Finally, the last possible action is instantiated reincorporating the character jaguar knight; this action flows and, as the only option available, it is used as the next action in the story.

**CONTEXT ***
*** Time => 13 Action: princess KILLED jaguar_knight Tension: 30**
**Charac: JAGUAR_KNIGHT Pos: NoWhere Status: Dead**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**PRINCESS(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**PRINCESS(+3,2):JAGUAR_KNIGHT**
**PRINCESS(-3,1):PRINCESS**
**Tensions =>**
**Ad(ENEMY):JAGUAR_KNIGHT**
**Ad(JAGUAR_KNIGHT):PRINCESS**

**Charac: ENEMY Pos: NoWhere Status: Dead**

At this point the story has taken a 'strange' direction; the princess fell in love with jaguar knight and then she killed him. This apparent incongruity will be resolved later; at the moment MEXICA is busy generating actions. Observe that the princess' context now includes the Emotional Link PRINCESS(-3,1):PRINCESS, i.e. the princess hates herself as a consequence of killing the jaguar knight.

New possible next actions are again retrieved from long-term memory:

**ASSOCIATIVE STRUCTURE ***
*** Time => 13 Action: princess KILLED jaguar_knight Tension: 30**
**Charac: JAGUAR_KNIGHT Pos: NoWhere Status: Dead**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Ad(JAGUAR_KNIGHT):PRINCESS**

**Charac: ENEMY Pos: NoWhere Status: Dead**

**INDEXES ***
**JAGUAR_KNIGHT: 0,0 ASIII-0 PRINCESS: 10,15 ASIII-0 ENEMY: 0,0 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ****

**PRINCESS possible next actions: ****

**ENEMY possible next actions: ****

**** Impasse : Engage-State with evaluation ...**

No possible next actions are brought to working memory and an impasse is declared. MEXICA switches to the Reflective State in order to try to break the impasse.

**** Switching to Rf-S ...**

**R$ inserting PRINCESS DISCOVERED_MURDER_OF JAGUAR_KNIGHT Pre PRINCESS KILLED JAGUAR_KNIGHT**

MEXICA detects that some preconditions have not been fulfilled and inserts an action to satisfy them. The process works as follows. MEXICA retrieved from memory the action PRINCESS KILLED JAGUAR_KNIGHT which (at least at the moment) does not make any sense at all. Thus, it is necessary to insert an action to explain the killing event. MEXICA justifies the princess' behaviour (i.e. fulfils the preconditions) by inserting the action **PRINCESS DISCOVERED_MURDER_OF JAGUAR_KNIGHT** (this action represents that the princess realises that the knight murdered someone she loves). In this way the coherence problem, i.e. the preconditions problem, is resolved.

So, the story developed so far looks as follows:

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
PRINCESS AFFRONTED ENEMY
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
PRINCESS DISCOVERED_MURDER_OF JAGUAR_KNIGHT
PRINCESS KILLED JAGUAR_KNIGHT

Now, MEXICA switches back to the Engaged State to verify if the actions inserted help to break the impasse. That is, the consequences of the actions inserted might have modified the characters' context in such a way that the Associative Structures are perhaps now able to match an atom in long-term memory.

***** Switching to Eg-S ...**
**CONTEXT *****
***** Time => 14 Action: princess KILLED jaguar_knight Tension: 70**
**Charac: JAGUAR_KNIGHT Pos: NoWhere Status: Dead**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Emotional Links =>**
**PRINCESS(-3,1):ENEMY**
**PRINCESS(+3,1):JAGUAR_KNIGHT**
**PRINCESS(-3,1):JAGUAR_KNIGHT**
**PRINCESS(+3,2):JAGUAR_KNIGHT**
**PRINCESS(-3,1):PRINCESS**
**Tensions =>**

**Ad(ENEMY):JAGUAR_KNIGHT**
**Ad(JAGUAR_KNIGHT):PRINCESS**
**Ce(PRINCESS):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

A Tension due to Clashing Emotions has been added in the princess' context. When the princess realises that the knight is the murder of someone she loves the Emotional Link PRINCESS(-3,1):JAGUAR_KNIGHT is triggered. As a consequence, when the inferred postconditions are verified, MEXICA detects that the princess has contradictory (or clashing) Emotional Links towards jaguar knight. In this way, the Tension Ce(PRINCESS):JAGUAR_KNIGHT is also triggered.

So, MEXICA forms the Associative Structure from the princess' context and verifies if the impasse is broken, i.e. it tries again to retrieve possible next actions from memory.

**ASSOCIATIVE STRUCTURE ***
***** Time => 14 Action: princess KILLED jaguar_knight Tension: 70**
**Charac: JAGUAR_KNIGHT Pos: NoWhere Status: Dead**

**Charac: PRINCESS Pos: Chapultepec Forest Status: Alive**
**Tensions =>**
**Ad(JAGUAR_KNIGHT):PRINCESS**
**Ce(PRINCESS):JAGUAR_KNIGHT**

**Charac: ENEMY Pos: NoWhere Status: Dead**

**INDEXES ***
**JAGUAR_KNIGHT: 0,0 ASIII-0 PRINCESS: 10,15 ASIII-0 ENEMY: 0,0 ASIII-0**

**JAGUAR_KNIGHT possible next actions: ****

**PRINCESS possible next actions: ****

**ENEMY possible next actions: ****

***** Impasse : Engage-State with evaluation ...**

However, nothing is brought to working memory so, MEXICA switches back to the Reflective State to try to break the impasse.

***** Switching to Rf-S ...**
***** Breaking an impasse.**
**R$ Attempting to select a next action...**
**R$ Deleting ANYONE REALISED**
**R$ Action selected: PRINCESS EXILED PRINCESS**
**R$ Action selected does not flow (NoFlow-); trying again.**
**R$ Attempting to select a next action...**
**R$ Action selected: PRINCESS KILLED PRINCESS**
***** R$ Impasse BROKEN...**

MEXICA groups all those actions which in Previous Stories have followed the action KILLED, deletes all compound actions in such a group and selects one of them randomly. In this case PRINCESS

EXILED PRINCESS is chosen; however, as the reports indicates, this action does not flow and a new one is selected. In the second attempt the action PRINCESS KILLED PRINCESS is chosen, it flows, so the impasse broken.

After the impasse has been broken the story is evaluated again.

**R$ Checking novelty: number of times a sequence happens in other stories**
**R$ Seq:1x1 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x0 Seq:6x0 Seq:7x0 Seq:8x1 Seq:9x0 Seq:10x1 Seq:11x1 Seq:12x0 Seq:13x0 Seq:14x1 Seq:15x2**
**R$ Adequate novelty: actual value is LOW**
**R$ Evaluating the Tensional Representations ...**
**R$ The frame number 1 is smaller than the story in progress.**
**R$ The frame number 2 is smaller than the story in progress.**
**R$ The frame number 4 is smaller than the story in progress.**
**R$ The frame number 5 is smaller than the story in progress.**
**R$ The frame number 6 is smaller than the story in progress.**
**R$ The frame number 7 is smaller than the story in progress.**
**R$ F3-R:9**
**R$ Frame:3 PT:TDn Chances:1**
**==> End of Story: All characters are dead.**

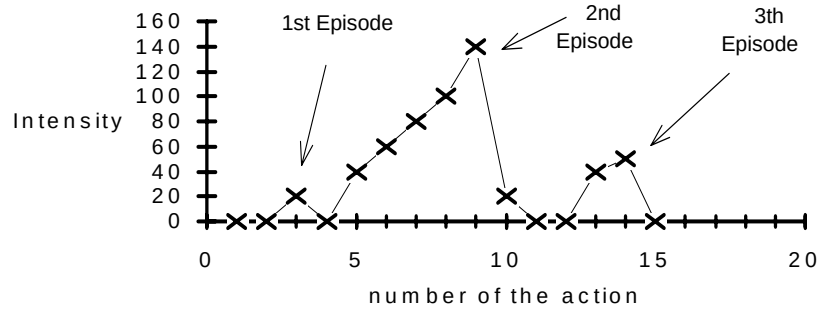
Regarding novelty, the story is classified as adequate and the Novelty Guideline set to Low. Regarding the Tensional Representation, the story in progress is bigger than all Previous Stories except story number three. So, again frame three is used to set the Tensional Guidelines. However, MEXICA detects that all characters in the story are dead and it finishes the story.

So, the story created by MEXICA is:

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
PRINCESS AFFRONTED ENEMY
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
PRINCESS DISCOVERED_MURDER_OF JAGUAR_KNIGHT
PRINCESS KILLED JAGUAR_KNIGHT
PRINCESS KILLED PRINCESS

The final graphic of the Tensional Representation looks as follows:

Fig. 5.3 Tensional Representation




Now, MEXICA performs the Final Analysis and inserts three new actions. After the event where the knight has the accident, MEXICA inserts HEALTH_RISK_1 to indicate that the princess has decided to cure the knight. After the kidnapping, the action PR_FREE_1 is inserted to indicate that the knight has decided to rescue the princess. Finally, after the princess discovers that the knight murdered her father, the action CLASH_EMOTION_1 is inserted to indicate the princess' contradictory feelings towards the knight.

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS *HEALTH_RISK_1* JAGUAR_KNIGHT
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
JAGUAR_KNIGHT *PR_FREE_1* PRINCESS
PRINCESS AFFRONTED ENEMY
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
PRINCESS DISCOVERED_MURDER_OF JAGUAR_KNIGHT
PRINCESS *CLASH_EMOTION_1* JAGUAR_KNIGHT
PRINCESS KILLED JAGUAR_KNIGHT
PRINCESS KILLED PRINCESS

Finally, MEXICA gets from the Primitive Actions Structure all the texts associated to the Primitive Actions and prints the final version of the story. That is the version that the reader found at the beginning of this chapter.

## 5.3 Analysis of the story.

*The princess who cured the jaguar knight* is a good example of the kind of story that MEXICA develops as a result of the interaction between the Engaged and Reflective States. This story is clearly the result of teamwork between states; eight actions were produced during the engagement (actions number 6, 9, 10, 11, 12, 13, 14, 17) and nine during reflection (1, 2, 3, 4, 7, 8, 15, 16, 18; action number five was the initial one). MEXICA starts to develop the story producing material under the Engaged State. Then, it switches to the Reflective State where the story is modified to satisfy preconditions, and the guidelines are set according to the result of the analysis and comparison between the story in progress and the Previous Stories. It switches back to the Engaged State where new material is produced following the requirements specified by the guidelines. It regularly returns to the Reflective State where the guidelines are updated based on the new material produced. MEXICA goes back to the Engaged State to produce more material and, when an impasse is declared, it switches to the Reflective State, breaks the impasse and ends the story.
So, during the Reflective State MEXICA sets the value of the guidelines based on the analysis of the material produced during the Engaged State. On the other hand, during the Engaged State MEXICA produces material following the guidelines set during the Reflective State.

In the following paragraphs, some important aspects of the development of the story are analysed.

### 5.3.1 Lack of Possible Next Actions.

In the example story, actions 10 to 13 are included in the story because they are the only possible next actions retrieved from long-term memory.

(Act 10) JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
(Act 11) JAGUAR_KNIGHT ATTACKED ENEMY
(Act 12) JAGUAR_KNIGHT KILLED ENEMY
(Act 13) JAGUAR_KNIGHT RESCUED PRINCESS

That is, MEXICA only knows one way to continue the story when the enemy kidnaps the princess. The reason why this situation arises can be explained through an example based on an experience of the author of this work. If some years ago someone had asked this author to write a short story (about any topic) where a particular scene required a detailed description of a deserted beach, such a description would have included a very sunny and warm beach full of sand. Some years ago that was the only coherent, possible description which could have been retrieved from the author's mind; or in other words, that was the only kind of beach he knew. The reader can imagine how shocking was for the writer of these lines his first visit to Brighton. It was a real experience to discover that, cold beaches full of pebbles also exist!

Something analogous happens to MEXICA in this story. The information encoded in the Abstract Representation, including all possible next actions, comes exclusively from the file of Previous Stories. So, the potential directions that a story written by MEXICA can take depend on the number of choices provided by such Previous Stories. In this example, MEXICA can just retrieve one sequence of actions when the enemy kidnaps the princess. If new stories with alternative next actions are added to the Previous Stories, MEXICA will be able to retrieve different options from long-term memory. These new alternatives must satisfy genre constraints. Genre constraints prevent the system from including unacceptable possible next actions in a story. For instance "Jaguar Knight washed his sucks" might well be a possible next action; only genre constraints make it unacceptable. MEXICA utilises the filters to verify these type of constraints.

### 5.3.2 The ACAS-Process and the Development of the Story.

For this particular example, all Associative Structures which retrieved sets of possible next actions from long-term memory belong to Type I. That is, MEXICA was not able to match atoms with Associative Structures of Type II or III. So, this example does not show the utility of Dynamic Structures. However, the significance of the ACAS-Process can be observed through the whole example. Seven of the eight actions chosen as the next event in the story during the Engaged State were brought into working memory through the ACAS-Process. And twelve of the 14 sets of possible next actions retrieved during the development of the tale were brought into working memory in the same way.

The ACAS-Constant plays an important role in the development of the tale. For example, in four of those twelve sets of possible next actions the atom matched was equal to the Associative Structure in 50%; in seven, the atom matched was equal to the Associative Structure in less than 57%; and in ten such a similarity was under 65%. These data evidence the strong relation between the evolution of the story and the value of the ACAS-Constant (particularly in the range from 50% to 65%). For example, if such a constant is modified in one point (i.e. to 51%) MEXICA can no longer reproduce the story under analysis since the atom which contains the action ANYONE KIDNAPPED PRINCESS cannot be matched (see the analysis of the first context produced in the story in section 5.2 and the example in section 5.4.1).

### 5.3.3 An Example of an Action Retrieved Through the ACAS-Process.

There is a peculiar moment in the development of the tale when, after the knight rescues the princess and she falls in love with him (during the production of material in the Engaged State), the story seems to take a senseless direction.

JAGUAR_KNIGHT RESCUED PRINCESS

PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
PRINCESS KILLED JAGUAR_KNIGHT

An action which (at least at that moment) does not have any connection with the previous events in the story and which appears to be completely illogical (PRINCESS KILLED JAGUAR_KNIGHT) is chosen as the next event in the tale.

This situation arises as a result of the ACAS-Process and the value of the ACAS-Constant. By default at least 50% of the atom must be equal to the Associative Structure. MEXICA matches an atom that fulfils this condition in the position (2,11). The Associative Structure used to match that atom, and a comparison between the original atom and the same atom after being instantiated is now presented (see also in Appendix E the report of the Abstract Representation produced by the Previous Stories).

Associative Structure.
Charac: PRINCESS
Emotional Links =>
JAGUAR_KNIGHT(+3,1):PRINCESS
PRINCESS(-3,1):ENEMY
JAGUAR_KNIGHT(-3,1):ENEMY
PRINCESS(+3,1):JAGUAR_KNIGHT
PRINCESS(+3,2):JAGUAR_KNIGHT
JAGUAR_KNIGHT(+2,1):JAGUAR_KNIGHT
Tensions =>
Ad(ENEMY):JAGUAR_KNIGHT

| Original Atom | Atom after been instantiated |
|---|---|
| Tension: 2 EmoLin: 11 | Tension: 2 EmoLin: 11 |
| EmoLin=> | EmoLin=> |
| A(+3,1):C | jaguar_knight(+3,1):princess |
| B(+3,1):C | B(+3,1):princess |
| C(-3,1):D | princess(-3,1):enemy |
| A(-3,1):D | jaguar_knight(-3,1):enemy |
| B(-3,1):D | B(-3,1):enemy |
| C(+3,1):A | princess(+3,1):jaguar_knight |
| C(+3,2):A | princess(+3,2):jaguar_knight |
| A(+2,1):A | jaguar_knight(+2,1):jaguar_knight |
| B(+2,1):A | B(+2,1):jaguar_knight |
| B(+3,2):A | B(+3,2):jaguar_knight |
| A(+3,2):B | jaguar_knight(+3,2):B |
| Tension=> | Tension=> |
| Ad(D):A | Ad(enemy):jaguar_knight |
| Lc(C):B | Lc(princess):B |
| NexAct=> | NexAct=> |
| c LOOKED_FOR_AND_FOUND b | princess LOOKED_FOR_AND_FOUND b |
| c KILLED b | princess KILLED b |

This atom encodes the context produced after the following sequence of actions in tale number three in the file of Previous Stories were executed (see Appendix D for a list of the Previous Stories):

PRINCESS REALISED EAGLE_KNIGHT WERE_IN_LOVE_WITH LADY
PRINCESS LOOKED_FOR_AND_FOUND LADY

The action which follows this sequence (and which becomes one of the possible next actions in the atom) is PRINCESS KILLED LADY. Although this atom encodes the context of a scene different to the actual context of the story in progress, MEXICA recognises enough similarities between them and matches the atom. This makes sense since both stories share a similar prior episode (an enemy who kidnaps the princess and a knight who rescues her). So, it is not strange that at least 50% of the atom is equal to the Associative Structure. However, the circumstances surrounding the action where the princess kills the Lady (in the tale in the Previous Stories) are completely different to the circumstances when the princess kills jaguar knight.
In the former case, a Tension due to a Love Competition between the princess and the Lady causes the murder of the Lady; in the latter case there is not a reason to justify the action.

So, what it is happening here is that, based on the similarities detected between the atom and the Associative Structure, and as a result of the instantiation process, MEXICA identifies as a coherent possible next action in the story the killing of the knight by the princess. Is this a mistake in the design of the system? No; after all it is the episode unfolded from the incongruous princess' conduct that at the end gives the originality to the story. What this situation shows is the importance of an adequate value for the ACAS-Constant. A high value produces actions which fix well in the story, but which are very predictable. A low value produces novel situations; however, as this example demonstrates, they might require that MEXICA sorts out a way to link previous events in the story with that particular situation. If they are completely unrelated to the context of the story in progress, MEXICA might not be able to sort this situation out.

### 5.3.4 Instantiating the Action.

The process followed to obtain such an event includes another step. When MEXICA matches the atom, what it retrieves is the action PRINCESS KILLED ANYONE. That is, it is necessary to instantiate it. And as the examples in section 5.4.2 shows, the character chosen to instantiate the action can affect the direction that a story takes.

**E$ instantiating PRINCESS KILLED JAGUAR_KNIGHT ReiCha**

In this case, the parameter Forbidden Actors is set to Half-Active which allows reincorporating the character jaguar knight in the action. And it is at this moment when MEXICA produces the novel action.

The following paragraphs describe the role of such an instantiation process in the production of new actions.

Atoms have a strong relation between the characters in the body of the atom (i.e. the characters included in the Tensions and Emotional Links) and the characters in the set of possible next actions. For instance, in the atom matched in this example it is possible to observe a Tension due to Love Competition between characters C and B and, as one of the possible next actions, the same character C killing B.

Now, when the characters in the atom are substituted with those in the Associative Structure, B cannot be correlated to any of them (the correlation between characters is established as follows: A-jaguar_knight, B-?, C-princess, D-enemy)

This brings a problem; the victim of the murder must be someone who has a love competition with the princess, but no one in the Associative Structure (and in the story in progress) fulfils this requirement. That is the reason why when PRINCESS KILLED JAGUAR_KNIGHT is selected it looks out of context. In the original setting the princess kills her rival, not the man she is in love with.

MEXICA has three alternative solutions to instantiate actions in this situation; reincorporate characters, choose a character based on the Group Class and Previous Stories, or select one randomly. As mentioned earlier, for this example MEXICA reincorporates a character.

The relevant point to observe here is how the combination of the ACAS-Process and the instantiation process generates a unique situation. MEXICA retrieves an action that is not very well connected with the rest of the story; however, for the way it is instantiated, that action opens a new range of possibilities for the story to move forwards. In this case, by reincorporating jaguar knight MEXICA modifies the dynamic between the characters producing a situation not present in any of the tales in the file of Previous Stories (a princess killing her lover). If the action had been instantiated in a different way, this unique situation never would have been arisen.

So, MEXICA produces a novel event that gives an unexpected twist to the story. Such an event is not the consequence of a random procedure, a routine written with the specific goal to achieve this scene, or predefined story-structures; it is the result of general retrieval and instantiation processes that are able to construct a story-context not present in the Previous Stories. These general routines give MEXICA enough flexibility to produce novel situations in different contexts.

### 5.3.5 Preconditions.

This example clearly shows the role and importance of preconditions in MEXICA. They are not taken into consideration during the production of material in the Engaged State; however, during the Reflective State they play a central part to maintain the logic in the story. This characteristic allows the material produced during engagement to escape from the rigidity imposed by the requirement of satisfying an action's preconditions before they can be used. But at the same time it permits, through a

precondition verification process run each time MEXICA switches to the Reflective State, to corroborate and correct the consistency of the story in progress.
Thus, during the Engaged State a new situation is made up and during the Reflective State a link between the previous events in the story and the new action is developed. In this way, both states work together to produce novelty while the Reflective State preserves the consistency in the story.

### 5.3.6 The Importance of Flowing.

The process that verifies if an action flows is one of the most frequently used routines during story development. It is utilised both during the Engaged and the Reflective States, which evidences its importance. Through this example there are different instances of the way it helps to keep the story moving. For example, after the action PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT is performed, MEXICA retrieves PRINCESS LOOKED_FOR_AND_FOUND ANYONE as one of the possible next actions.

**E$ instantiating PRINCESS LOOKED_FOR_AND_FOUND JAGUAR_KNIGHT ReiCha**
**E$ Instantiated action deleted ( NoFlow-); trying again.**

MEXICA attempts to instantiate the action reincorporating the character jaguar knight, but it is rejected because it does not flow. And of course such an action cannot make the story flow because the princess is already in the same location as the jaguar knight. That is, to introduce an action where the princess looks for and finds jaguar knight does not make much sense in a story where both characters are already in the same place. So, the option is deleted and an incongruity avoided through the verification of the flowing of an action.
It can be argued that MEXICA should be able to sort out this impropriety in the same way it does when the princess kills the jaguar knight (also, one of the possible next actions retrieved at that moment). However, there is an important difference between those two actions. MEXICA knows that if the princess kills the jaguar knight the Tension to the Reader increases, so the story moves on. By contrast, the action LOOK_FOR_AND_FOUND just produces a change in location; in MEXICA a change in location (which does not modify Emotional Links or Tensions) has a low probability of leading to some interesting sequence of actions. Nevertheless, the function of this process is to make sure the story flows, not to avoid incongruousness (that is the work of the precondition verification process); this extra help that the process provides to keep the logic in the story is a side effect and it is subordinated to the condition of making the story move.

So, in general terms during the Engaged State MEXICA makes the story flow and during the Reflective State MEXICA connects coherently the different events happening in the tale.

### 5.3.7 Guidelines.

MEXICA starts the story development under the Engaged State; so all the guidelines are set to their default values: Permanent Tension to TendencyUp and Novelty to Low. After three actions have been generated MEXICA switches to the Reflective State to evaluate the story in progress.

**R$ Adequate novelty: guideline set to LOW.**
**R$ Evaluating the Tensional Representations ...**
**R$ F1-R:4 F2-R:0 F3-R:5 F4-R:1 F5-R:3 F6-R:3 F7-R:4**
**R$ Frame:3 PT:TDn Chances:1**

In this first evaluation the novelty is classified as adequate and set to Low. The Tensional Representation of the story in progress matches frame number three, which provokes that the Permanent Tension is set to the new value of Tendency Down. The Chances are set to one.
Now, MEXICA switches back to the Reflective State. After updating the context with JAGUAR_KNIGHT LOOK_FOR_AND_FOUND ENEMY, it retrieves from long-term memory the action where the knight attacks the enemy.

**E$ JAGUAR_KNIGHT ATTACKED ENEMY was not deleted because 1 chances left.**

This action does not fulfil the requirement of Tendency Down specified in the guidelines; however, MEXICA does not delete it because the guidelines also specify that there is one chance left. So, as the only option retrieved from long-term memory, this action is selected as the next event in the tale.
After the context is updated with the event of the attack, MEXICA retrieves the following possible next action from long-term memory:

***** FILTER JAGUAR_KNIGHT FOUGHT ENEMY Ten(GLn:TnDn)-**

However this time, because it does not fulfil the guidelines and there are no chances left, the action is deleted. Since it was the only option retrieved from long-term memory MEXICA launches a new search to find the next event in the story. It retrieves JAGUAR_KNIGHT KILLED ENEMY and the story keeps on developing.

These two examples show the influence of the guidelines in the production of material during the Engaged State. Each time an action is eliminated or approved (i.e. not deleted) the fate of the story in progress is affected. For instance, JAGUAR_KNIGHT FOUGHT ENEMY triggers the postconditions Lr(enemy):jaguar_knight+ and Lr(jaguar_knight):enemy+; that combination of Tensions is never present in the story. So, if this action had been used (instead of being deleted) MEXICA would have retrieved from long-term memory a different set of possible actions which would have led the story towards a different direction.

In the same way, if JAGUAR_KNIGHT ATTACKED ENEMY had been rejected and other action used instead, the story would have developed in a different way.

The function of the Tensional Guidelines is to push the story towards degradation-improvement processes necessary to generate interesting stories. As the graphic of the Tensional Representation shows (see Figure 5.3), for this example MEXICA produces three of such processes. Guidelines are set based on Previous Stories; and although the Tensional Representation of the story in progress is similar to the one of tale number three in the file of Previous Stories, they are not the same. In this way MEXICA generates a new Tensional Representation which can be used in the develop of future stories.

Nevertheless, the final story, and consequently the final Tensional Representation, is the result of the interaction of the whole system. And the guidelines are just another element of such a system. If during the developing of a tale they hinder the attempt to solve a problem instead of helping (e.g. when breaking an impasse) they are ignored.

There is a point to mention regarding originality. Although MEXICA never detects any problem with the novelty of the story in progress (the guideline is always set to Low), it is possible to discover a complication with it. The rescuing scene in the story in progress is very similar to the one found in tale number three in the Previous Stories.

Story in Progress
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT

Previous Story (tale 3)
EAGLE_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
EAGLE_KNIGHT ATTACKED ENEMY
EAGLE_KNIGHT FOUGHT ENEMY
EAGLE_KNIGHT KILLED ENEMY
EAGLE_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE EAGLE_KNIGHT

MEXICA does not detect this similarity because its main concern is to avoid copying any of the Previous Stories. That is, MEXICA does not verify if the story in progress is developing a scene already used in other tale; what it is checking is that the (whole) story it is creating has not been already written. Or in other words, if a used scene does not constitute more than 49% of the story in progress MEXICA does not detect the similarity.

Although the story in progress and tale number three as a whole are not very similar, it will improve MEXICA's performance to detect those cases.

## 5.4 Modifying some of the Parameters Definable by the User.

In all the following examples the initial action given by the user is PRINCESS CURED JAGUAR_KNIGHT. The story analysed in section 5.2 is referred to as the Story-Sample. In order to make the following explanations as simple as possible, the Final Analysis and the conversion from Primitive Actions to the final text are not included in any of the stories in the rest of the chapter.

### 5.4.1 Modifying the ACAS-Constant.

When the ACAS-Constant is set to 51% the action ANYONE KIDNAPPED PRINCESS is not retrieved anymore; MEXICA selects randomly an action between the available options and goes ahead with the story. This is an example of a story developed under such constraint.

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
JAGUAR_KNIGHT MUGGED PRINCESS
PRINCESS ATTACKED JAGUAR_KNIGHT
JAGUAR_KNIGHT WOUNDED PRINCESS
JAGUAR_KNIGHT RAN_AWAY

In this story a knight has an accident and the princess cures him. However, by contrast with the Story-Sample, this time the knight mugs the princess. The princess reacts by attacking the knight, who wounds her and runs away.

It can be observed that this story is 50% shorter than the Story-Sample. Two characters are used instead of three and certainly it does not lack originality; one never expects the mugging scene. However, the story does not end properly; the reader never knows what happens to the princess. The reason for this bad end is explained later.

For some readers there might be a further problem: an explanation of why the knight mugs the princess is necessary. It can be argued that the answer to this question must be found in a reader's interpretation of the tale; i.e. based on the information given by the story, the reader must imagine what circumstances lead to that situation. For example, it can be supposed that the knight is a corrupt character that obtains satisfaction by mugging persons. So, after the princess cures him she becomes an easy victim.

Although this is an arbitrary explanation, for some readers it might justify the mugging event; but even if this explanation is not good enough, at least it brings to discussion an interesting matter. How explicit must the stories be? How much space must be left to readers' imagination? In MEXICA the answer to these questions is in the user's hands; as more preconditions are defined more explicit explanations of characters' behaviour will be produced. However, the more preconditions are attached to a Primitive Action the more difficult it is to satisfy them, which implies less options available to develop the story. This might lead the system to the generation of more predictable stories. So, it is necessary to find an adequate balance.

A general review of the inside process followed to develop this story is now explained. After the characters' context is updated with PRINCESS CURED JAGUAR_KNIGHT, MEXICA retrieves from long-term memory a set of possible next actions. It selects randomly JAGUAR_KNIGHT MUGGED PRINCESS between the options available and updates characters' contexts. However, when it tries to retrieve more possible next actions an impasse is declared.

***** Impasse : Engage-State**
***** Switching to Rf-S ...**
***** Breaking an impasse.**
**R$ Attempting to select a next action...**
**R$ Deleting PRINCESS REALISED**
**R$ No Action selected!.**
**R$ looking for equivalent action..**
**R$ WOUNDED is equivalent to MUGGED**
**R$ Attempting to select a next action...**
**R$ Action selected: PRINCESS ATTACKED JAGUAR_KNIGHT**
***** R$ Impasse BROKEN...**

MEXICA verifies which actions have followed MUGGED in the Previous Stories. It just finds the compound action REALISED which is eliminated (compound actions are just used when solving preconditions). So, MEXICA looks in the Primitive Actions Structure for an action equivalent to MUGGED; the action selected is WOUNDED. So, MEXICA looks again in the Concrete Representations for all actions that have followed WOUNDED in the Previous Stories. This time it finds ATTACK, which is instantiated and the impasse is broken.
In this part of the story it is possible to observe the way MEXICA breaks impasses using equivalent actions. MEXICA finds that to wound someone has similar consequences as mugging someone. So, this similarity is exploited to break the impasse.

MEXICA switches back to the Engaged State and again it cannot retrieved possible next actions from long-term memory and another impasse is declared. The impasse is broken with the action JAGUAR_KNIGHT WOUNDED PRINCESS. It switches back to the Engaged State and an impasse

happens again; this time it is broken with the action JAGUAR_KNIGHT RAN_AWAY. Finally, another impasse is declared but in this occasion MEXICA cannot break it and the story is abandoned.

As this analysis shows, to increment the ACAS-Constant in one point does not just imply that an action is not available anymore. Its major consequence is that the whole dynamic of the system is modified. All actions, except number four (given by the user) and five (retrieved from long-term memory) are generated during the Reflective State. So, during the development of the story MEXICA cannot match any atom in long-term memory.

The effect that the modification of the ACAS-Constant has depends on the information in the Abstract Representation. For example, if the ACAS-Constant is set to 40% MEXICA has the same behaviour than the one reported in this section. The reason is that the Abstract Representation does not include any atom that can be matched under that condition. So, in practical terms, for this example it is the same if the ACAS-Constant is set to 40% or 50%.
The reason for the bad end in this story is that MEXICA does not know how to continue the tale. The Previous Stories do not include any analogous situation to the one of the story in progress and the system simply has to renounce it.

### 5.4.2 Modifying the Instantiation of Characters (Forbidden Actors).

The way an action is instantiated has important consequences in the development of a tale. It shapes the relation between the characters in the story. This relation (represented by the Emotional Links and Tensions in the characters' context) forms the material to construct the Associative Structure. Thus, the way an action is instantiated influences which possible next actions are retrieved from long-term memory. In this section, two examples are presented to illustrate this situation. All the parameters definable by the user in these two stories have the same value as those used to generate the Story-Sample; the only difference is the value of the Forbidden Actors.

A. Forbidden Actors Set to No Active.

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
JAGUAR_KNIGHT KIDNAPPED PRINCESS

This story is generated with the parameter Forbidden Actors set to No Active. As a consequence MEXICA is able to use any of the characters in the story to instantiate an action retrieved from long-term memory.

**JAGUAR_KNIGHT possible next actions: ****
**ANYONE KIDNAPPED PRINCESS**

**E$ instantiating JAGUAR_KNIGHT KIDNAPPED PRINCESS ReiCha(ActualActor)-**

As in the case of the Story-Sample, after characters' contexts are updated with PRINCESS CURED JAGUAR_KNIGHT the action ANYONE KIDNAPPED PRINCESS is retrieved. MEXICA instantiates the action with the character jaguar knight and uses it as the following event in the tale. However, after it is executed MEXICA cannot match any atom in long-term memory. The impasse cannot be broken, so the story is abandoned.

In this way, although the information in the Abstract Representation is the same for the Story-Sample and for this tale, a difference in the manner an action is instantiated results in an unsuccessful attempt to develop a story.

B. Forbidden Actors Set to Active.

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
PRINCESS AFFRONTED ENEMY
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
LADY ACTOR
PRINCESS WENT_TEXCOCO_LAKE
PRINCESS WAS_FOND_OF LADY
LADY ATTEMPTED_TO_TAKE_ADVANTAGE_OF PRINCESS
PRINCESS AFFRONTED LADY
LADY ATTACKED PRINCESS
PRINCESS KILLED LADY
JAGUAR_KNIGHT WENT_TEXCOCO_LAKE
PRINCESS ATTEMPTED_TO_TAKE_ADVANTAGE_OF JAGUAR_KNIGHT
JAGUAR_KNIGHT AFFRONTED PRINCESS
PRINCESS ATTACKED JAGUAR_KNIGHT
JAGUAR_KNIGHT KILLED PRINCESS

This story is generated with the parameter Forbidden Actors set to Active. As a consequence MEXICA cannot use the forbidden characters to instantiate actions retrieved from long-term memory. In this way, as in the case of the Story-Sample, when the action ANYONE KIDNAPPED PRINCESS is retrieved it is instantiated (based on the Group Class and the Previous Stories) with the character enemy. The story

in progress develops in the same way that the Story-Sample does. After PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT is executed MEXICA retrieves as one of the possible next actions PRINCESS KILLED ANYONE.

**PRINCESS possible next actions: ****
**PRINCESS LOOKED_FOR_AND_FOUND ANYONE**
**PRINCESS KILLED ANYONE**

**E$ instantiating PRINCESS KILLED LADY PSt-**

Because Forbidden Actors is active MEXICA needs to introduce a new character in the story (neither princess nor jaguar knight nor enemy can be used to instantiate the action). Based on Group Class and Previous Stories the character Lady is selected. As a consequence the relation between characters changes in comparison with the characters' relation in the Story-Sample; so, at this point this story takes a different direction. MEXICA updates the characters' contexts with the last event selected and retrieves new actions from long-term memory. JAGUAR_KNIGHT KILLED PRINCESS is chosen as the next event in the story. So, the last four actions in the story in progress are:

JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
PRINCESS KILLED LADY
JAGUAR_KNIGHT KILLED PRINCESS

MEXICA switches to the Reflective State and inserts all the actions necessary to justify the killing of the Lady and the killing of the princess. However, when it tries to evaluate the tale it turns out that the story in progress is bigger than any of the tales in the Previous Stories. So, MEXICA has to abandon it.

Again, this example shows the significance of the way actions are instantiated in the shape of the resulting tale. A whole new episode to justify the killing of the Lady has to be inserted as a consequence of the introduction of the new character. Or in other words, the introduction of a new character to instantiate PRINCESS KILLED ANYONE causes a different episode to the one used to justify the murder of the knight in the Story-Sample is generated. The action JAGUAR_KNIGHT KILLED PRINCESS is retrieved just because of the context produced by the event where the lady is murdered (this option is not available in the Story-Sample); MEXICA now requires to justify this new death. In this way, the episode to justify the killing of the princess is an indirect consequence of the use of the character Lady.
Ensuing from it one can realise that the final direction that this story takes, which differs from the Story-Sample's end, is produced by the introduction of the new character in the tale.

This story also gives the opportunity to analyse a shortcoming in MEXICA; it is related to the process to fulfil preconditions. MEXICA justifies the murder of the Lady in an inadequate way. That episode

does not really connect with the rest of the story; in fact, if it is eliminated it does not make any difference to the tale. This problem arises because that routine just concerns finding actions which fulfil the preconditions; that is, it is insensitive to the characters' context. Something similar happens with the following episode; it is not very convincing that the princess tries to take advantage of the man she loves.

The necessity for a more sophisticated problem-solving routines in the Reflective State is clear. For instance, a procedure where an initial state, final desired state and a set of constrains are defined, and as an outcome an episode is developed. In this example the initial state would be the characters' contexts after the princess falls in love with the knight; the final state the action where she kills the lady; finally, based on an analysis of the princess' context (she is the murderer), the constraint would be to involve the new character with some of the other characters in the tale. In this case, since the princess is in love with the knight but he is not in love with her, a good reason to kill the lady would be that the knight loves her and the princess gets jealous.

### 5.4.3 Modifying the Operation Mode.

In this section stories generated under different operation modes are shown. Comparison of these different modes is delayed until Section 5.5

The differences between the E1&ER1 and E2&ER2 operation modes affect the filtering process and the way actions are instantiated. Under the E1&ER1 operation modes any action retrieved from long-term memory is a candidate to be selected as the next event in the story; all actions are instantiated through a random procedure.
Under the E2&ER2 operation modes the filtering process eliminates those actions retrieved from long-term memory which neither flow nor fulfil the requirements specified by the guidelines (when MEXICA is running under the E2 operation mode it lacks the evaluation process executed during the Reflective State; such a process updates the values of the guidelines according to the way the story is developing. So, during this operation mode the guidelines are set with default values and kept unchanged during the whole process). The instantiation process reincorporates characters, or copies the way actions have been instantiated in Previous Stories, or as the last option randomly instantiates an action.

The type of outcome obtained when running different operation modes depends very much on the Previous Stories. For example, actions 10 to 13 are included in the Story-Sample because they are the only option retrieved from long-term memory (see Section 5.3.1). So, in this case it does not really matter which operation mode is active, the outcome is the same.

When the Previous Stories offer more options the differences start to become obvious. For example, the lack of the Novelty Guideline under E1 and ER1 operation modes leaves MEXICA blind to detect when it is just copying an old tale instead of developing a new one. Also, the lack of the flowing-routine, which helps to avoid wandering around without any direction, makes MEXICA more vulnerable to generating senseless and/or uninteresting sequences of actions.

However, on the other hand the ER1 operation mode gives the opportunity to experiment with a system where the interaction between the Engaged and Reflective State is reduced. During the Reflective State MEXICA just breaks impasses and solves preconditions; no guidelines are created. In this way, it is possible to study the effect that the feedback (the guidelines) has on the development of a story. For example, the experiment described in section 5.5 shows how in certain circumstances the ER2 operation mode gets blocked while the ER1 is able to produce some material. The E1 allows evaluation of the effect of the Reflective State in such circumstances.

The features displayed by the operation modes also change according to the usefulness of the material retrieved from long-term memory (an action is classified as useful when it flows and follows the guidelines). Three general cases illustrate this situation.
Case 1: When during the development of a story at least one of the sets of possible next actions retrieved from long-term memory contains as a minimum one useful action to the story together with some other no useful actions (either in the same set and/or in other of the sets).

Set of possible next actions Character 1.
Action 1: not useful
Action 2: useful

Set of possible next action Character 2.
Action 1: not useful

When MEXICA is running under E1 or ER1 it has the potential to reproduce any of the stories developed under E2 or ER2; however, the same is not true in the opposite direction. That is, when running under E2 or ER2 MEXICA cannot reproduce all the stories created under E1 or ER1. So, it looks as if the E1&ER1 have the potential to be more productive that the E2&ER2 operation modes. It can be argued that the extra options that the first two operation modes have are just actions that are not useful for the story, hence they will not lead to anything productive. However, that is not necessarily true all the time. For example, in the Story-Sample the possible next action JAGUAR_KNIGHT WENT_HUNTING_WITH PRINCESS is eliminated because it does not flow, although it looks as a sensible action to do after the princess cures the knight.

In the same way, the fact that a possible next action does not follow the guidelines it does not necessarily imply that it will mislead the development of the tale (in fact the guidelines allow some

flexibility at that respect with the field Chances). The concept of actions that are not useful is a general one, and those which fall in this category are not always non-productive for the story in progress. The study and comparison of tales developed under E1&ER1 and E2&ER2 operation modes might help to establish better ways to classify the actions.

Case 2: When during the development of a story all sets of possible next actions retrieved from long-term memory contain just useful actions to the story.

Possible net actions Character 1.
Action 1: useful
Action 2: useful

Possible next actions Character 2.
Action 1: useful

In this case, there is no difference if MEXICA is running under the ER1 or ER2 operations modes; the options to produce the outcome are the same.

Case 3: When during the development of a story, all the sets of possible next actions retrieved from long-term memory contain just no useful actions to the story.

Possible net actions Character 1.
Action 1: not useful
Action 2: not useful

Possible next actions Character 2.
Action 1: not useful

In this case, under the E2&ER2 when the filters reject all the sets of possible next actions retrieved from long-term memory the system is forced to launch a new search in memory; or in other words, it is forced to bring new options to working memory. The E1&ER1 will never have access to this new set of possible next actions.

The following lines shown examples of stories produced by MEXICA under different operation modes. They are all variations of the Story-Sample; i.e. they were developed exactly in the same conditions that the Story-Sample (same initial action, same value for all the parameters, and same set of Previous Stories).

A. Engaged and Reflective States 1 (ER1)

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT

PRINCESS CURED JAGUAR_KNIGHT
LADY KIDNAPPED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND LADY
VIRGIN FOUND_BY_ACCIDENT LADY
PRINCESS AFFRONTED LADY
LADY ATTACKED PRINCESS
PRINCESS FOUGHT LADY
LADY KILLED PRINCESS
JAGUAR_KNIGHT MADE_PRISONER LADY

The first actions in this story are developed in the same way as in the Story-Sample. However, soon some differences start to appear. MEXICA instantiates the kidnapping (action number 5) with the character Lady instead of the character enemy. That is, Under ER2 MEXICA instantiates that action through the Groups Class and Previous Stories method; however, under ER1 MEXICA instantiates the same action randomly. Or in other words, under ER2 MEXICA knows that the enemy is a plausible character to kidnap the princess (that is the way it has been used in Previous Stories); however, under ER1 MEXICA does not have that information, so it instantiates the action with any available character. For this example it is not really important who kidnaps the princess; both, the enemy and the Lady are new so the dynamic between characters is not altered. Nevertheless, it might make more sense to have the enemy as a kidnapper than the Lady.

After the kidnapping MEXICA selects the event where the knight looks for and finds the Lady (instead of the one where the Lady attacks the princess, like in the Story-Sample). This selection is made randomly (i.e. it does not have to do with the operation mode) but it causes the characters' contexts to change with respect to the characters' contexts in the Story-Sample. So, the story starts to takes its own direction.

Now MEXICA selects VIRGIN FOUND_BY_ACCIDENT LADY. It is clear how this action does not match with the rest of the story, i.e. the action does not flow. But because MEXICA is running under ER1 it cannot detect this situation. However, apart from distracting the story's reader with an irrelevant event, this action has another consequence. It introduces a new character in the story, or maybe it is better to say, a new character's context; and, as explained later, this new character's context plays a relevant role in the development of the tale. But at the moment Virgin's context is empty (the action FOUND_BY_ACCIDENT just produces a change in location, it does not trigger Emotional Links or Tensions).

The story continues with the princess affronting the Lady. Then, the attack on the princess is performed; at that moment all characters are in the same location, therefore, all their contexts are updated with the consequences of that action.

Now, when MEXICA tries to retrieve possible next actions from long-term memory, the Associative Structure built from the Virgin's context is the only one which can match an atom; neither of the other characters' Associative Structures are able to bring options to working memory. Thus, as a result of the introduction of a new character through a no flowing action MEXICA avoids an impasse.

PRINCESS FOUGHT LADY (the only option available) is chosen as the next action in the tale. When MEXICA tries to bring more possible next actions to working memory, again Virgin's Associative Structure is the only one which can match an atom (another impasse avoided). This time LADY KILLED PRINCESS is incorporated into the tale.

Then, MEXICA retrieves from the knight's Associative Structure JAGUAR_KNIGHT MADE_PRISONER LADY. After this action is incorporated into the story an unbreakable impasse is declared and the story ends.

When MEXICA is running under ER1 operation mode actions which do not flow might be included in the story in progress; VIRGIN FOUND_BY_ACCIDENT LADY is an example. From a reader's point of view that action is irrelevant for the tale. However, from a ER1 operation mode's perspective, it gives to MEXICA the opportunity to avoid two impasses. It would be helpful to have a process that, after the story is finished, could detect such kind of actions and eliminate them from the tale.

B. Engaged State 2 (E2).

*** NEW STORY:
PRINCESS CURED JAGUAR_KNIGHT
ENEMY KIDNAPPED PRINCESS
ENEMY ATTACKED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND ENEMY
JAGUAR_KNIGHT ATTACKED ENEMY
JAGUAR_KNIGHT FOUGHT ENEMY
JAGUAR_KNIGHT KILLED ENEMY
JAGUAR_KNIGHT RESCUED PRINCESS
PRINCESS FELL_IN_LOVE JAGUAR_KNIGHT
PRINCESS KILLED LADY
JAGUAR_KNIGHT KILLED PRINCESS
JAGUAR_KNIGHT KILLED JAGUAR_KNIGHT

This story is presented for comparison with the Story-Sample developed under the ER2 operation mode. It shows how the story looks without the actions inserted during the Reflective State. This example must not be taken as a suggestion that differences between tales developed under E2 and ER2 operation modes are always just some extra events. Actions inserted during the Reflective State can modify the characters' context in a way that a story developed under E2 operation mode will take a completely different direction that one developed under ER2.

C. Engaged State 1 (E1).

*** NEW STORY:
PRINCESS CURED JAGUAR_KNIGHT

LADY KIDNAPPED PRINCESS
JAGUAR_KNIGHT LOOKED_FOR_AND_FOUND LADY
VIRGIN FOUND_BY_ACCIDENT LADY
LADY ATTACKED PRINCESS
PRINCESS FOUGHT LADY
LADY KILLED PRINCESS
JAGUAR_KNIGHT MADE_PRISONER LADY

As in the previous story, this tale is presented for comparison with the story developed under the ER1 operation mode.

## 5.5 Comparing Operation Modes.

This section compares the results obtained when MEXICA runs under different operation modes; in particular it concentrates on explaining and comparing a story produced by the system under ER1 and ER2 operation modes.

### 5.5.1 *The Kidnapped Tlatoani*.

When MEXICA tries to develop a story under the operation mode E1 or E2 having as a first action TLATOANI BECAME_FREE, the outcome obtained is:

*** NEW STORY:
TLATOANI BECAME_FREE

MEXICA is not able to produce anything. The reason is that such a first action has never been used in any of the tales in the Previous Stories, therefore, the first action produces an impasse.
When MEXICA runs under the ER2 operation mode the following story, called *The Kidnapped Tlatoani*, is developed:

*** NEW STORY:
TLATOANI ACTOR
PRIEST KIDNAPPED TLATOANI
TLATOANI BECAME_FREE
TLATOANI AFFRONTED PRIEST
PRIEST ATTACKED TLATOANI
TLATOANI FOUGHT PRIEST
PRIEST WOUNDED TLATOANI
PRIEST RAN_AWAY
PRINCE ACTOR
PRINCE WENT_FOREST
PRINCE REALISED PRIEST WOUNDED TLATOANI
TLATOANI WAS_FOND_OF PRINCE
PRINCE ATTEMPTED_TO_TAKE_ADVANTAGE_OF TLATOANI
TLATOANI AFFRONTED PRINCE
PRINCE DID_NOT_CURE TLATOANI
PRINCE WENT_TENOCHTITLAN_CITY
TLATOANI DIED_BY_INJURIES

As commented before, the first action produces an impasse. MEXICA switches to the Reflective State and before trying to break the impasse it verifies preconditions. MEXICA inserts the kidnapping (and the action ACTOR) to justify the escaping. Because some actions are inserted to fulfil the preconditions MEXICA switches back to the Engaged State to see if the impasse has been broken through the new two actions. That is, MEXICA checks if such actions have modified the characters' contexts in a way that the Associative Structures are now able to match an atom. And they do. Both the Priest and Tlatoani's Associative Structures are able to bring possible next actions to working memory.

MEXICA retrieves from long-term memory the events where the Priest attacks the Tlatoani, the fight between both of them and the wounding of the Tlatoani. Then MEXICA switches back to the Reflective State. It inserts the affront action to justify the attacking, and verifies novelty and the Tensional Representation. The system switches back to the Engaged State and the development of the story continues.

MEXICA retrieves from long-term memory the actions PRIEST RAN_AWAY, PRINCE DID_NOT_CURE TLATOANI and PRINCE WENT_TENOCHTITLAN_CITY. Then, it switches back to the Reflective State.

At this point the story has a singular moment; after the Priest runs away the system introduces a new character in the tale that decides not to help the wounded Tlatoani. MEXICA requires to justify this situation.

PRIEST RAN_AWAY
PRINCE DID_NOT_CURE TLATOANI

The first step is to sort the location problem out; in order for the Prince does not cure the Tlatoani it is necessary that both characters are located in the same place.

**R$ inserting PRINCE ACTOR Loc PRINCE DID_NOT_CURE TLATOANI**
**R$ inserting PRINCE WENT_FOREST Loc PRINCE DID_NOT_CURE TLATOANI**

MEXICA solves it by sending the Prince to the forest (the original setting of the story is the Texcoco Lake; however, as a result of the kidnapping action the Tlatoani is located in the forest. See the postconditions of this action in the definition of the Primitive Actions in Appendix C). At the moment, this part of the story looks as follows:

PRIEST RAN_AWAY
PRINCE ACTOR
PRINCE WENT_FOREST
PRINCE DID_NOT_CURE TLATOANI

Now, there is another problem to solve. The Prince cannot decline to cure the Tlatoani if he is not aware that the Tlatoani is injured. Because the Prince was not present when the Priest wounded the Tlatoani, his context did not register that situation.

**R$ inserting PRINCE REALISED PRIEST WOUNDED TLATOANI pre PRINCE DID_NOT_CURE TLATOANI**

MEXICA sorts out this situation by inserting the compound action REALISED. MEXICA analyses all characters' contexts and discovers that the preconditions which satisfies the action DID_NOT_CURE are already present in some of them, but not in the Prince's context. That means that the action which fulfils the required preconditions has already been performed in the story; the problem is that the Prince is not aware of it. MEXICA examines the story in progress to detect which action satisfies the desired preconditions and creates a compound action to make the Prince aware of it.
Then, in a similar way as in the Story-Sample, the rest of the events necessary to justify DID_NOT_CURE are inserted producing the following scenario:

PRINCE WENT_FOREST
PRINCE REALISED PRIEST WOUNDED TLATOANI
TLATOANI WAS_FOND_OF PRINCE
PRINCE ATTEMPTED_TO_TAKE_ADVANTAGE_OF TLATOANI
TLATOANI AFFRONTED PRINCE
PRINCE DID_NOT_CURE TLATOANI

MEXICA checks novelty and the Tensional Representation and switches back to the Engaged State. A couple of attempts to retrieve possible next actions from long-term memory are launched but no useful actions are brought to working memory.

***** FILTER TLATOANI DIED_BY_INJURIES Ten(GLn:GoUp)-**

One of those useless retrieved actions is TLATOANI DIED_BY_INJURIES; it does not satisfy the guidelines and is eliminated. An impasse is declared and MEXICA switches to the Reflective State. The process to break the impasse is run and the action selected by the system to keep on moving the story is TLATOANI DIED_BY_INJURIES, the one just rejected.

What happens is that after PRINCE DID_NOT_CURE TLATOANI is justified MEXICA tries to go ahead with the story and, as indicated by the guidelines, it is looking for an action which increments the Tension to the Reader. The death of the Tlatoani produces the opposite effect, so it is discarded as an option when it is retrieved from long-term memory. However, no other alternative is retrieved and an impasse is declared. Under this circumstances the priority of the system is to break the impasse, so the guidelines are put aside and MEXICA switches to the Reflective State looking for any action which helps to continue the story. And TLATOANI DIED_BY_INJURIES is the first option it finds which

can break the impasse; thus, it is inserted in the story in progress and MEXICA switches back to the Engaged State.
Then, another impasse is declared but this time MEXICA cannot break it and the story finishes.

It might seem that although MEXICA is set to start the development of this story under the Engaged State, in practical terms it really starts under the Reflective State. That is, nothing is done under the initial Engaged State but to declare the impasse; MEXICA switches to the Reflective State where it inserts some actions to satisfy the preconditions and switches back to the Engaged State to develop the story. And apparently that is the process that will be followed if MEXICA is set to start the story under the Reflective State. Thus, it looks as in practical terms MEXICA starts the development of this tale under such a Reflective State.
However that is not really true. If MEXICA is set to start to develop the story under the Reflective State the impasse at the beginning of the story will never be declared. After the initial action is given by the user MEXICA will go straight to insert the actions required to satisfy the preconditions, and assign to the guidelines the right values based on the results of the evaluation of novelty and the Tensional Representation; then, it will switch to the Engaged State to start to retrieve actions which fulfil such guidelines.
However, when MEXICA starts under the Engaged State and the impasse is declared, its main priority is to find an action that allows continuing the development of the story. MEXICA switches to the Reflective State and no evaluation process is executed; it just breaks the impasse and switches back to the Engaged State to start to retrieve actions. As a consequence the guidelines keep their initial default value.
Thus, the difference between setting MEXICA to start the story under the Engaged State or the Reflective State is the value assigned to the guidelines at the beginning of the process.
To observe the consequences of such difference an experiment is run; MEXICA is set to start the same story under the Reflective State. The process works as follows. The actions TLATOANI ACTOR and PRIEST KIDNAPPED TLATOANI are inserted to fulfil the preconditions of the initial action. MEXICA evaluates the tale and finds that frame two is the most alike to the Tensional Representation of the story in progress; so, it sets the Permanent Tension to Tendency Down. The novelty is classified as adequate and set to Low.

Reflective State
TLATOANI ACTOR
PRIEST KIDNAPPED TLATOANI
TLATOANI BECAME_FREE
Engaged State
PRIEST ATTACKED TLATOANI

MEXICA switches to the Engaged State and retrieves PRIEST ATTACKED TLATOANI. Although the action does not fulfil the guidelines it is not eliminated because there is one chance left; so, it is

added to the tale. So far there is no difference between this story and the one developed under the Engaged State as the initial state. Then MEXICA retrieves from long-term memory TLATOANI FOUGHT PRIEST; but this time the action is eliminated because it does not satisfy the guidelines. As a result, this story takes a different direction that the previous tale (the one developed under Engagement as the initial state).

*The Kidnapped Tlatoani* illustrates the impact that a selected (by the user) initial state can have on the progress of a story. In this case, MEXICA is set to start the story under the Engaged State but it is forced to switch to the Reflective due to an impasse. However, the outcome generated when the system is set to start the story under the Reflective State is different.

The consequences of choosing a particular initial state can be observed not only when an impasse is declared. If the first action in the story produces a context which can match an atom in long-term memory, but at the same time has preconditions to be satisfied, the initial state selected can guide the story towards completely different events. What makes the difference is the way the action(s) inserted modifies the characters' context. Such modifications can push MEXICA to match different atoms retrieving different possible next actions.

Nevertheless some times the initial state can be irrelevant in the fate of a tale even when actions to satisfy preconditions are added to the story in progress. The Story-Sample exemplifies this case where the actions inserted to justify the event where the princess cures the knight do not have any consequence in the development of the tale; i.e., the sets of possible next actions retrieved from long-term memory at the beginning of the development of the story do not change if the initial state is set to Reflective or Engaged.

### 5.5.2 Advantages of the ER1 (compared with ER2).

In previous sections it has been pointed out the benefits of the processes which verify the usefulness of actions under the ER2 operation mode (the verification that an action flows and fulfils the Novelty and Tensional Guidelines). Also, it has been mentioned how the lack of such processes under the ER1 operation mode makes MEXICA more vulnerable to produce stories with senseless sequences of actions.

This section attempts to show how in certain circumstances the ER1 can be the most convenient operation mode to try to develop a tale. Such circumstances are obviously those where MEXICA gets blocked under the ER2; i.e., when the guidelines become so hard to fulfil that few or none of the actions retrieved from long-term memory can satisfy them.

To simulate such conditions a new group of twelve tales is joined to the file of Previous Stories. All of them were created by MEXICA (most of the stories studied in this chapter are included); few actions have been added or eliminated from some stories to improve their quality.

Most of these new stories are variations of the original seven; they are very similar between them or share alike episodes. The idea is to saturate MEXICA with the same kind of information. In this way, the difficulty of producing novel stories is increased. That is, although the number of tales has increased by more than 100%, the amount of Primitive Actions is still the same and no different topics are introduced in the stories. As a consequence, the number of times actions in general have been used raises making more difficult to find actions which can fulfil strict requirements of novelty; also, due to the similarity between topics, no new alternatives or directions where to lead new tales are generated.

MEXICA is given the task to develop a story which initial actions is TLATOANI BECAME_FREE. To trigger the strict requirements of novelty the story of *The Kidnapped Tlatoani* and a variation of it are also included in the new file of Previous Stories. That is, when MEXICA developed *The Kidnapped Tlatoani*, the seven tales in the old file of Previous Stories were just sufficient to generate some atoms that allow MEXICA to develop this tale. The tales added to the new file of Previous Stories do not improve this situation (as explained some lines earlier, they do not offer new options where to lead the story). So, including *The Kidnapped Tlatoani* and a variation of it makes more difficult for MEXICA to come with a novel story since the few alternatives available in long-term memory has been already used in those two tales.

The definable parameters are set as follows:

**Initial State:RfS CtEg-Rf:1 ACAS-Constant:50% Guidelines.Chances:0**
**Forbidden Actors:Active Num_actions:40 times_used:234**
**Detection of end of cycle NO-active. Logical actions NO-active.**
**Novelty=> Strict 15%(2) High 50%(6) Medium 75%(9)**

MEXICA is set to start in the Reflective State; in this way it goes straight to verify preconditions and evaluate the story. So, it can detect immediately the similarity between the story in progress and the tales in Previous Stories. The parameter CtEg-Rf is set to one to force MEXICA to evaluate the story each time an action is retrieved from long-term memory and added to the story.

The outcomes obtained under ER2 and ER1 are now presented.

A. Operation Mode: Engaged and Reflective States 2.

As expected, under the ER2 operation mode MEXICA cannot produce a story.

*** NEW STORY:
TLATOANI ACTOR
PRINCE KIDNAPPED TLATOANI
TLATOANI BECAME_FREE

After three actions the story is abandoned. The steps followed to try to develop the story are now explained. MEXICA starts the process under the Reflective State; it inserts the events necessary to satisfy the preconditions of the action BECAME_FREE and evaluates the novelty. It detects that the story developed so far (i.e. the first three actions) is equal to two of the tales in the Previous Stories (to *The Kidnapped Tlatoani* and a variation of it). So, MEXICA sets the value of the Novelty Guideline to Strict.
It switches to the Engaged State and tries to retrieve possible next actions from long-term memory. However, none of the options available fulfils the requirements for novelty; so all they are eliminated. An impasse is declared and MEXICA switches to the Reflective State to try to break it.
However, all the options found by MEXICA to break the impasse also failed to satisfy the Novelty Guidelines. So, the story is abandoned.

In this way, following the guidelines established during the analytical process (the Reflective State) MEXICA is not able to produce anything.

B. Operation Mode: Engaged and Reflective States 1.

The following actions are part of the story produced under ER1 operation mode.

*** NEW STORY:
TLATOANI ACTOR
LADY KIDNAPPED TLATOANI
TLATOANI BECAME_FREE
EAGLE_KNIGHT ACTOR
EAGLE_KNIGHT WENT_FOREST
LADY LAUGH_AT EAGLE_KNIGHT
EAGLE_KNIGHT MADE_PRISONER LADY
LADY WOUNDED EAGLE_KNIGHT
TLATOANI EXILED LADY

The original story includes some redundant sequences of actions, which have been omitted in order to clearly show the best material produced. The whole story is analysed in the following section 5.6.

This example shows that under the ER1 operation mode MEXICA is not just able to avoid getting blocked but also to produce some novel material.

The process followed to generate the story is now explained. As in the previous case, MEXICA starts the development of the story in the Reflective State. So, it inserts the first two actions to justify BECAME_FREE and then it evaluates the story. Although it detects that the story is equal to two of the Previous Stories there is no communication between the Engaged and Reflective States, so that fact is ignored. MEXICA switches to Engagement and starts to retrieve actions from long-term memory.

One of those actions is EAGLE_KNIGHT MADE_PRISONER LADY, which is selected randomly as the next event in the tale.

This action has been used just in four occasions in Previous Stories; so, it is very close to the standards of novelty specified under the ER2 operation mode. This gives MEXICA the opportunity to develop a story with a high degree of originality.

MEXICA switches back to the Reflective State (the CtEg-Rf is set to one). It is necessary to satisfy the preconditions of EAGLE_KNIGHT MADE_PRISONER LADY. First, the actions EAGLE_KNIGHT ACTOR and EAGLE_KNIGHT WENT_FOREST are inserted to solve the location problem. Now, MEXICA looks for an event which justifies MADE_PRISONER; three actions are rejected because they do not reach the novelty requirement (remember that when MEXICA is verifying preconditions or breaking impasses, it always checks the novelty of the actions. That is, in the ER1 operation mode the guidelines are ignored during the Engaged State, but during the Reflective State they still being taken into account).

Finally LADY LAUGH_AT EAGLE_KNIGHT, which fulfils the novelty requirement and the preconditions, is found and inserted. (If to laugh at Eagle knight is enough reason to take the Lady prisoner is a relative question; in MEXICA the answer is linked to the preconditions and postconditions defined by the user in the Primitive Actions.)

When the novelty is evaluated MEXICA finds that just three of the sequences have been used in Previous Stories; so, the tale is classified as adequate and novelty set to Low.

**R$ Checking novelty: number of times a sequence happens in other stories**
**R$ Seq:1x2 Seq:2x2 Seq:3x0 Seq:4x0 Seq:5x0 Seq:6x0 Seq:7x4**
**R$ Adequate novelty: guideline set to LOW.**

In the following actions MEXICA wanders around until it randomly selects LADY WOUNDED EAGLE_KNIGHT which leads to TLATOANI EXILED LADY. Then again it wanders around until the maximum number of actions allowed in a new tales is reached. The story then finishes.

As demonstrated in this example, the ER1 operation mode can be very useful when MEXICA gets blocked under ER2, or when the user wants to make some experiments in which the Engaged and Reflective States work independently.

Nevertheless, the production of senseless sequences of actions is still a problem. A possible solution is to include in the ER1 the flowing-verification routine which will help to improve the quality of the material generated; however, some of the lack-of-constraints characteristics will be lost. It seems a better idea to include a routine that could detect the junk-actions and eliminate them from the final tale.

## 5.6 Inadequate Stories.

In this section some inadequate stories developed by MEXICA are presented together with an explanation of the causes which led to the generation of such tales.

A. The following lines show the whole version of the story analysed in the previous section.

*** NEW STORY:
TLATOANI ACTOR
LADY KIDNAPPED TLATOANI
TLATOANI BECAME_FREE
EAGLE_KNIGHT ACTOR
EAGLE_KNIGHT WENT_FOREST
LADY LAUGH_AT EAGLE_KNIGHT
EAGLE_KNIGHT MADE_PRISONER LADY
FISHERMAN LOOKED_FOR_AND_FOUND EAGLE_KNIGHT
TRADER LOOKED_FOR_AND_FOUND EAGLE_KNIGHT
FISHERMAN LOOKED_FOR_AND_FOUND EAGLE_KNIGHT
TRADER LOOKED_FOR_AND_FOUND EAGLE_KNIGHT
FISHERMAN LOOKED_FOR_AND_FOUND EAGLE_KNIGHT
TRADER LOOKED_FOR_AND_FOUND EAGLE_KNIGHT
LADY WENT_FOREST
LADY WOUNDED EAGLE_KNIGHT
TLATOANI EXILED LADY
FISHERMAN WENT_FOREST
WARRIOR WENT_FOREST
TRADER WENT_FOREST
WARRIOR WENT_FOREST

This story exemplifies some of the problems that MEXICA finds when it develops stories under the ER1 operation mode.

The process that generated such a tale is now explained. After EAGLE_KNIGHT MADE_PRISONER LADY is selected as the next event in the story, MEXICA retrieves from memory a new set of possible next actions.

**INDEXES ***
**TLATOANI: 10,15 ASIII-0 LADY: 10,15 ASIII-0 EAGLE_KNIGHT: 4,2 ASI-50**

**TLATOANI possible next actions: ****

**LADY possible next actions: ****

**EAGLE_KNIGHT possible next actions: ****
**ANYONE LOOKED_FOR_AND_FOUND EAGLE_KNIGHT**
**LADY WOUNDED EAGLE_KNIGHT**

The action LOOKED_FOR_AND_FOUND does not flow; it just produces a change in the location. When it is selected randomly as the next action in the tale, the Emotional Links and Tensions in the characters' contexts are not modified. As a consequence the same set of possible next actions is retrieved again from Long-term Memory.

MEXICA keeps on selecting LOOKED_FOR_AND_FOUND as the next event in the tale; so, it falls in a kind of loop until LADY WOUNDED EAGLE_KNIGHT is chosen as the next action. The same situation occurs with the last part of the story.

As commented some lines earlier, probably the best solution is a routine that can detect and get rid of the junk-actions once the story is finished.

B. The following story has as first action PRINCESS CURED JAGUAR_KNIGHT:

*** NEW STORY:
JAGUAR_KNIGHT ACTOR
PRINCESS ACTOR
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS ATTEMPTED_TO_TAKE_ADVANTAGE_OF JAGUAR_KNIGHT
JAGUAR_KNIGHT AFFRONTED PRINCESS
PRINCESS DID_NOT_CURE JAGUAR_KNIGHT
PRINCESS WENT_TENOCHTITLAN_CITY
JAGUAR_KNIGHT DIED_BY_INJURIES

The difficulty with this story is that it does not make very much sense: the knight has an accident, the princess cures him, and immediately after that the knight has another accident and, out of the blue, the princess tries to take advantage of him. Or in other words, the problem with this story can be divided in two parts: first an action puts the health of the knight in danger and although this situation is overcome, again the same action puts the health of the knight in risk; it does not make the story flow. And second, the princess's behaviour is incongruent.

The process that generated this tale is now explained. MEXICA starts the development of the story under the Engaged State; the following are the first actions retrieved and selected to be part of the tale:

PRINCESS CURED JAGUAR_KNIGHT
JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS DID_NOT_CURE JAGUAR_KNIGHT
PRINCESS WENT_TENOCHTITLAN_CITY

After that MEXICA switches to the Reflective State to verify preconditions. MEXICA inserts the action to justify the event where the princess cures the knight and then the first problem arises. As a consequence of this process the same action, almost in a row, can be found twice in the tale. Thus, as a result of this situation, the flow of the story is damaged.

JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
JAGUAR_KNIGHT HAD_AN_ACCIDENT

This problem arises because during the Reflective State MEXICA does not analyse the story in progress to insert an action which does not just fulfil the preconditions, but also harmonise with the rest of the tale; e.g. if MEXICA had been able to detect that HAD_AN_ACCIDENT follows PRINCESS CURED JAGUAR_KNIGHT it could have chosen a different action to satisfy the preconditions of CURED.

This argument blames the routines in the Reflective State of the problem; however, something similar can be said about the Engaged State. Why does MEXICA select as the next event in the story, just after the princess cures the knight, an action where the knight has an accident? It does not make very much sense since, although the action itself flows, it does not help the story to move on. So, it is necessary to provide MEXICA with a routine that can detect this situations.

The second problem is why the princess suddenly tries to take advantage of the knight, when she has just helped him. In this case, the precondition of ATTEMPTED_TO_TAKE_ADVANTAGE_OF is responsible; some extra preconditions would have forced MEXICA to justify the episode more coherently. However, this solution (incrementing preconditions) presents the risk that the user might end predetermining sequences of actions which is against MEXICA's philosophy (c.f. TALE-SPIN in section 2.4.2).

A better solution is to combine the use of just the strictly-necessary preconditions to avoid the production of incoherent episodes, with more powerful analytical routines in the Reflective State; such routines must take into account the characters' context when they select the actions to satisfy preconditions.

C. The following story has as first action TLATOANI BECAME_FREE.

*** NEW STORY:
TLATOANI ACTOR
PRIEST KIDNAPPED TLATOANI
TLATOANI BECAME_FREE
TLATOANI AFFRONTED PRIEST
PRIEST ATTACKED TLATOANI
TLATOANI FOUGHT PRIEST
PRIEST KILLED TLATOANI
PRIEST WAS_FOND_OF PRIEST
PRIEST ATTEMPTED_TO_TAKE_ADVANTAGE_OF PRIEST
PRIEST AFFRONTED PRIEST
PRIEST ATTACKED PRIEST
PRIEST EXILED PRIEST

The problem with this story is the way MEXICA justifies the action PRIEST EXILED PRIEST. The tale was generated as follows. MEXICA starts to develop the story in the usual way. After PRIEST KILLED TLATOANI is chosen as the next event in the tale an impasse is declared. Such an impasse is broken with the action PRIEST EXILED PRIEST; i.e. from Previous Stories MEXICA knows that a coherent next action after the Priest kills the Tlatoani is that the Priest exiles himself. However, MEXICA is not able to link the murder with the exile; instead, it inserts actions which fulfil the preconditions but do not fix in the tale.

Again, better analytical routines would help to avoid this kind of problems. However, to be fair with the Reflective State the failure of this example is also due to the user of the system (i.e. the author of this thesis).

The precondition of the action A EXILED B is A(-2,*):B. To link the murder with the exile it is necessary that the Priest develops a negative Emotional Link towards himself, maybe due to regretfulness. However, that action (or a similar one) does not exist in the file of Primitive Actions. So, MEXICA did not really have the possibility to successfully end the story.

## 5.7 Summary.

This chapter has analysed in depth the way MEXICA develops stories. Examples that illustrate the similarities and differences between the four operation modes and some of the parameters definable by the user have been presented. Finally, some of the problems found while testing the system have also been shown to give a completely panorama of MEXICA. An evaluation of MEXICA is presented in the following chapter.

# Chapter VI

# Evaluation

MEXICA is a *computer model* of a writing process. As stated in Chapter I and following Eglen (Eglen 1992, p. 2) computer models have three main purposes:

1. To verify that the theory they represent works (at least at a computational level).
2. To force the modeller to think about all the details of a hypothesis rather than just concentrating on the cardinal components of it.
3. To allow easy testing of the hypothesis under different circumstances, which in some cases can be difficult or not feasible to perform in human subjects.

This chapter evaluates MEXICA from these three perspectives. That is, since MEXICA is a *computer model* of a cognitive process, this chapter evaluates if the goals stated for a computer model have been achieved.

The chapter is organised as follows. Section 6.1 examines those aspects related to the evaluation of the theory. In order to verify that the engagement-reflection theory works, it is necessary to evaluate if MEXICA satisfies the main postulates of the model: the production of material without the use of explicit goals or predefined story-structures, and the production of stories as result of the interaction between engagement and reflection. To assess the latter aspect, this section introduces the engagement-reflection maps. These maps visualise the interaction between states during the writing process. The second step to verify if the theory works consists in assessing MEXICA's outputs. Four stories produced under different operation modes and with different values for the variable Tension to the Reader are evaluated based on criteria previously established. To complement this evaluation and compare MEXICA's outputs against other program's stories, fifty subjects completed a questionnaire to evaluate computerised stories. This questionnaire included four of MEXICA's stories and two produced by other programs.

The development of the computer model based on the engagement-reflection account forced the designer of MEXICA to think of all the details of the model. Particularly important are the creative process and the way of producing interesting stories. Section 6.2 analyses these two processes. The creative process is assessed by comparing the novelty of stories created by the system against the tales in the Previous Stories. The Associative Structure and the ACAS-process are examined to show how they contribute to generate novel knowledge in the system. In the same way, the method employed to produce interesting stories is analysed. This method is based on comparisons between the Tension to the Reader in the story in progress and the Previous Stories. This section includes, when it is considered appropriate, comparisons with previous works.

Section 6.3 evaluates if MEXICA offers enough facilities to test the model under different circumstances. The different features included in the system to allow easy testing under different contexts (e.g. the

definition of the Primitive Actions and Previous Stories, the different parameters defined by the user, and the utility of the reports produced by the system) are analysed.

## 6.1 Evaluating the theory.

As a computer model, MEXICA must be able to provide the information necessary to evaluate if the theory it embodies works. That is, it must demonstrate or refute the possibility of developing stories (at least a computational level) as a result of an engagement-reflection cycle. How can MEXICA demonstrate this? First, it is necessary to assess if MEXICA satisfies the main postulates of the engagement-reflection model and then evaluate if MEXICA's outputs are satisfactory.

During this work, two main premises have been mentioned as the key elements that distinguish this research from previous models (e.g. see Chapter I or Section 3.2.6):

1. During engagement MEXICA generates material without using explicit goals or predefined story structures.
2. MEXICA's outputs are the result of an engagement-reflection *interaction*.

Thus, it is necessary to demonstrate that these postulates are satisfied by the system. In the same way, this research claims that MEXICA is able to produce adequate outputs. Thus, it is necessary to evaluate if:

3. MEXICA's outputs can be considered as (frameworks for) stories.

That is, MEXICA must be able to produce texts that can be considered as short stories or at least as frameworks for short stories. Otherwise, the system cannot be considered as a model of the writing process. Although during this work MEXICA's outputs have been referred as stories, this author believes that computerised story telling is far from producing stories similar to those created by human beings. To make clear this distinction, in the questionnaire presented in Section 6.1.4 the outputs produced by the programs are referred as frameworks for short stories.

### 6.1.1 Production of Material during Engagement.

The main objective of the Engaged State is to produce material without using explicit goals or predefined structures. That is, to simulate part of the process where writers use writing as a way to discover what to say. Since MEXICA lacks any routine that employs goals or story structures to guide the development of a story during engagement, it is possible to conclude that all material produced during the Engaged State satisfies this requirement.

This objective is achieved through the use of the Abstract Representation and the routines to retrieve possible next actions from long-term memory. They allow MEXICA to recognise similarities between the context in the story in progress and analogous situations that have occurred in Previous Stories, and use them to select the next event in the tale.

By contrast, previous works require an explicit guide that indicates the path to follow to avoid illogical outcomes during story development. As a consequence these systems suffer some problems of rigidity. For

example, MINSTREL (Turner 1993) and GESTER (Pemberton, 1989) make use of explicit information about story structures to assure the production of coherent and interesting episodes. TALE-SPIN (Meehan, 1981) utilises goal-directed reasoning or inference functions to generate sequences of predefined actions to follow.

*In this way, MEXICA shows that a different method to predefined story structures and problem-solving techniques can be used to generate coherent sequences of actions during the story development.*

### 6.1.2 Engagement-Reflection Maps.

In previous chapters the routines that represent the Engaged and Reflective States have been analysed in detail and their main characteristics highlighted. However, to represent engagement and reflection in the computer model and generate texts is not enough in order to conclude that the theory works. One of the main claims of the theory is that outputs are the result of the *interaction* between engagement and reflection. To evaluate the degree of this interaction a set of tables called engagement-reflection maps are employed. They visualise MEXICA's dynamics in terms of engagement and reflection during the development of a story. The following is a map of the story *The princess who cured the Jaguar Knight* (see Section 5.1) in terms of the Engaged and Reflective States:

| | |
|---|---|
| Reflective State | 4-6,15 |
| Initial Action | 0 |
| Engaged State | 1 |
| Reflective State | 7, 16 |
| Engaged State | 2,3,8-11 |
| Reflective State | 13,17 |
| Engaged State | 12 |
| Reflective State | 14 |

Reflection 50.0%
Engagement 44.4%

In order to explain how to interpret the map it is necessary to remember the way MEXICA generates this story. The user gives an initial event; then MEXICA generates three events under engagement and switches to reflection. That is, the initial action is given by the user at time=0, the first action during engagement is generated at time=1, the second at time=2, and the third at time=3. This can be represented in an engagement-reflection map as follows:

| | |
|---|---|
| Initial Action | 0 |
| Engaged State | 1-3 |

Map 1: Reflection 0.0%,
Engagement 75.0%

The cell in black indicates the initial action (given by the user). Cells in white indicate the actions generated during engagement; cells in grey indicate the actions generated during reflection. The number of the map and the percentage of events generated during reflection and engagement is indicated at the bottom of the table. The numbers in the second column in the map indicate the time in which the actions were generated. The position of the entry in the table indicates the position of events within the story, with the start of the story at the top of the table and the end of the story at the bottom of the table. The order in which actions are presented in one cell is the same order they appear in the story. Thus, map 1 indicates that the order of the actions in the story produced so far is 0,1,2,3, end.

During reflection MEXICA inserts four actions at times 4, 5, 6 and 7 to satisfy the preconditions of the story in progress. Three of those actions are inserted at the beginning of the story and the fourth just after the action generated at time=1. This is represented as follows:

| | |
|---|---|
| Reflective State | 4-6 |
| Initial Action | 0 |
| Engaged State | 1 |
| Reflective State | 7 |
| Engaged State | 2,3 |

Map 2: Reflection 50.0%
Engagement 37.5%

So far, this map indicates that the first three actions that the reader finds in the story in progress are generated during reflection at time=4, time=5 and time=6. The fourth event in the story is given by the user at time=0. The fifth event that the reader finds in the story in progress is generated during engagement at time=1, and so on.

Now MEXICA switches back to engagement and generates three events at time=8, time=9 and time=10. It switches to reflection but all the preconditions are satisfied, so no event is inserted. It switches again to engagement and produces an action at time=11, at time=12 and then an impasse is declared. At this moment the map looks as follows:

| | |
|---|---|
| Reflective State | 4-6 |
| Initial Action | 0 |
| Engaged State | 1 |
| Reflective State | 7 |
| Engaged State | 2,3,8-12 |

Map 3: Reflection 30.8%
Engagement 61.5%

The only difference between this map and the previous one is that five events have been included during engagement to the story in progress between time=8 and time=12. MEXICA switches to reflection and

inserts an action at time=13 to satisfy the preconditions of the action generated at time=12. An event is inserted at the end of the story at time=14 to try to break the impasse. The map at this point looks as follows:

| | |
|---|---|
| Reflective State | 4-6 |
| Initial Action | 0 |
| Engaged State | 1 |
| Reflective State | 7 |
| Engaged State | 2,3,8-11 |
| Reflective State | 13 |
| Engaged State | 12 |
| Reflective State | 14 |

Map 4: Reflection 40.0%
Engagement 53.3%

The impasse cannot be broken and the story is abandoned. MEXICA switches to reflection to analyse the story and inserts three events at time=15, time=16 and time=17 to produce the final version. So, the map looks as follows:

| | |
|---|---|
| Reflective State | 4-6,15 |
| Initial Action | 0 |
| Engaged State | 1 |
| Reflective State | 7, 16 |
| Engaged State | 2,3,8-11 |
| Reflective State | 13,17 |
| Engaged State | 12 |
| Reflective State | 14 |

Map 5: Reflection 50.0%
Engagement 44.4%

This engagement-reflection map clearly shows:

- How the order in which the story is presented to the reader is not the same order in which it is generated.
- Engagement and reflection both contribute to writing different parts of the story in a dynamic manner. Furthermore, the story develops in a non-linear way rather than linearly progressing from the start of the story to its end.
- Most importantly, it clearly shows how the final story is the result of interactions between engagement and reflection: 50.0% of the story is created during reflection and 44.4% during engagement (the user gives the first action, i.e. 5.6% of the story). Notice how, as a result of the engagement-reflection

cycle, MEXICA intercalates different events during the development of the story. Each time a new action is inserted the story context is modified affecting the possible following actions to be retrieved. In the same way, all those events retrieved from memory whose preconditions are not satisfied provoke new actions to be included in the story.

The following table compares the percentage of events produced during engagement and reflection for each of the maps presented in this example:

| MAP | Reflection | Engagement |
|---|---|---|
| 1 | 0.0% | 75.0% |
| 2 | 50.0% | 37.5% |
| 3 | 30.8% | 61.5% |
| 4 | 40.0% | 53.3% |
| 5 | 50.0% | 44.4% |

The cells in dark grey highlight those states that generate more events. In this table we can observe how during the developing of the story there is a continuum switching in the leadership of the production of material between states. For example, in map 3 one can observe how the actions generated during engagement duplicate the number of actions generated during reflection. However, this trend changes through the development of the story and in the final version of the story (map 5) the number of actions generated in each state is very similar. The relation between actions generated during engagement and reflection changes due to the interaction between states and the different circumstances surrounding the developing of the story (e.g. how many actions with unsatisfied preconditions are retrieved). Such circumstances change from one story to another. For example, the following table shows the map of the story *The lovers* (see Section 6.1.3):

| | |
|---|---|
| Reflective State | 4-6 |
| Initial Action | 0 |
| Engaged State | 1-3 |
| Reflective State | 10,14,15 |
| Engaged State | 7 |
| Reflective State | 16 |
| Engaged State | 8,9,11,12 |
| Reflective State | 17 |
| Engaged State | 13 |

Reflection 44.4%
Engagement 50%

Comparing this map with the one of the story *The princess who cured the Jaguar Knight* shows some of the differences in the dynamic of the system during the development of stories. Both stories are formed by

eighteen actions. However, during the development of the story *The princess who cured the Jaguar Knight* MEXICA retrieves more actions from memory whose preconditions are already satisfied than during the writing of *The lovers.* This situation can be observed in the princess' story map: see how the second engagement block has six actions, where four of them in a row (from 8 to 11) do not require to be justified (the other story only links three actions in a row). On the other hand, in the story *The lovers* more events are produced during engagement than in the story *The princess who cured the Jaguar Knight* (see the percentages at the bottom of each table). These differences only show how each story has its own dynamic during the development process.

*The material generated by MEXICA is the result of the interaction between engagement and reflection, and such interaction depends on the characteristics of each story in progress.*

### 6.1.3 Evaluating the Stories.

Evaluating MEXICA's output —or any other computerised storyteller— is problematic; a story that someone judges odd can be acceptable to another person. Thus, it is necessary to establish clear criteria to evaluate such outputs. A common method used from primary schools (see Enciclopedia Técnica de la Educación, 1990) to university literature courses to study fiction consists in separating and analysing the different properties or parts that form a particular piece of fiction. Notice that to isolate the elements that forms a novel, short story, etc., only works from a didactic point of view. That is, the separation between theme and style and narrative order is artificial and only acceptable for expositional and analytical reasons. It never happens in reality because what a novel says is inseparable from the way it is said (Vargas Llosa 1997, p.34)

What elements in the short stories produced by MEXICA must be evaluated? At the beginning of this research it is stated that MEXICA can produce stories that flow in a coherent way and are interesting (i.e. produce suspense, tension in the reader). Thus, these are two aspects that require to be assessed. One of the main differences between MEXICA and previous works is that MEXICA avoids using predefined story structures to produce a tale. Ensuing from this, the structure of MEXICA's outputs also needs considering. Another important difference between MEXICA and previous works has to do with the way the content of a story (i.e. what the story is about, what it says) is generated (MEXICA avoids using explicit goals or predefined story-structures). Thus, it is necessary to evaluate the content of MEXICA's stories. Other aspects like kind of language used, vocabulary, variety in the use of phrases, etc. are not part of this research (e.g. Natural Language Processing is out of the scope of this work) and therefore are not considered for evaluation. Thus, the stories produced by MEXICA will be evaluated according to the following four criteria:

- Flow and coherence
- Structure

- ❖ Content
- ❖ Suspense

The Collins English Dictionary defines coherence as “logical or natural connection or consistency.” Thus, this section analyses if the sequence of actions in MEXICA’s outputs flow in a logical or natural way. To produce interesting stories MEXICA builds suspense through the Tensional Representation method. Brewer and Lichtenstein (1982, p.481) affirm that a story involving suspense must include an initial event —which leads to significant positive or negative consequences for one of the characters in the narrative— and an outcome or resolution for such an event. Suspense is produced when the reader gets interested about the possible consequences that the initial event might have for the character. It ends when the outcome of the initial action is introduced into the narrative. In order to build up the suspense additional events are included between the initial action and its resolution.

Thus, this section studies if MEXICA’s stories produce suspense. The content has to do with what the story is about, what it says. Thus, this section examines if MEXICA’s stories have an adequate content and how complex it is. Finally, Clayton (1996) defines narrative structure as “how a writer orders the events of a story”(p.12). The order in which events are organised has a major impact on the story; e.g. the organisation of a murder fiction is not the same as the organisation of a fable. Some people propose that the structure of stories account for their enjoyment (Brewer and Lichtenstein 1982). Thus, this section studies if the MEXICA’s outputs have a clear structure. In this way, a good story would be that which:

- Flows in a coherent way.
- Has a clear structure.
- Has an adequate content.
- Is interesting for the reader.

These aspects are examined by this author in four stories produced by MEXICA under different operation modes and with different tensions to the reader. Two of MEXICA’s stories were generated under ER2 operation mode and two under E2 operation mode. To include another variable in the analysis, one of the ER2 stories and one of the E2 stories were forced to have low values for the variable Tension to the Reader, i.e. MEXICA was forced to produce two “boring” stories. In this way, it is possible to evaluate if the method employed to generate interesting stories works. Thus, the four stories can be classified as ER2, ER2-LTR (where LTR stands for Low Tension to the Reader, i.e. boring stories), E2, E2-LTR. These stories were selected because they were representative examples of the kind of stories MEXICA produced under these constraints.

**A. Analysis of the Stories.**

E2-LTR.
Although at the beginning Princess did not want to admit

it, Princess fell in love with Tlatoani. For long time Tlatoani and Lady had been flirting. Now, openly they accepted the mutual attraction they felt for each other. Princess hated Lady

The **E2-LTR** narrative is logical (the princess is in love with the Tlatoani; however, the Tlatoani and the lady like each other and as a consequence the princes hates the lady). However, the narrative is too short that it is difficult to find a clear story-structure (it gives the impression of being an extract from other story), it does not say anything (just that the princess hates lady) and fails to produce any suspense. The lack of these elements makes difficult to classify it as story.

E2

Hunter was an ambitious person and wanted to be rich and powerful. So, Hunter kidnapped Princess and went to Chapultepec forest. Hunter's plan was to ask for an important amount of cacauatl (cacao beans) and quetzalli (quetzal) feathers to liberate Princess. Farmer thoroughly observed Hunter. Then, Farmer took a dagger, jumped towards Hunter and attacked Hunter. Suddenly, Farmer and Hunter were involved in a violent fight. Hunter went in search of some medical plants and cured Princess. As a result Princess was very grateful to Hunter. Hunter and Princess went to the Great Tenochtitlan city.

The **E2** narrative presents a structure that allows distinguishing three main parts: the princess' kidnapping, the fight between the farmer and the hunter, and the hunter curing the princess and going back home. However, there is a lack of a coherent flow. In the first part of the story the farmer is observing the hunter; however, it is never explained how or when the farmer found the hunter (the forest is not an obvious place to find a farmer). Also, there is not an explanation of why the farmer suddenly attacks the hunter (one might assume that the farmer is trying to rescue the princess, but the situation is not clear). But the main logical gaps are in the following part. The hunter and the farmer are involved in a violent fight and in the next event, out of the blue, the hunter is searching medical plants to cure the princess. How and when does the fight stop? Does the hunter kill the farmer? How and when does the princess get injured? And finally, if hunter's intention was to get some economical benefit from the princess, Why does he go back home with her? The system is trying to introduce some suspense through the kidnapping, the fight, and the illness of the princess, but the lack of coherence prevents the reader of getting involved with the characters and the suspense is not produced. The same occurs with the content, i.e. the logical gaps avoids a proper linking of ideas and as a result there is not a clear notion of what the story is about.

E2-LTR

Jaguar_knight was an inhabitant of the Great Tenochtitlan. Princess was an inhabitant of the Great Tenochtitlan. Jaguar_knight was walking when Ehecatl (god of the wind) blew and an old tree collapsed injuring badly Jaguar_knight. Princess went in search of some medical

> plants and cured Jaguar_knight. As a result Jaguar_knight was very grateful to Princess. Jaguar_knight rewarded Princess with some cacauatl (cacao beans) and quetzalli (quetzal) feathers.

The events in the **ER2-LTR** story flow in a coherent way and they are well structured. There is a clear introduction, an event that leads to negative consequences for the knight (degradation process) and a resolution. All the events are very logical: due to the wind there is an accident, the princess cures the knight and as a consequence he rewards her. However, the story is very boring. Nothing really happens since the tension produced by the accident is solved immediately. That is, any possibility of suspense is killed immediately. As a consequence of this situation, the content of the story is very simple: someone gets ill, his partner cures him and everybody is happy.

ER2 (The Lovers)

Jaguar_knight was an inhabitant of the great Tenochtitlan. Princess was an inhabitant of the great Tenochtitlan. From the first day they met, Princess felt a special affection for Jaguar_knight. Although at the beginning Princess did not want to admit it, Princess fell in love with Jaguar_knight. Princess respected and admired Artist because Artist's heroic and intrepid behaviour during the last Flowery-war. For long time Jaguar_knight and Princess had been flirting. Now, openly they accepted the mutual attraction they felt for each other. Jaguar_knight was an ambitious person and wanted to be rich and powerful. So, Jaguar_knight kidnapped Artist and went to Chapultepec forest. Jaguar_knight's plan was to ask for an important amount of cacauatl (cacao beans) and quetzalli (quetzal) feathers to liberate Artist. Princess had ambivalent thoughts towards Jaguar_knight. On one hand princess had strong feelings towards Jaguar_knight but on the other hand Princess abominated what Jaguar_knight did. Suddenly, the day turned into night and after seconds the sun shone again. Princess was scared. The Shaman explained to Princess that Tonatiuh (the divinity representing the sun) was demanding Princess to rescue Artist and punish the criminal. Otherwise Princess's family would die. Early in the Morning Princess went to Chapultepec forest. Princess thoroughly observed Jaguar_knight. Then, Princess took a dagger, jumped towards Jaguar_knight and attacked Jaguar_knight. Jaguar_knight was shocked by Princess's actions and for some seconds Jaguar_knight did not know what to do. Suddenly, Princess and Jaguar_knight were involved in a violent fight. In a fast movement, Jaguar_knight wounded Princess. An intense haemorrhage arose which weakened Princess. Jaguar_knight felt panic and ran away. Thus, while Tlahuizcalpantecuhtli (the god who affected people's fate with his lance) observed, Princess cut the rope which bound Artist. Finally, Artist was free again! Princess was emotionally affected and was not sure if what Princess did was right. Princess was really confused. The injuries that Princess received were very serious. So, while praying to Mictlantecuhtli (the lord of the land of the dead) Princess died.

**ER2** story presents a clear structure. At the beginning the main characters are introduced in the story and the emotional links that tie them are clearly established. Then, the main degradation process starts: the knight kidnaps the artist. This situation not only affects the artist but also reaches the princess who is confronted with two options: following the man she loves or fighting against what she thinks is abominating. A sign sent by the gods (the eclipse) makes her mind up; so, she decides to go and rescue the artist. The rescue scene includes the beginning of a new degradation process: her lover injures the princess. Finally the resolution arrives: the artist is liberated, the princes dies questioning her own behaviour and the knight escapes. The whole story flows in a very coherent way, i.e. each action performed in the tale is justified. Particularly important is the event where divine forces command the princess to go and rescue the artist: it explains princess' behaviour and drives the story towards its tragic end. The content is also interesting: the story talks about someone at the crossroads, the dilemma of deciding between two opposite

options and the conflict it produces. The fact that her lover is who kills the princess produces an ironic situation and suggests how, at the end, any decision would have brought a sad end. The dilemma, the fighting and wounding events produces suspense in the reader and makes an interesting story.

From this analysis it is concluded that the story ER2 (also referred as *The Lovers*) better meets criteria of coherence, structure, content and suspense established at the beginning of this section as a characteristics of a good story. The ER2-LTR story satisfies the coherence and structure points; the content is not very well managed and there is a lack of suspense. Thus, this story is classified as the second best. The E2 story presents a not very clear structure and a serious problem with the coherence that produces a lack of content and problems with the suspense. So, this story is classified as third. The E2-LTR story is the worst since it does not satisfy any aspect.

| | ER2 | ER2-LTR | E2 | E2-LTR |
|---|---|---|---|---|
| Coherence | Y | Y | N | N |
| Structure | Y | Y | ~ | N |
| Content | Y | ~ | N | N |
| Suspense | Y | N | ~ | N |

(Y= yes, N= no, ~= maybe)

This initial analysis shows differences between the four types of stories. These differences are more rigorously examined in the form of a questionnaire in the following section.

### 6.1.4 The Questionnaire.

In order to test the initial results obtained after the analysis in Section 6.1.3 and compare MEXICA's outputs with other programs' stories, a questionnaire to find people's opinion about a group of computerised stories was designed. Its purpose was to ask a heterogeneous group of persons to assess the flow and coherence, structure, content, suspense and overall quality of short stories produced by MEXICA and other computer programs. The full questionnaire is given in Appendix G.

**A. Description of the Questionnaire.**

The questionnaire was presented as a PhD research in computer-based story generation. It collected some personal data of the participants: their age, sex, nationality and last academic grade obtained. Seven stories were included: four produced by MEXICA (the stories analysed in Section 6.1.3), one by GESTER, one by MINSTREL and one by the author of this research. These stories were selected by the author as representative examples of the kind of stories these programs produced. For example, in the case of GESTER's story, Pemberton included it as a part of an international paper published by her (Pemberton 1989). In the case of MINSTREL's story, it is the first tale the reader finds in Turner's PhD thesis (Turner

1993). The author of this work created the last story included in the questionnaire; this fact is not mentioned to the subjects participating to avoid prejudices in their answers. This story was written trying to imitate the same language used in the other stories in the questionnaire. However, this author made an effort to produce the best structure, content, coherence and suspense he could in the story. This story, called the HUMAN story, provides a comparison between human and computer-generated stories. The presentation order of the seven stories in the questionnaire was selected at random. This is the result:

- Story #1 MEXICA E2
- Story #2 GESTER
- Story #3 MEXICA ER2-LTR.
- Story #4 HUMAN story.
- Story #5 MEXICA E2-LTR.
- Story #6 MINSTREL
- Story #7 MEXICA ER2

Subjects were asked to evaluate the flow and coherence, structure, content, suspense and overall quality of each of the seven narratives. The questionnaire did not include any definition or explanation of what is understood for each of these five aspects. Since it was required that all subjects participating in the questionnaire must have finished their A-levels (or equivalent), it is assumed that (at least) they posses a basic understanding of these terms. For each aspect to be evaluated there were five possible answers ranging from “very good” to “very poor”. An additional question to know how much subjects liked each story was included. At the end of the questionnaire subjects ranked the seven stories: one for the best, seven for the worst. Also, a space was provided to write any comments they felt like expressing about the questionnaire.

**B. Description of Subjects**.

Fifty subjects answered the questionnaire; they were required to be over 21 and have passed A-level (or equivalent) grade. This constraint produced a subject pool (42% female, 58% male). The average age of the participants was 30.92; the youngest was 25 years old, the oldest 62. The percentage of participants classified by nationalities and their grade of education is showed in table 6.1: 38% of them were Americans (Brazilians, Canadians, Mexicans and USAns) and 62% Europeans (Austrians, British, Dutch, French, Germans, Greeks, Norwegians and Polish). Regarding their education, 92% of them were graduated, 68% possessed postgraduate degrees and 6% did not answer the question.

| **Nationality** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mexican | British | German | Brazilian | Polish | Norwegian | Greek | USA | French | Canadian | Dutch | Austrian |
| 20% | 20% | 16% | 12% | 10% | 6% | 4% | 4% | 2% | 2% | 2% | 2% |

| Education | | | | | |
|---|---|---|---|---|---|
| Unknown | Diploma | Bachelor | Master | MPhil | PhD |
| 6% | 2% | 24% | 46% | 4% | 18% |

**Table 6.1 Nationalities and educational level of the subjects that answered the questionnaire.**

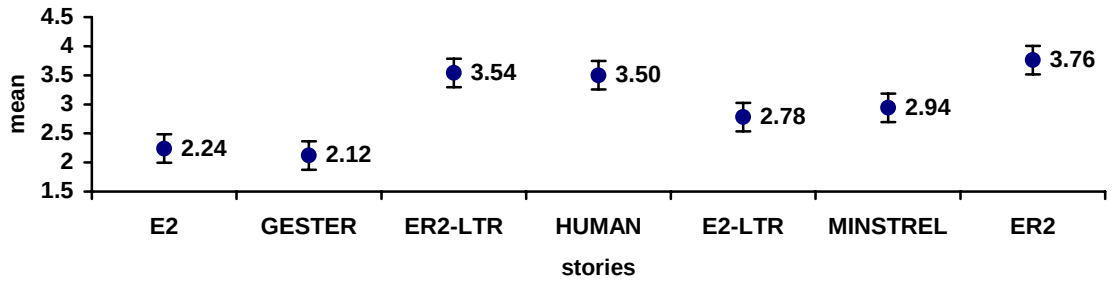
Although English was a second language for most of the subjects, stories were short and simple enough for the language not to be an issue. All questionnaires were sent and returned via electronic mail.

**C. Results.**

In all cases the Friedman analysis of variance is applied to obtain the level of significance. Following Greene and d'Oliveira (1981) values from 1 to 5 are allotted to the five-point scale between very poor and very good (and between not at all and a lot). For each evaluated aspect, the assessment of each story is equal to its mean. The confidence interval at 95% level is included for each result.

**Narrative flow and coherence**. The following are the results obtained from the evaluation of the narrative flow and coherence ($p<.01$): MEXICA ER2 3.76±0.29, MEXICA ER2-LTR 3.54±0.26, Human 3.50±0.35, MINSTREL 2.94±0.31, MEXICA E2-LTR 2.78±0.27, MEXICA E2 2.24±0.26 and GESTER 2.12±0.28.

**Fig. 6.1 Evaluation of the Narrative Flow and Coherence**



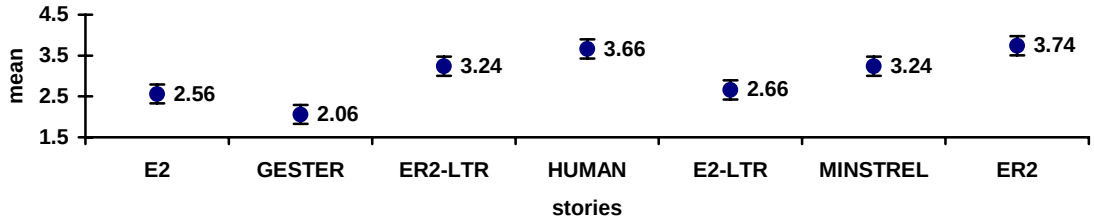

The rating of MEXICA's stories meets the results of the preliminary analysis of Section 6.1.3. The following comments made by two subjects, mention the lack of coherence in story E2 (i.e. story #1 in the questionnaire):

> `#1 comment: there's a problem. We never hear why princess needs to be cured -- has she been injured? why and when? ...`
>
> `Narrative #1 contains an illogical jump; it looks like a part is missing from an otherwise good story.`

The two stories produced under ER2 operation mode (stories #3 and #7 in the questionnaire) obtained — between the seven stories— the highest score in the evaluation (together with the Human story!). These results suggest that MEXICA's ER2 stories have a satisfactory flow and coherence.

**Structure**. The following are the results obtained from the evaluation of the narrative structure ($p<.01$): MEXICA ER2 3.74±0.24, Human 3.66±0.29, MINSTREL 3.24±0.27, MEXICA ER2-LTR 3.24±0.27, MEXICA E2-LTR 2.66±0.28, MEXICA E2 2.56±0.27 and GESTER 2.06±0.30.

**Fig. 6.2 Evaluation of the Narrative Structure**




In the case of MEXICA's outputs —as expected— the two stories generated under ER2 operation mode obtained a higher evaluation than those generated under E2 operation mode. However, contrary to the analysis done in Section 6.1.3, the majority of the subjects considered that the E2-LTR story had a better structure than the E2 story. Nevertheless, the confidence level indicates no difference.

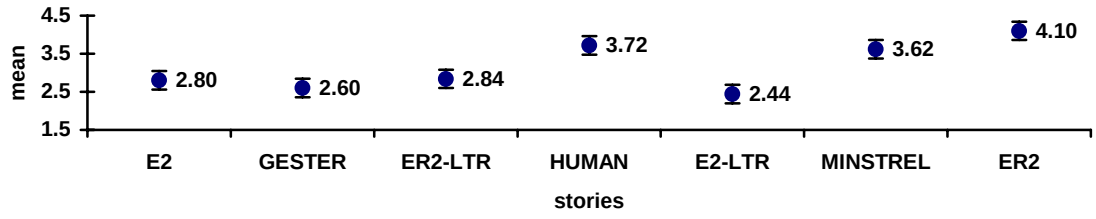
Although MINSTREL and GESTER make use of explicit story structures information to build they stories, MEXICA got the highest score in this aspect. This result suggests that it is possible to produce stories with an adequate structure without explicitly predefining it. Notice that MEXICA ER2 story obtained a higher evaluation than the human story. This result seems to suggest that, in opinion of the subjects participating in the questionnaire, MEXICA is able to structure a computer-style story better (or at least with the same quality) than the author of this work is.

**Content**. The following are the results obtained from the evaluation of the content ($p<.01$) (see Fig. 6.3): MEXICA ER2 4.10±0.26, Human 3.72±0.26, MINSTREL 3.62±0.25, MEXICA ER2-LTR 2.84±0.24, MEXICA E2 2.80±0.27, GESTER 2.60±0.28 and MEXICA E2-LTR 2.44±0.27.

Regarding MEXICA's outputs, this time the results obtained from the questionnaire supported the analysis in Section 6.1.3: ER2 got the highest score, followed by ER2-LTR, E2 and E2-LTR. Fig. 6.3 clearly shows an important difference between ER2 and the rest of MEXICA's stories.

MEXICA obtained the highest and lowest evaluation in this aspect between all the stories. That is, MEXICA produced the story with the best content and with the worst content. These results reflect the importance of the suspense and reflective processes in the production of satisfactory contents.

**Fig. 6.3 Evaluation of the Content**



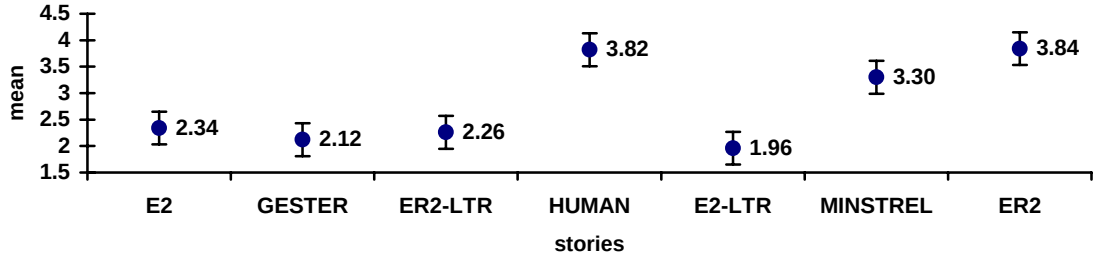

Subjects evaluated the content of the ER2 story higher than the content of the human story. This result took the attention of this author since the human story included some humour, a characteristic not found in any of the other six stories. However, although this fact was important for some of the subjects, it did not influence the overall result. The following comments show this situation:

```
4 was a bit humorous, which was pleasant.

Number 7 was good because of the rise and fall of suspense,
and was only beaten by number 4 because of the humour in narrative
number 4.
```

**Suspense**. The following are the results obtained from the evaluation of the suspense ($p<.01$): MEXICA ER2 3.84±0.30, Human 3.82±0.28, MINSTREL 3.30±0.29, MEXICA E2 2.34±0.26, MEXICA ER2-LTR 2.26±0.25, GESTER 2.12±0.30 and MEXICA E2-LTR 1.96±0.26.

**Fig. 6.4 Evaluation of the Suspense**



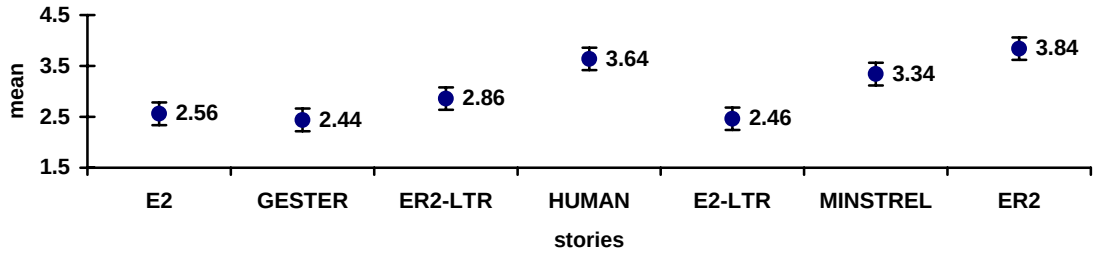

With respect to MEXICA's outputs, the results obtained meet what was expected: ER2 got the highest score followed by E2 story, while ER2-LTR story got the third place followed by E2-LTR story. That is, those stories forced to maintain low values for the Tension to the Reader got lower scores in the suspense assessment than those produced normally. Fig. 6.4 shows a difference between ER2 and the rest of MEXICA's stories, as it was mentioned in the initial analysis in Section 6.1.3. The following is a comment made by one of the subjects regarding ER2-LTR story (i.e. story #3 in the questionnaire):

```
Narrative 3  is coherent but everything goes normal, correct
(except for the accident which is immediately solved ) and
unavoidably boring.  There is no motivation (problem to be solved,
suspense, drama, hate, love, crime, etc.) for a short story.
```

MEXICA ER2 story together with the human story got the highest score. These results suggest that the process followed by MEXICA to create suspense and interesting stories work adequately.

**Overall Quality**. The following are the results obtained from the evaluation of the overall quality (p<.01): MEXICA ER2 3.84±0.32, Human 3.64±0.31, MINSTREL 3.34±0.30, MEXICA ER2-LTR 2.86±0.25, MEXICA E2 2.56±0.28, MEXICA E2-LTR 2.46±0.28 and GESTER 2.44±0.30.

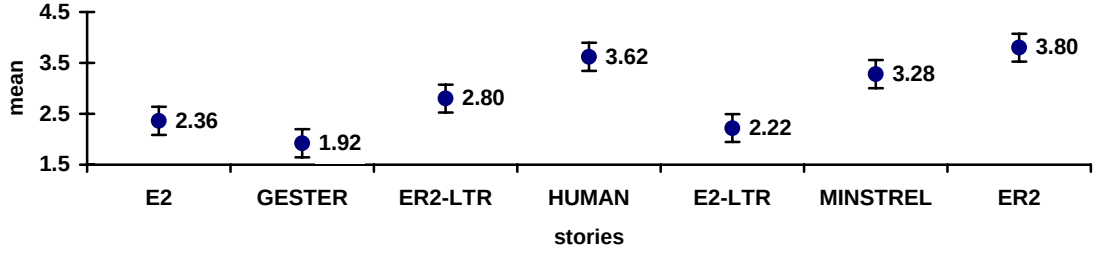
**Fig. 6.5 Evaluation of the Overall Quality**




Regarding MEXICA's outputs, the results of the assessment of the overall quality meet the conclusions in Section 6.1.3: ER2 was considered the best story, followed by ER2-LTR, E2 and E2-LTR.
Subjects evaluated MEXICA-ER2 as the story with the best overall quality. These results suggest that MEXICA is able to produce satisfactory computerised short stories.

**Liking of the stories.** The following are the results obtained from the evaluation of the liking of the stories (p<.01): MEXICA ER2 3.80±0.28, Human 3.62±0.25, MINSTREL 3.28±0.25, MEXICA ER2-LTR 2.80±0.21, MEXICA E2 2.36±0.21, MEXICA E2-LTR 2.22±0.25 and GESTER 1.92±0.29.

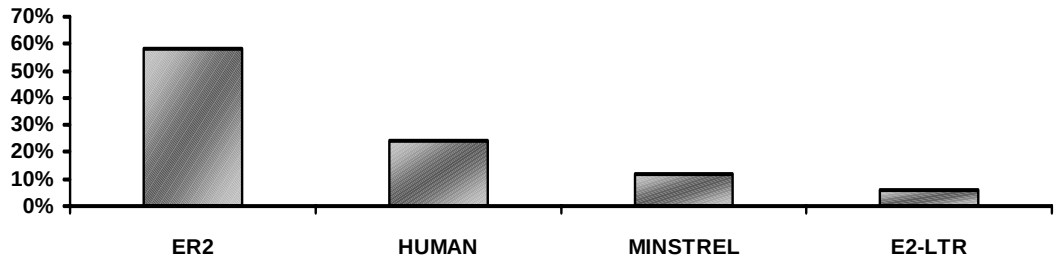
**Fig. 6.6 Evaluation of how much the Stories were Liked**




Subjects evaluated MEXICA ER2 story as the favourite story.

Figure 6.7 shows those stories ranked as the best: 58% of the subjects considered MEXICA ER2 as the best story, 24% chose the human story as the best one, 12% selected MINSTREL and 6% MEXICA E2-LTR story.

**Fig. 6.7 Evaluation of the Best Story.**




To establish a possible correlation between these results and the length of stories, the number of words in each narratives was registered: MEXICA ER2 was the longest story in the questionnaire (328 words in 35 lines); the Human was the second longest story in the questionnaire (221 words in 20 lines); MINSTREL was the third longest story (177 words in 20 lines). This analysis suggested that there was a correlation between those stories rated as the best and their lengths. However, it is interesting to point out that, although MEXICA E2-LTR was the shortest story in the questionnaire (41 words in 4 lines), it was considered as the best story by 6% of the subjects. Nobody considered MEXICA E2 (95 words in 10 lines), GESTER (179 words in 19 lines) or MEXICA ER2-LTR (66 words in 8 lines), which were longer, as the best story.

**D. Some Comments.**

MEXICA and MINSTREL are the programs that obtained the highest scores. Each row of the following table compares the comments made by the same subject about the stories produced by these programs.

| MINSTREL's story | MEXICA's ER2-story |
|---|---|
| 6 was hard to place. It was a good story, but it made many obvious statements about what was happening—statements that could be easily inferred. | 7 was poorly written but was the most interesting.• |
| Narrative #6 has a good content but contains a couple of the irritating telegram phrases that narrative #2 is full of. | Narrative #7 is good. Only in the end it becomes a bit incoherent. |
| #6 Comment: story is suspenseful. There are linguistic problems: sentence 3 and 4 duplicate information which is confusing. Too much is spelled out throughout the story. More should be implicit. Let the readers do the inference! This is a cool story, I really liked it a lot. the ending is unexpected and funny!!!! Was it really machine generated or is this a filler??? | #7 Anaphora resolution specially bad! The ending is a anti-climactic. The overall connection of the story and complexity is impressive, though. The princesses' conflict is well worked on and makes a good story. |
| Narratives 2,4,5 and 6 are OK. They can have some inconsistencies but overall are fine. | Narrative 7 is dense, there are different characters with ambiguous feelings and there is a story (action) really happening. |

**Table 6.2 Comparison of comments about stories #6 and #7.**

These comments are included since they allow the reader to visualise how some subjects perceived the evaluated stories, information that cannot be inferred from the answers in the questionnaire. For example, to question if story #6 was really machine generated (see the third row in Table 6.2) is a good compliment to MINSTREL; the same occurs with this person's opinion regarding ER2-story's complexity.

**E. Conclusions.**

- Stories produced under ER2 operation mode have better coherence, structure and content than those produced under E2 operation mode (people evaluated higher these aspects in the stories generated under ER2 than those produced under E2).
- The use of the Tension to the Reader as a method to produce interesting stories (suspense) works adequately. Subjects perceived the lack of suspense when outputs were forced to have low values of tension.
- Under the ER2 operation mode, MEXICA produces its best stories.
- Subjects evaluated MEXICA ER2 story higher than those representing other important systems.
- Subjects evaluated the coherence, structure, content and suspense of the MEXICA ER2 story higher than the ones of the story produced by the author of this work. This result suggests that subjects consider that MEXICA is able to produce computer-style stories (at least) similar to the ones produced by this author.

At the beginning of this section the criteria to evaluate stories was defined: coherence, structure, content and suspense. MEXICA ER2, MINSTREL and the human's stories got the highest scores in these aspects. And such stories were the ones people like the most and the ones that got the best evaluation in the overall quality as a framework for a short story point. This suggests that the selection of these aspects as criteria to evaluate stories is adequate.

Finally, it is interesting to notice how some of the subjects who answered the questionnaire seemed to enjoy it. For example, two subjects commented:

```
The stories were quite funny!
What do you want to show or find out?

It was really fun doing this experiment!!
```

However, others seemed to be against computerised story production:

```
I would suggest to stop the experiment with PCs literature, unless
the
purpose is to prove they are not the right poets.
```

*The results obtained from the questionnaire support the thesis that the engagement-reflection cycle is a viable model to produce adequate frameworks for short stories.*

## 6.2 Evaluating the Details of the Model.

MEXICA is a good example of how a computer model forces the modeller to think about all the details of a theory. Sharples' (1996) account of the writing process is very general, i.e. it does not include details about the cognitive processes performed during writing. Thus, an important part of this research consists of specifying all those details in order to create and implement the computer model. The computer model topic of this research is very complex and includes many processes that interact continuously to produce an output. However, there are two that —due to their importance— require a special consideration: the creative process followed by MEXICA and the method employed to produce interesting stories.

### 6.2.1 Evaluating the Creative Process in MEXICA.

As mentioned in Section 3.2.6 and following Sharples (1996), creativity is defined here as the production of novel and adequate outputs. In Sections 6.1.3 and 6.1.4 the appropriateness of MEXICA's outputs has been assessed. In this section the capacity of MEXICA to produce novel stories is evaluated.

| Story | Topic |
|---|---|
| Previous Story #1 | Love and Disloyalty. This story is about a knight who falls in love with his brother's girlfriend and decides to kidnap her. |
| Previous Story #2 | Love and Obsession. This story is about a princess who falls in love with a knight. When she realises that he is in love with another woman, the princess decides to kill her rival. |
| Previous Story #3 | Envy. This story is about a prince who envies his father position. The prince's ambition is so big that he abandons his father in the forest after he suffers an accident. |
| Previous Story #4 | Love and Obsession. This story is about a knight who is in love with a woman who is attracted to a different man. The knight decides to attack his rival. |
| Previous Story #5 | Valour. This story is about a kidnapped princess who is rescued by a farmer. The farmer is wounded during the rescue and dies. |
| Previous Story #6 | Gratitude. This story is about a hunter who saves the life of a Tlatoani, and later the Tlatoani does the same for the hunter. |
| The princess who cured the Jaguar Knight | Love and Revenge. This story is about a kidnapped princess who is rescued by a knight. The princess falls in love with the knight. However, she realises that the knight murdered of her father and decides to kill him. |
| The lovers. | Love and Values. This story is about a princess who is in love with a man whose values clash with the princess' values. Thus, she has to decide between following her values or following her man. |

**Table 6.3 Relation of the themes in the Previous Stories and two tales created by MEXICA.**

The criterion used to evaluate the novelty of MEXICA's outputs consists in comparing the topics of the tales produced by the system against the topics of the set of Previous Stories. That is, since all structures in

memory representing knowledge are formed from the set of Previous Stories given by the user, a novel story would be that whose topic is original with respect to any of the tales' topics in the Previous Stories. This method of assessment is inspired by Boden's ideas. For her, "The psychological sense [of creativity] concern ideas ... that are fundamentally novel with respect to *the individual mind* which had the idea." (Boden 1992, p.32) In the same way, in this research the computational sense of creativity concern stories produced by the system that are novel with respect to the set of Previous Stories loaded in its memory. Table 6.3 shows a relation of the topics in the file of Previous Stories and the topics of two stories created by MEXICA.

Although some events in the new tales might be similar to some episodes in the Previous Stories (Section 5.3.1 offers a clear explanation of why this similarity arises) Table 6.3 shows how the topics of the stories produce by MEXICA are novel with respect to the Previous Stories.

*Thus, MEXICA is capable of producing novel and adequate stories.*

**A. Processes Involved in the Production of Novel Stories.**

Although the whole system participates during the production of a novel tale, two core elements are responsible for bringing novel events into working memory: the Associative Structures and the ACAS-Process.

Associative Structures are dynamic organisations built from characters' contexts used to match atoms in long-term memory. Each time an Associative Structure is transformed, the requirements to match an atom are also modified and options not available in previous searches are now reachable. Although only two types of transformations have been implemented, other ways to modify the structure can be easily developed and included in the code.

The ACAS-Process allows matching atoms with a greater number of elements than the Associative Structure. That is, the ACAS-Process is analogous to transforming the Associative Structure by adding new Emotional Links or Tensions, in order to make it match a bigger atom. However, there is an important difference between the ACAS-Process and the transformation process. New elements added to the Associative Structure through a transformation routine are fixed; they cannot be removed until a new transformation is executed. By contrast, the ACAS-Process simulates some kind of "dynamic added elements". That is, through the ACAS-Process the Associative Structure behaves as if it had a fixed part (representing the core characteristics of the structure) and a dynamic part able to adapt to different atoms each time a match is tried. When an atom with similar characteristics but greater number of elements than the Associative Structure is found, the ACAS-Process produces the same effect as if all of the missing elements were added automatically to the Associative Structure in order to make it match the atom. Because this process can be repeated several times in a search, the overall effect is that of an Associative Structure able to adapt to various atoms with different characteristics.

**B. Production of Novel Knowledge.**

MEXICA transforms Associative Structures or executes the ACAS-Process when contexts not represented in long-term memory arise, or when no atom can be matched after all options brought to Working Memory have been rejected by the filters.

As a result of these processes, during story development MEXICA is able to generate contexts not present before in long-term memory. For example, in Section 5.2—after the action ENEMY KIDNAPPED PRINCESS is executed— the resulting princess and jaguar knight's contexts cannot be found in the Abstract Representation. Two new contexts are therefore generated by the system. This is indicated in the report by the expression PRINCESS: 3,7 ASI-50 JAGUAR_KNIGHT: 1,7 ASI-50 which means that the princess matched an atom 50% equal to the Associative Structure I and the knight matched and atom 50% equal to the Associative Structure I. That is, because new contexts have been created MEXICA cannot match an atom equal to the contexts in memory. Thus, the ACAS-Process is executed to match an atom 50% similar to the original context.

Other examples illustrating the same phenomena can be found in Section 5.2. The ability to produce contexts not present in the Abstract Representation is a very important characteristic of the system that allows producing novel stories. In other words, different authors see writing as a way of transforming experiences into new realities (see Section 2.2.1). Inspired by those ideas, MEXICA transforms information extracted from the Previous Stories into new contexts, resulting in the production of novel tales.

*MEXICA is able to create contexts not present in the system before.*

Of all the previous works studied in this thesis, only MINSTREL (Turner 1993) has explicit routines to evaluate the novelty of the story in progress and, when necessary, to modify events in memory to produced novel material not present before in the system. It is difficult to compare MINSTREL's heuristics against MEXICA's because they have very different approaches. In MINSTREL such heuristics (called TRAMs) attempt to create novel situations by transforming and adapting episodes in memory in order to instantiate predefined themes. By contrast, MEXICA attempts to recognise similar contexts to generate novel sequences of actions.

Nevertheless, some differences can be mentioned. An important and clear one is that MINSTREL is not able to produce novel themes to develop stories; all possible topics in MINSTREL are predefined. And furthermore, the structure that any story can have has also been decided in advance. In this way, creativity in MINSTREL means to generate novel episodes to instantiate pre-determinate structures. By contrast, in MEXICA the themes of stories are not defined a priori. Instead, they develop as the program is used repeatedly. Of course, any topic developed by MEXICA ultimately depends on the information stored in the Previous Stories. However, the flexibility of the processes included in the system permits developing themes not explicitly defined in the Previous Stories.

TRAMs can produce interesting and complex episodes. However, sometimes they look as if they were written to achieve particular events and able to work properly only under certain circumstances (see Section 2.4.3). If MINSTREL is fed with new themes and episodes it is necessary to write a new set of TRAMs that can transform them. By contrast, MEXICA's routines are made to identify similar contexts independently of the theme and so can adapt to new situations. Furthermore, parameters like the ACAS-Constant, the Novelty Percentage and Novelty Constants allow experimenting with different aspects of the creative process.

*Based on the information stored in the Previous Stories MEXICA is capable of producing novel tales. The Associative Structure and the ACAS-Process are the main routines used to retrieve original material from memory. MEXICA is able to produce novel structures in memory (representing new knowledge) that can be used to generate original tales.*

### 6.2.2 Evaluating the Tensional Representation as a Way to Produce Interesting Stories.

Conflicts, and the tension they produce in the reader, are essential components to create interesting stories. And although the ACAS-Process and Associative Structures are useful to retrieve events, it is no guarantee that the actions retrieved from long-term memory will produce an interesting story.

MEXICA solves this problem through the use of Tensional Representations. They represent degradation-improvement processes that register the tension of the story in progress (see Figure 5.3). By default a story is classified as producing enough interest when its Tensional Representation is at least 50% equal to the Tensional Representation of any of the Previous Stories (also called frames). Thus, in order to evaluate the story in progress MEXICA compares its Tensional Representation against all available frames, selects the frame most similar to it, and checks if they are at least 50% equal (see example in Section 5.2).

Although the evaluation of the story in progress is based on the similarity with a frame, the process of developing a tale is flexible enough to allow forming new Tensional Representations instead of just copying old ones. To illustrate this situation the reader can compare in Section 5.2 the Tensional Representations of the story in progress and all the Previous Stories. The result of the evaluation of the Tensional Representation is used to set the Tensional Guidelines that influence the production of material during the Engaged State (see Section 5.3.7).

*MEXICA verifies if a story is interesting by comparing the Tensional Representation of the story in progress against the Tensional Representation of all Previous Stories. The method is flexible enough to allow forming new Tensional Representations instead of just copying the old ones.*

The effectiveness of this method has been tested in the questionnaire described in Section 6.1.4. As reported earlier, those stories with low Tension to the Reader were the worst evaluated in suspense, while the stories with high Tension to the Reader obtained the best assessments.

MINSTREL (Turner, 1993) has a different way to produce interesting stories. Since the writing process consists of instantiating predefined structures (known as themes), MINSTREL simply includes in those structures elements that will make the story interesting. For example, the theme "Hasty-Impulse-Regretted" (Turner, 1993 p.267) is inspired by Romeo and Juliet's tragic end. When Romeo finds Juliet's body, he kills himself thinking she is dead. So, the message of this theme is to avoid doing things in haste, especially when their consequences are irreversible. MINSTREL represents this theme as a set of structures that must be instantiated. These structures can be described as follows. Character X has a belief that prevents him from achieving a goal. This, and his hasty personality, makes him do something irreversible. Character X learns something new which supersedes the evidence for his earlier belief. So, now that Character X has a different belief he wants to retract from his earlier action but he cannot because it is irreversible (Turner 1993, p.268).
This example illustrates how the events that will produce tension in the reader and make the story interesting are defined in MINSTREL's structures before the writing process starts. By contrast, in MEXICA those elements are introduced in the story as a part of the writing process. That is, MEXICA performs constant evaluations of the story in progress to try to avoid the production of boring tales. Filters also help to eliminate actions that do not contribute to develop interesting stories.

Something similar to MINSTREL occurs in GESTER (Pemberton 1989). The grammar assures that a story includes an initial situation, a development (which involves a complication, a plan to overcome the problem, etc.), and a final situation. TALE-SPIN (Meehan, 1981) does not include any process to evaluate the interest produced by a story.

## 6.3 Evaluation of MEXICA as a Research Tool.

One of the main objectives of this research is to give the user the opportunity to test the system under diverse circumstances. This section examines if this objective is met.
The computer program topic of this research can be simplified to two main components: the structures in memory and the processes that use those structures to generate new stories. If users can control the content of such structures and manipulate the features of the writing processes easily, the goal of allowing easy testing under different circumstances is achieved.
All memory structures in MEXICA are built from the files of Primitive Actions and Previous Stories. Thus, this section analyses the facilities offered by the system to define both of them and mentions how such structures affect the writing process. In the same way, the parameters definable by the user offer a

straightforward method to control some aspects of the writing process. Thus, they are also studied. Finally, the utility of reports produced by the system is considered.

**A. Primitive Actions.**

Primitive Actions, their preconditions and postconditions are used to build the Primitive Actions Structure. They are definable by the user through a simple language known as Primitive Actions Definition (PAD) (see Appendix A). PAD offers the following facilities:

- The use of the symbol star ('*') to refer to multiple actors or types of Emotional Links.
- The symbol percentage ('%') to allow establishing the intensity of an Emotional Link between characters at run time (i.e. at the moment of developing a story).
- Linked Characters to allow establishing some of the actors participating in an Emotional Link at run time, etc.

Examples are shown in Section 4.1. These facilities permit easy definition of complex events involving multiple preconditions and postconditions. This characteristic contrasts with the Conceptual Dependency model used by TALE-SPIN (Meehan, 1981) and MINSTREL (Turner, 1991) where the definition of some events can involve very complicated structures. During this work it has been pointed out in different occasions the way preconditions affect the writing process, and how postconditions modify the story-world context and therefore the process of retrieving actions from memory. Thus, the opportunity to define them not only allows establishing control over the content of the structures in memory but also influencing the developing process (e.g. satisfaction of preconditions, search of equivalent actions to break an impasse).

*Thus, the possibility of defining and modifying actions, preconditions and postconditions in a very simple way gives the user the opportunity to control the content of the Primitive Actions Structures. The information in such structures constrains some of MEXICA's processes (e.g. satisfaction of preconditions).*

**B. Definition of Previous Stories.**

The user defines all Previous Stories in the system through a language called Description of Previous Stories (DPS). DPS allows the specification of an unlimited number of stories without any restriction in their length. There are only two requirements to define them: the stories must exclusively include events defined as Primitive Actions and follow the DPS' syntax rules. The option of control over the content of the Previous Stories is important because the Concrete, Abstract and Tensional representations are created with information extracted from this file. In other words, MEXICA's structures representing knowledge are built from the Previous Stories. In this manner, the user can influence the way these structures are organised. For example, through the Previous Stories the user defines relations between story-contexts and logical possible next actions to perform. Thus, MEXICA knows that when a character is ill (story-context) it is necessary to look for a doctor (logical possible action). The control of the content in the Previous

Stories is also useful for other purposes. For instance, the example in Section 5.5.2 shows how the user can select certain Previous Stories to create the right conditions to test some of the characteristics in MEXICA.

*The Previous Stories determine the content of the main structures (representing knowledge) that guide the writing process in MEXICA. Thus, through their definition, the user can influence the way these structures are organised and therefore the writing process.*

**C. Parameters Definable by the User.**

MEXICA offers the user the possibility of manipulating twenty-three different parameters that constrain the story development process (see Table 4.1). The number of experiments and tests that can be done by varying all the different parameters available in the system is so large that only some of them can be reported in this work. In the experiments described in this thesis the following parameters are manipulated: ACAS-Constant (Section 5.4.1), Forbidden Actors (Section 5.4.2), the Operation Modes (Sections 5.4.3 and 5.5), the Initial State (Section 5.5.1) and the CtEg-Rf (Section 5.5.2).
The flexibility that these parameters offer allows, for example, confirming some hypothesis developed at the beginning of this research (e.g. the differences reported between operation modes). Also, the testing under different conditions has raised aspects not considered earlier (e.g. the large impact that in the developing of a story can have the different ways of instantiating characters). This information can be very useful to develop novel computer programs that can explore new aspects of the Engagement and Reflection cycle. It is also hoped that it will help to improve or develop new models of the writing process.

*More than 20 parameters definable by the user allow constraining and modifying different features of the writing process in MEXICA.*

**D. Reports in MEXICA.**

MEXICA generates three reports (some examples can be found in Appendixes E, and F). The first traces step-by-step the way Previous Stories are processed; it is very useful to study and analyse the way characters' contexts behave and therefore the way atoms are created in long-term memory. It also includes the graphic of the Tensional Representation of all Previous Stories. The second is a map of the Abstract Representation that includes all atoms and their position. Finally, the third is the familiar New Story Context's Report that traces the development of a new tale. For questions of space, only examples of the second and third report are presented in the thesis. However, notice that the first and third reports are the same; the only difference is that the former reports the Previous Stories and the latter the story in progress.
The importance and utility of the last report is obvious. However, the other two reports are also indispensable to trace, analyse and understand many of the processes in MEXICA. For example, with the

help of the map of the Abstract Representation the user can figure out some of the consequences of modifying the ACAS-Constant.

**E. Conclusion.**

One of the main purposes of a computer model is to allow easy testing of the hypothesis (represented by the model) under different circumstances, which in some cases can be difficult or not feasible to perform in human subjects. MEXICA has proved to be flexible enough to permit such testing under different circumstances. It is important to stress that such a flexibility is unique in MEXICA; that is, as far as the author of this work knows no other story-generator program gives the user this flexibility to experiment with the model it represents.

## 6.4 Summary.

This chapter evaluated MEXICA as a computer model. It was divided in three sections.
The first section tested whether the engagement-reflection theory worked. The first step to show that the theory worked was to demonstrate that MEXICA embodied the theory's main postulates: production of material without the use of predefined story-structures or explicit goals, and the production of material as the result of interactions between engagement and reflection. The second step to evaluate the theory was to examine the outputs produced by the system. Criteria to perform this evaluation were established, and four stories developed by MEXICA assessed. To validate the results obtained from this evaluation and compare MEXICA's outputs against other programs stories, a questionnaire to discover people's opinion about computerised stories was designed and given to 50 subjects. The results from the questionnaire indicated that MEXICA ER2 obtained the highest score.

The second section analysed the creative process and the method used to produce interesting stories. Following Sharples (1996), creativity was defined as producing adequate and novel outputs. In this way, adequacy was assessed through the questionnaire in Section 6.1. Novelty was assessed by comparing the themes of the stories produced by MEXICA against the themes of the Previous Stories. During the evaluation MEXICA generated interesting stories by using degradation-improvement processes to create suspense. This method was analysed in Section 6.2; the results from the questionnaire showed that this was an appropriate method to produce interesting stories.

The last section examined all the facilities that MEXICA offered to experiment with the model. In MEXICA all knowledge in memory was built from the Primitive Actions and Previous Stories. These files were built by the user, allowing her/him to control the content of memory. Furthermore, a large number of parameters that constrain the story development process were modifiable by the user. Once the story was written, reports were printed to help analyse and interpret the results obtained from MEXICA. As far as the author of this work knows, no other system offers these facilities.

# Chapter VII

# Conclusions

Most computer (and psychological) models represent writing as an analytical and conscious activity where the author knows what to say before the writing-process starts. The present research proposes a different alternative based upon the account proposed by Sharples (1996). It sees the writing process as an interaction between states of engagement and reflection. The Engaged State generates material for reflection avoiding the use of deliberate planning and explicit story structures. The Reflective State analyses and evaluates the material produced during engagement, and sends guidelines for the production of material to the Engaged State.

## 7.1 Recapitulation of MEXICA.

This research has demonstrated the plausibility of developing a computer model of creativity in writing in terms of the Engaged and Reflective States. In this way, MEXICA complements and extends previous models based on problem-solving techniques and predefined story structures.

- MEXICA complements previous models: during engagement it produces sequences of actions without the use of goals or predefined story structures.
- MEXICA extends previous models: it is able to combine engagement methods with problem solving techniques in one computer model to produce novel and interesting stories.

### 7.1.1 Recapitulation of the Engaged State.

The following processes are used during engagement:

1) Create an Associative Structure from characters' contexts.
2) Match an atom in memory and retrieve set of possible next actions.
3) Filter the set of possible next actions.
4) Select the next action in the story.

The story development process starts when the user provides an initial action to the system and characters' contexts in working memory are updated. Then, MEXICA creates an Associative Structure and tries to match an atom. If the process fails (or the filters reject all retrieved options) the system transforms the Associative Structure or runs the ACAS-Process to try to match another atom. When valid alternatives are brought into working memory the system selects one at random as the next event in the tale, updates characters' contexts and goes back to step 1.

The transformation of the Associative Structure and the flexibility offered by the ACAS-Process are essential parts of the mechanism to produce novel and interesting stories in MEXICA. They allow matching of contexts in long-term memory similar to the one of the story in progress; in this way, novel sequences of actions that fix with the rest of the story can be produced.

Filters have two main functions: to keep the story moving and to eliminate all those actions that do not satisfy the requirements imposed by the guidelines. The former process is performed by a routine that verifies if an action flows; the latter by a routine that verifies if an action satisfies the guidelines. MEXICA verifies that any action generated during engagement or any action inserted to break an impasse flows. During the experiments performed to test the prototype, this routine proved to be a very important element during the development of a story.

Any action generated during engagement must satisfy the requirements established by the guidelines. However, only the Novelty Guideline is checked during reflection; i.e., any action inserted to break an impasse must only satisfy the Novelty Guideline (guidelines are not verified when satisfying preconditions). During reflection MEXICA gives priority to novelty than to Tension.

During engagement there is not any explicit evaluation process. That is, filters do not assess the worth of actions (there is no reference to measure such a worth). Filters merely block actions with certain characteristics while allowing others to pass.

Thus, the flexibility offered by the Dynamic Associative Structures and the ACAS-Process, combined with the elimination process performed by the Filters, are the essence of the production of material during the Engaged State.

### 7.1.2 Recapitulation of the Reflective State.

During the Reflective State MEXICA performs four main tasks:
1) Verify and satisfy preconditions.
2) Break impasses.
3) Evaluate the story in progress.
4) Update the guidelines.

MEXICA uses preconditions as a way to keep the logic in the story (i.e. to assure that all actions occur in a logical way). When it detects that one or more actions have unsatisfied preconditions, the events necessary to fulfil them are inserted. MEXICA is able to insert whole episodes in order to keep the consistency of the story.

When an impasse is declared MEXICA switches to the Reflective State. Before trying to break the impasse all preconditions are verified; if new actions are inserted to fulfil the preconditions, the characters' contexts might be modified in a way that the Associative Structure can now match atoms (breaking the impasse). If the impasse remains, MEXICA tries to retrieve from the Concrete Representation an action that in previous stories has been preceded by the action which triggered the impasse, and uses it to break it. If this option fails, MEXICA looks for an Equivalent Action and follows the steps just described. If this option fails again an unbreakable impasse is declared and the story abandoned. This process exemplifies how routines designed for different purposes (in this case the satisfaction of preconditions) can be used to complement others.

During the evaluation of novelty MEXICA compares the story in progress against all Previous Stories. If more than 50% of the story in progress is equal to some of the Previous Stories, a request for more original actions is sent to the Engaged State through the Novelty Guideline. (The value of 50% is modifiable by the user).

Concerning the evaluation of tension, MEXICA selects between all the Tensional Representations available the most similar to the one of the story in progress; this Tensional Representation is referred to as a frame. When the Tensional Representation of the story in progress is less than 50% equal to the frame, the story is considered as not generating enough interest; a request for actions producing more tension is sent to the Engaged State through the Tensional Guidelines. On the other hand, if they are similar enough, the Tensional Guidelines are relaxed allowing arising different values for the Tension to the Reader. In this way, MEXICA is able to create new Tensional Representations using the old ones as a guide. (As in the case of novelty, the value of 50% is modifiable by the user).

### 7.1.3 Interaction between States.

MEXICA produces stories as a result of the interaction between the Engaged and Reflective States. Different examples illustrate this core characteristic of the system; maybe the best of them is the way the guidelines work. During engagement, the production of material is influenced by the guidelines; during reflection, the guidelines are updated based on the result of the evaluation of the material produced during engagement. The final story is the result of the interaction between both states.
Other examples are given by the routines to satisfy preconditions and break impasses. Both are active only during reflection; they insert new actions to the story in progress that affects characters' contexts and therefore the retrieval process during engagement. On the other hand, the material produced during engagement determines the number and type of actions inserted by those processes.

Thus, MEXICA combines two apparently opposite ways of seeing writing into one computer model.

### 7.1.4 The Research Tool.

MEXICA allows the user to experiment with different aspects of the model. All the information to build the structures in long-term memory is definable by the user through text files. In the same way, the user can control twenty three parameters that constrain different aspects of the story-development process. As a result of this flexibility provided by MEXICA, different angles of the Engaged-Reflective States model can be studied. For example, in the experiments reported in Chapter V (where some of the parameters are modified) it is possible to observe:

- How the ACAS-Constant alters the dynamics of the system (see Section 5.4.1).
- The link between preconditions and predictable stories (see Section 5.4.1).
- The way the instantiation process affects the direction a story takes (see Section 5.4.2-B).
- How the value of the Initial State affects the development of a story (see Section 5.5.1).
- The differences between operation modes (see Section 5.5.2).

Etc.

These results are important to develop more powerful versions of MEXICA (see Section 7.2); they might also help to develop and test new general models of writing.

## 7.2 Future Work.

Although MEXICA achieves the objectives defined at the beginning of this thesis, it still is far from being a complete model of writing. Some of the main problems are:

- Aspects like writer's motivation, re-description processes, etc. have been omitted from the model.
- The Reflective State lacks powerful problem-solving routines that can help to improve the quality of the outcome.
- The Engaged State fails to include in the retrieval process important aspects like characters' personality, social roles, etc.

This section suggests ways to overcome some of these limitations. It is divided in four parts. The first describes different ways to improve some of the existing processes in MEXICA. The second recommends routines that can be added to the system to make it more powerful. The third proposes some starting points for further research. Finally, the fourth proposes further research regarding the engagement-reflection model.

### 7.2.1 Improving Existing Routines.

A. Analysis of characters' contexts and the story in progress.

The Reflective State can be significantly improved through the development of some routines to analyse characters' contexts and the story in progress. They are necessary when actions are inserted to satisfy preconditions or break impasses. Three examples describing the main characteristics that such routines must include are now presented.

Routine 1. This routine can be used each time MEXICA needs to insert actions to satisfy preconditions. It works as follows:
1) Look in the Primitive Actions Structure for all possible alternatives that satisfy the required preconditions.
2) Analyse the characters' contexts to establish the kind of relationship existing between the actors in the tale.
3) Based on this analysis select between all available options the action that best matches the story in progress.
For instance, in the example in Section 5.4.2-B MEXICA needs to justify PRINCESS KILLED LADY. An analysis of the story reveals that the Princess is in love with Jaguar Knight; so, based on this information this routine must look for the best action available to justify the murder, e.g. LADY TRIED_TO_SEDUCE JAGUAR_KNIGHT.

Routine 2. Before inserting an action (either when satisfying preconditions or breaking an impasse), this routine must analyse which other events have occurred in the story to avoid unnecessary repetition of actions. For instance, in the example in Section 5.4.2-B MEXICA inserts the action ATTEMPTED_TO_TAKE_ADVANTAGE_OF twice to satisfy different preconditions.

Routine 3. This routine is similar to the first one. When MEXICA is satisfying preconditions or breaking an impasse, this routine can look for all possible options and analyse which of them best satisfies the requirements established by the guidelines. This can be useful to avoid cases like the one in Section 5.5.1, where an action just rejected by the filters is inserted to break an impasse without analysing other alternatives.

B. Evaluation of Novelty.

Although the routine to evaluate the novelty of a story in progress works, it is not ideal. For example, it will be more effective to compare shorter parts of the story instead of comparing just half or the whole

of it. Also, it is better to compare sequences with more than two actions and detect sequences that share the same actions but are arranged in a different order. For example, MEXICA cannot currently detect the similarity between PRINCESS DRANK_A_POISON, PRINCESS SAT_ON_THE_CHAIR, PRINCESS_GOT_ILL and the sequence PRINCESS SAT_ON_THE_CHAIR, PRINCESS DRANK_A_POISON, PRINCESS_GOT_ILL. The modifications proposed here would help to avoid this situation.

C. Retrieval of Possible Next Actions.

Although the process to retrieve possible next actions from memory has proved to work properly, some modifications would allow exploiting the information in the Abstract Representation in a more efficient way.
For example, when MEXICA runs the ACAS-Process (i.e. when it is trying to match an atom that includes the Associative Structure as part of its organisation) all atoms smaller than the Associative Structure are ignored. However, they might contain possible next actions useful for the story in progress. So, it is necessary to develop a routine similar to the ACAS-Process but which also processes atoms smaller than the Associative Structure.

D. Filters.

Filters have proved to be an important and efficient part of the Engaged State. Nevertheless, they require some improvements. For example, it is necessary to add to the filters a procedure that can recognise and eliminate those possible next actions which can be used to satisfy the preconditions of the last event in the story. This will help to avoid problems like the one shown in Section 5.6-B. In this example, MEXICA generates the following sequence of actions:

JAGUAR_KNIGHT HAD_AN_ACCIDENT
PRINCESS CURED JAGUAR_KNIGHT
JAGUAR_KNIGHT HAD_AN_ACCIDENT

If MEXICA were able to recognise that HAD_AN_ACCIDENT satisfies the preconditions for CURED, it could have avoided selecting it as the next event in the story.

### 7.2.2 Adding New Routines to MEXICA.

A. Extending the Definition of Primitive Actions.

Preconditions and Postconditions play a fundamental role in MEXICA. They are the material used to build the Abstract Representation and they influence different processes that affect the way stories are

developed. The Primitive Actions Description is used to define events with complex requirements and consequences. However, improvements can be made. The following are two examples:

- The possibility of refering to a third character not participating in the action.
- The possibility of using conditionals and logic operators (e.g. the operator OR).

With these modifications the preconditions of the action A GOT_JEALOUS_OF B could be defined as follows:

A GOT_JEALOUS_OF B
PRE
A(+3,2):C
C(+3,2):B
OR
A(+3,2):C
B(+3,2):C

That is, character A will get jealous of B if A is in love with C and C is in love with B, or if character A is in love with C and character B is also in love with C. Another interesting addition will be the possibility of defining as a precondition some of the tensions which result from inferred postconditions. In this way, the second part of the preconditions in the last example could be substituted by a tension due to love competition between A and B (Lc(A):B).

A GOT_JEALOUS_OF B
PRE
A(+3,2):C
C(+3,2):B
OR
Lc(A):B

At the moment, MEXICA can only work with events whose preconditions can be satisfied with the insertion of one action. All these modifications will require a routine capable of inserting two or more actions to satisfy preconditions.

B. Representing Social Roles and Personality.

The behaviour expected from a character depends on its social role and personality. For a particular story-situation, a reader would anticipate different reactions from a prudent Tlatoani, an irresponsible Priest and a brave Hunter. However, with only the exception of the Enemy (when an Enemy is killed the tension is not incremented), MEXICA does not make any explicit distinction between the actors in a tale. And although the group class helps to instantiate actions based on characters' behaviour in Previous Stories, it is necessary to develop routines to anticipate possible conducts. Such routines must

include an analysis of characters' contexts in order to associate them with some particular personalities. Social roles can be linked to expected events. In this way, the selection of next action in the story will be influenced by social roles and characters' personality.

C. Producing Longer Stories.

MEXICA cannot produce stories with a bigger number of actions than the longest tale in the Previous Stories. Because the evaluation of the story in progress, and therefore the guidelines, depends on a comparison between the Tensional Representation of the story in progress and the frame, MEXICA cannot function when it does not have anything to compare with. So, MEXICA requires a routine that can generalise the information encoded in the Tensional Representation in order to continue producing guidelines even if the story in progress is bigger than the frame.

D. Removing non-useful Actions.

Section 5.6-A shows an example of a story developed under ER1 operation mode. The story contains valuable material although, due to the lack of filters, it also includes some non-useful actions. This situation indicates the necessity for a routine that, after a story has been written, can analyse and remove events irrelevant to the tale. This routine also could be used in stories created under different operation modes. For instance, in the example in Section 5.4.2-B the actions ACTOR at the beginning can be eliminated without affecting the story.

E. Representing Bad Stories.

In MEXICA all Previous Stories represent examples of adequate tales. However, it will be convenient to also include examples of bad stories. In this way, having a model of what must not be done will help to improve the quality of the tales.

F. Using Predefined Structures and Author's Goals.

Predefined story structures have an important characteristic: they assure that the outcome will achieve specific targets. If MEXICA had a story grammar similar to GESTER's (Pemberton 1989), which were only used as a general reference to compare the story in progress (in an analogous way as the Tensional Representation works) the structure of MEXICA's tales would improve. In other words, as long as structures are not used to predefine the output at any level (structural level or actions level), they can be useful references in the development of a tale.

In the same way, the introduction of routines similar to the author's goals in MINSTREL (Turner 1993), which could help to build suspense, tragedy, etc. during the Reflective State, also will help to improve the quality of the stories develop by MEXICA.

## 7.3 Further Research.

A. Characters' Contexts and Atoms.

Characters' contexts and atoms provide the infrastructure necessary to generate coherent sequences of actions. However, more complex and therefore interesting stories require more complete characters' contexts. On the other hand, if they become too complicated it will be impossible to manage them. So, it is necessary to find the right balance.

The first obvious step is to increase the range of Emotional Links and Tensions available. In this way, things like envy or gratitude could explicitly be represented. A missing element in MEXICA that seems to be important in any story is the necessity of power (in all its different manifestations), which might be included as a Tension. Physical properties (e.g. hunger) or objects (e.g. a weapon) could also be part of characters' contexts.

B. Global Intentions and Writer's Demons.

Writing is a very complicated process, which clearly involves many factors currently absent in MEXICA. Some authors have suggested some of them. For example, Smith talks about global intentions influencing the writing process:

> This word, this sentence that I am writing now was not a concern of mine when I began this book, or even the present chapter. My global intentions have brought me to the point where I am now, and my global intentions will, I hope, carry me to the end. (Smith, 1982 p.90)

Some artists have pointed out that they write because of a necessity to express certain events that have made an important impact in them. Different people describe such events in different ways; e.g., Mario Vargas Llosa refers to them as demons that follow the writer:

> The "demons": facts, people, dreams, myths, which... antagonised the writer with her reality, were recorded with fire in her memory and tormented her soul, and became the material of her enterprise of reality's edification, and which she will try to retrieve and exorcise simultaneously with words and fantasy... (Vargas Llosa 1971, cit. in Klahn & Corral p. 372)

Thus, a good topic for further research is to investigate how some processes representing these global intentions and demons can be included in the model. For example, for the first case a structure representing global intentions can be defined. All atoms sharing certain characteristics with such a

structure will be more likely to be retrieved. In this way, the material produced during engagement will be influenced by the global intentions.
Regarding writer's demons, it is possible to develop a routine which could detect certain elements in characters' contexts which could be linked to events representing shocking experiences (demons). For example, maybe a tension due to Clashing Emotions can be associated with a frightening previous experience. Thus, if MEXICA detects in some of the characters' contexts a Clashing Emotion, it will trigger some kind of inferred postconditions (e.g. a tension representing fear) producing a new context.

C. Psychological Models.

Some of the ideas of the Representational Redescription theory (Karmiloff-Smith, 1995) can be found in this work. MEXICA's Concrete, Abstract and Tensional Representations embodies the concept of multiple representations at different levels of abstraction of the same information. This situation suggests the possibility of using the present model to investigate part of Karmillof-Smith's theory. That is, MEXICA offers a framework where the redescription process might be simulated. For example, some routines can be written to detect and group atoms into sets that share similar characteristics. Under particular circumstances representing some kind of behavioural mastery (e.g. when all atoms in one of those sets have been used X number of times) a redescription process can be fired, and a new, more abstract representation of the set of atoms (maybe analogous to a molecule) created.

In the same way, similarities between theories of Concept Retrieval (Raaijmakers & Shiffrin, cited in Torrance et al. 1996) and MEXICA's retrieval process can be found. The most important similarities are:
1) Probes are formed by permanent and non-permanent cues.
2) The content in the probe determines which concepts are brought into working memory.
3) Concepts are generated in clusters (i.e., a probe activates different related concepts).

Thus, although differences also exist (e.g. the way probes are updated), MEXICA can offer a computational environment to study some aspects of such a theory. The differences between MEXICA and the Concept Retrieval theory can be minimised through the development of some routines; e.g., a routine that allows the user to decide the way the transformation process works. This routine must include a procedure to explicitly define which part of the structure is fixed, which part is modifiable and the kind of transformations applicable to it.

## 7.4 Further Research on the Engagement and Reflection Theory.

At the beginning of this thesis, the general objectives of MEXICA as a computer model were established:

- Verify if a theory works.
- Specify the details of the processes involved in the model.
- Provide an environment to test the model under different circumstances.

This section examines how the results obtained from MEXICA as a computer model can be used as a base for further research into the theory of engagement and reflection.

1) Verification of the theory.- MEXICA has demonstrated that the engagement-reflection cycle is a plausible model of writing. In this way, it offers a frame where some psychological and computer hypothesis of writing can be tested (see Section 7.3).

2) Details of the process.- Implementation of the model required a detailed description of the processes involved in the engagement-reflection cycle. This is an important contribution for the theory since Sharples (1994, 1996) does not offer any details of such processes.
In his account Sharples (1996) mentions how the writer reflects on the material created during engagement, and how plans and constraints created during reflection guide further periods of engagement. MEXICA's implementation suggests explicit details of how that interaction works and the repercussions it has.

Further research in the way engagement and reflection affects and influences each other must be done to implement future versions of MEXICA (e.g. given the right constraints, a recursive call to an engagement-reflection cycle could be done to satisfy preconditions. It would be interesting to study the effects that such a recursive process has on the system, and compare them with the current results). These studies will be useful for psychologist interested in the engagement-reflection model..

Another aspect highlighted by MEXICA's implementation is the importance of a routine to explicitly verify if an action flows. Although it might seems quite obvious, it is a very important part of the development of stories. This is not explicitly mentioned in Sharples' (1996) account. In the same way, many computer models either do not include it (e.g. TALE-SPIN (Meehan, 1981)) or it is only an implicit part of the program (e.g., the predefined story structures in GESTER (Pemberton 1989) and MINSTREL (Turner, 1993)).

3) Adequate environment.- MEXICA offers an environment that allows testing of the model under different circumstances. As a result of it, the relevance of parameters such as the operation modes, the ACAS-Constant, Forbidden Actors (instantiation of characters), etc. has been shown. These results point to different possible areas of research.
For example, Section 5.4.3 analyses three different cases in which the characteristics displayed by the operation modes change. Many of the stories created by MEXICA are a combination of those three cases. Their study and analysis can help to establish some parameters that should allow future versions

of MEXICA to automatically switch between operation modes while developing a tale. In this way, MEXICA will be able to exploit the characteristics that are more convenient for the story in progress.
The operation modes E1 and ER1 can be associated with a kind of brainstorming process. In this way, these studies might help to establish ways in which writers could combine such brainstorming methods with more constrained processes.

## 7.5 Final Conclusion.

MEXICA has proved the plausibility of developing a computer model of creativity in writing in terms of the Engaged and Reflective States.
However, this work is only another step towards a better understanding of human creativity. It is hoped that it will encourage the research of all those aspects in the creative process not covered by previous models based on predefined story structures or problem-solving techniques. In this way, we might be able to better understand creativity, and therefore the way we think.

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# Appendix A

# Syntax of Primitive Actions.

This appendix gives a formal description of the syntax of a language called Primitive Actions Description (PAD). The specification of PAD's syntax is done in a story-grammar style where the following symbols are used:

'/' represents the logical operator OR.

'<>' indicates that an element is a non-terminal symbol.

'''' indicates that an element is a terminal symbol.

'{}' indicates that an element is optional.

',' indicates that the following element must be defined in the next line of the file.

'=' indicates the beginning of an expression.

'.' indicates the end of an expression.

'()' used to group elements to maintain the clarity of the definition.

A non-terminal symbol is an element that can be divided into sub-elements. A terminal symbol is an element that cannot be further divided. Any element on the left side of the symbol '=' is a non-terminal symbol. An expression defines the set of sub-elements given on the right-hand side, which form a non-terminal symbol. In this way, an element on the left side of the symbol '=' can be sub-divided in the elements included in the expression on the right side of the symbol '='.

Some of the elements in the Primitive Actions require to be defined on different lines. The symbol ',' is used to indicate that the next element must be defined in the following line of the text file. When elements are not separated by the symbol ',' they can be defined in one line, but there must be at least one space between them.

For example:

Definition of Primitive Actions = <Primitive Action>,
(<Definition of Primitive Actions>/ 'END').

must be interpreted as follows: The non-terminal symbol *Definition of Primitive Actions* can be sub-divided in the following elements: the non-terminal symbol <*Primitive Action*>, and (in the next line) either the non-terminal symbol <*Definition of Primitive Actions*> or the terminal symbol *'END'*.

A. Syntax to define Primitive Actions.

Definition of Primitive Actions = <Primitive Action>,
(<Definition of Primitive Actions>/ 'END').
Primitive Action = <Description of the Action>, {<Description Preconditions>},
{<Description Postconditions>}, {<Description Text>}.

Description of an Action = 'ACT', <String > <Number of Characters>.

Number of Characters = ‘1’/’2’/’3’.

Description of Preconditions = ‘PRE’, <List of Preconditions>.
List of Preconditions = <Precondition>, {<List of Preconditions>}.
Precondition = <Pre-Emotional Link>/<Pre-Tension>.
Pre-Emotional Link = ‘E’ <Character> <Character> <Intensity of EL> (<Type of Intensity>/’*’).
Pre-Tension = ‘T’ <Tension> <Character> {(<Character>/’*’) {‘+’} }.

Description Postconditions = {<Description Post-Emotional Link and Position>},
{<Description Post-Tension>}.
Description Post-Emotional Link and Position = ‘POS’, <List of Post-Emotional Link and Position>.
List of Post-Emotional Link and Position = (<List of Post-Emotional Link>/<List of Position>),
{<List of Post-Emotional Link and Position>}.

Description Text = ‘TEX’, <String_Text>, {<String_Text>}.
String_Text = (‘@A’ / ‘@B’ / ‘@C’ / <Symbol>) {<String_Text>}.

List of Post-Emotional Link = <Post-Emotional Link>, {<List of Post-Emotional Link>}.
Post-Emotional Link = ‘E’ (<Character>/<Linked Character>) <Character> (<Intensity of EL>/’%’)
<Type of Intensity>.
Linked Character = ‘La’/’Lb’/’Lc’.

List of Position = <Position>, {List of Position}.
Position = ‘P’ <Character> (<Number Position>/’b_pos’).
Number Position = ‘1’/.../’9’.

Description Pos Tension = ‘TEN’, <List of Pos Tension>.
List of Pos Tension = <Pos Tension>, {<List of Pos Tension>}.
Pos Tension = ‘T’ <Tension> <Character> {<Character> {‘+’} }.
Description Pos Position = ‘

Tension = ‘Ad’/’Lr’/’Hr’/’Pr’/’Ln’/’Hn’/’Pf’.
Intensity of EL = ‘-3’/.../’+3’.
Type of Intensity = ‘1’/’2’/’3’.
Character = ‘A’/’B’/’C’/’a’/’b’/’c’.
String = <Symbol> {<String >}.
Symbol = ‘a’/.../’z’/’A’/.../’Z’/’1’../’9’/’_’.

# Appendix B

## Syntax Previous Stories.

Following the same notation used in Appendix A, this appendix describes the syntax of a language called Definition of Previous Stories (DPS).

Previous Stories = <Story>, (<Previous Stories>/'END').

Story = 'STO', {Definition of Scenery}, <Sequence of Actions>.

Definition of Scenery = 'SCENERY' <Location>.
Location = 'Texcoco_Lake'/'Popocatepetl_Volcano'/Tlatelolco_Market'/'Palace'/'Tenochtitlan_City'/
'Temple'/'Jail'/'Chapultepect_Forest'.

Sequence of Actions = <Action>, {<Sequence of Actions>}.
Action = <Normal Action>/<Compound Action>.
Normal Action = <String Character> <String Action> <String Character>.
Compound Action = <String Character> ('WAS_TOLD'/'REALISED') <Normal Action>.
String Character = <String>.
String Action = <String>.
String = Any character represented in ASCIII.

# Appendix C

## Primitive Actions to Test the Prototype

For problems of space it is impossible to include all the Primitives Actions used to test MEXICA. However, this appendix includes representative examples. Notice that the Primitive Actions Definition language allows using the semicolon ‘;’ to insert comments in the specification of actions.
The syntax to define Primitive Actions specifies that associated texts must be defined in on line. However, sometimes such texts are too long that — in this appendix — it is necessary to use two or more lines. Those parts of the texts that cannot be included in the original first line are marked with the symbol ‘&-’.

```
ACT
Attacked 2
PRE
E a b -2 *      ; A(-2,*):B
POS
E b a -3 1      ; B(-3,1):A
E Lb a % 1     ; Lb(%,1):A
TEN
T Lr b a +      ; Lr(b):a+
TEXT
@A thoroughly observed @B. Then, @A took a dagger, jumped towards @B and attacked @B.
@A's frame of mind was very volatile and without thinking about it @A charged against @B.
```

```
ACT
Cured 2
PRE
T Hr b *
POS
E b a +3 1
E Lb a % 1
TEN
T Hn b a
TEXT
@A went in search of some medical plants and cured @B. As a result @B was very grateful to @A.
@A had heard that the Tepescohuitle was an effective curative plant. So, @A prepared a plasma and applied it to &- @B's wounds. It worked and @B started to recuperate! @B realised that @A's determination had saved @B's &- life.
```

```
ACT
died_by_injuries 1
PRE
T Hr a *
TEN
T Dead a
TEXT
The injuries that @A received were very serious. So, while praying to Mictlantecuhtli (the Lord of the land of the &- dead) @A died.
The injuries that @A received were very serious. However, @A knew that when a Mexica dies fighting, the Gods &- protect that soul in order it arrives safely to the other world. So, @A died in peace.
```

ACT
discovered_murder_of 2 ; @A discovers that @B killed someone very close to @A
PRE
E a b +2 *
POS
E a b -3 1
TEXT
@A was kissing @B when suddenly @A recognised @B's tattoo. It was the same as the one used by the fraternity &- which had murdered @A's father some months ago. At once all those terrible memories were present again.
@A was happy to have a strong relationship with @B. Suddenly, a farmer arrived and observed @B; there was &- no doubt, @B was the murder of @A's brother.

ACT
Had_an_accident 1
TEN
T Hr a -
TEXT
Tlaloc -the God of the rain- was angry and sent a storm. The heavy rain damaged the old wooden bridge. When &- @A tried to cross the river the bridge collapsed injuring badly @A's head.

ACT
Kidnapped 2
POS
E b a -3 1
E Lb a % 1
P a 9 ; A's position is set to Chapultepec Forest
P b 9 ; B's position is set to Chapultepec Forest
TEN
T Pr b a
TEXT
@A was an ambitious person and wanted to be rich and powerful. So, @A kidnapped @B and went to &- Chapultepec forest. @A's plan was to ask for an important amount of cacauatl (cacao beans) and quetzalli &- (quetzal) feathers to liberate @B.
@A was an ambitious person and wanted power and money in an easy way. So, @A kidnapped @B and went to &- Chapultepec forest. @A's plan was to ask for an important amount of cacauatl (cacao beans) and quetzalli &- (quetzal) feathers to liberate @B.
During the last war @B's father humiliated @A's family. Now, it was time of revenge and @A kidnapped @B. &- They went to the forest where @A tied @B to a huge rock. Exactly at midnight @A would cut @B up.

ACT
Killed 2
PRE
E a b -3 *
POS
E b a -3 1
E Lb a % 1
TEN
T Dead b a
TEXT
@A felt a deeply odium for @B. Invoking Huitzilopochtli, God of the war, @A cut @B's jugular. The blood &- covered the floor.
@A threw some dust in @B's face. Then, using a dagger @A perforated @B's chess. Imitating the Sacred &- Ceremony of the Sacrifice, @A took @B's heart with one hand and raised it towards the sun as a sign of &- respect to the Gods.
@A took a dagger and cut @B's throat. @B bled to death while Tonatiuh (the God representing the sun) disappeared in the horizon.

ACT
Rescued 2
PRE
T Pr b *
POS
E b a +3 1
E Lb a % 1
TEN
T Pf b a
TEXT
Thus, while Tlahuizcalpantecuhtli (the God who affected people's fate with his lance) observed, @A cut the rope &- which bound @B. Finally, @B was free again!
@A walked towards @B. Full of admiration for all the braveness that @B had shown in those hard moments @A &- liberated @B!

;SPECIAL ACTIONS *****
ACT
CLASH_EMOTION_1 2 ;the first time it appears in the story
TEXT
@A had ambivalent thoughts towards @B. On the one hand @A had strong feelings for @B but on the other &- hand @A abominated what @B did.
@A was emotionally tied to @B but @A could not accept @B's behaviour. What did @A must do?

ACT
CLASH_EMOTION_2 2 ; the second time a Ce appears in a story
TEXT
@A was shocked by @B's actions and for some seconds @A did not know what to do.

ACT
CLASH_EMOTION_3 1 ; When in a Ce both characters are the same.
TEXT
@A was emotionally devastated and was not sure if what @A did was right. @A was really confused.
@A was emotionally devastated and confused, and was not sure if what @A did was right.

ACT
Health_Risk_1 2 ; A = hero B = Victim A is aware of Hr(B)
TEXT
@A knew that @B could die and that @A had to do something about it.

ACT
Life_Risk_1 2 ; A = hero B = Victim A is aware of Lr(B)
TEXT
@A knew that the @B's life was in risk and had to do something about it.

ACT
Pr_Free_1 2 ; A = hero B = Victim A is aware of Hr(B)
TEXT
Although it was very dangerous @A decided to do something in order to liberate @B. For some minutes @A &- prayed to Quetzalcoatl -the feathered-snake, the God between the Gods- and asked for wisdom and braveness. &- Now @A was ready to find out its fate.
Suddenly, the day turned into night and after seconds the sun shone again. @A was scared. The Shaman &- explained to @A that Tonatiuh (the divinity representing the sun) was demanding @A to rescue @B and &- punish the criminal. Otherwise @A's family would die.

END

# Appendix D

## Previous Stories.

Previous Stories used to generate *The princess who cured the jaguar knight.*

| | |
|---|---|
| Sto ;1<br>Eagle_Knight Actor<br>Jaguar_Knight Actor<br>Eagle_Knight Was_In_Love_With Princess<br>Jaguar_Knight Was_In_Love_With Princess<br>Princess Was_In_Love_With Warrior<br>Eagle_Knight Got_Jealous_Of Warrior<br>Eagle_Knight Killed Warrior<br>Princess Attacked Eagle_Knight<br>Eagle_Knight Wounded Princess<br>Jaguar_Knight Attacked Eagle_Knight<br>Jaguar_Knight Fought Eagle_Knight<br>Jaguar_Knight Killed Eagle_Knight<br>Jaguar_Knight Exiled Jaguar_Knight | Sto ;2<br>Prince Went_Texcoco_Lake<br>Prince Had_An_Accident<br>Priest Found_By_Accident Prince<br>Priest Realised Prince Had_An_Accident<br>Priest Cured Prince<br>Prince Went_Palace<br>Fisherman Mugged Priest<br>Prince Realised Fisherman Mugged Priest<br>Prince Looked_For_And_Found Fisherman<br>Prince Made_Prisioner Fisherman |
| Sto ;3<br>Eagle_Knight Were_In_Love Lady<br>Eagle_Knight Loved Princess<br>Lady Loved Princess<br>Princess Went_Popocatepetl_Volcano<br>Enemy Kidnapped Princess<br>Eagle_Knight Realised Enemy Kidnapped Princess<br>Eagle_Knight Looked_For_And_Found Enemy<br>Eagle_Knight Attacked Enemy<br>Eagle_Knight Fought Enemy<br>Eagle_Knight Killed Enemy<br>Eagle_Knight Rescued Princess<br>Princess Fell_In_Love Eagle_Knight<br>Princess Realised Eagle_Knight Were_In_Love Lady<br>Princess Looked_For_And_Found Lady<br>Princess Killed Lady<br>Eagle_Knight Realised Princess Killed Lady<br>Eagle_Knight Followed Princess<br>Eagle_Knight Killed Princess<br>Eagle_Knight Killed Eagle_Knight | Sto ;4<br>Tlatoani Was_Father_Of Prince<br>Tlatoani Went_Hunting_With Prince<br>Tlatoani Had_An_Accident<br>Prince Did_Not_Cure Tlatoani<br>Prince Went_Tenochtitlan_City<br>Hunter Found_By_Accident Tlatoani<br>Hunter Realised Tlatoani Had_An_Accident<br>Hunter Cured Tlatoani<br>Tlatoani Rewarded Hunter<br>Tlatoani Looked_For_And_Found Prince<br>Tlatoani Exiled Prince |
| Sto ;5<br>Scenery City<br>Eagle_Knight Realised Eagle_Knight Was_In_Love_With Lady<br>Eagle_Knight Went_Tlatelolco_Market<br>Lady Was_Attracted_To Jaguar_Knight<br>Lady Went_Texcoco_Lake_With Jaguar_Knight<br>Eagle_Knight Followed Lady<br>Eagle_Knight Realised Lady Was_Attracted_To Jaguar_Knight<br>Eagle_Knight Got_Jealous_Of Jaguar_Knight<br>Eagle_Knight Attacked Jaguar_Knight<br>Eagle_Knight Wounded Jaguar_Knight<br>Lady Cured Jaguar_Knight<br>Eagle_Knight Exiled Eagle_Knight | Sto ;6<br>Scenery City<br>Eagle_Knight Realised Eagle_Knight Was_In_Love_With Lady<br>Eagle_Knight Went_Tlatelolco_Market<br>Lady Was_Attracted_To Jaguar_Knight<br>Lady Went_Texcoco_Lake_With Jaguar_Knight<br>Eagle_Knight Followed Lady<br>Eagle_Knight Realised Lady Was_Attracted_To Jaguar_Knight<br>Eagle_Knight Got_Jealous_Of Jaguar_Knight<br>Eagle_Knight Attacked Jaguar_Knight<br>Jaguar_Knight Fought Eagle_Knight<br>Jaguar_Knight Killed Eagle_Knight |

```
Sto ;7
Scenery City
Princess Went_Popocatepetl_Volcano
Hunter Kidnapped Princess
Farmer Found_By_Accident Hunter
Farmer Realised Hunter Kidnapped Princess
Hunter Attacked Farmer
Farmer Fought Hunter
Hunter Wounded Farmer
Hunter Ran_Away
Princess Did_Not_Cure Farmer
Princess Went_Tenochtitlan_City
Farmer Died_By_Injuries
```

Previous Stories used to generate *The lovers*.

```
STO;1
SCENERY Market
START
Eagle_Knight was_brother_of Jaguar_Knight
Eagle_Knight were_in_love Princess
Jaguar_Knight met Princess
Jaguar_Knight fell_in_love Princess
Jaguar_Knight tried_to_force_kiss Princess
Eagle_Knight realised Jaguar_Knight tried_to_force_kiss Princess
Eagle_Knight honor_was_damaged_by Jaguar_Knight
Eagle_Knight attacked Jaguar_Knight
Jaguar_Knight fought Eagle_Knight
Jaguar_Knight hurt Eagle_Knight
Jaguar_Knight kidnapped Princess
Priest cured Eagle_Knight
Eagle_Knight Looked_for_and_found Jaguar_Knight
Jaguar_Knight attacked Princess
Eagle_Knight killed Jaguar_Knight
Eagle_Knight rescued Princess
Eagle_Knight went_back_home Princess
```

```
STO;2
START
Eagle_Knight were_in_love Lady
Eagle_Knight admired_and_respected Princess
Princess Went_Popocatepetl_Volcano
Enemy kidnapped Princess
Eagle_Knight realised Enemy kidnapped Princess
Eagle_Knight Looked_for_and_found Enemy
Eagle_Knight attacked Enemy
Eagle_Knight fought Enemy
Eagle_Knight killed Enemy
Eagle_Knight Rescued Princess
Princess Fell_in_love Eagle_Knight
Princess realised Eagle_Knight were_in_love Lady
Princess Looked_for_and_found Lady
Princess killed Lady
Eagle_Knight realised Princess killed Lady
Eagle_Knight followed Princess
Eagle_Knight killed Princess
Eagle_Knight commited_suicide
```

| | |
|---|---|
| STO;3<br>START<br>Prince relatives_envy Tlatoani<br>Tlatoani Went_Hunting_With Prince<br>Tlatoani had_an_accident<br>Prince Did_Not_Cure Tlatoani<br>Prince Went_Tenochtitlan_City<br>Hunter Found_By_Accident Tlatoani<br>Hunter realised Tlatoani Had_an_accident<br>Hunter cured Tlatoani<br>Tlatoani Rewarded Hunter<br>Tlatoani Looked_for_and_Found Prince<br>Tlatoani hated_and_loved Prince<br>Tlatoani Exiled Prince | STO;4<br>SCENERY City<br>START<br>Eagle_Knight Was_in_Love_With Lady<br>Lady went_Texcoco_lake_with Jaguar_Knight<br>Lady Were_Attracted_to Jaguar_Knight<br>Eagle_Knight followed Lady<br>Eagle_Knight realised Lady Were_Attracted_to Jaguar_Knight<br>Eagle_Knight hated Jaguar_Knight<br>Eagle_Knight hated Lady<br>Eagle_Knight attacked Jaguar_Knight<br>Eagle_Knight fought Jaguar_Knight<br>Eagle_Knight wounded Jaguar_Knight<br>Lady killed Eagle_Knight<br>Lady Did_not_know_to_cure Jaguar_Knight<br>Jaguar_Knight died_by_injuries<br>Lady commited_Suicide |
| STO;5<br>SCENERY City<br>START<br>Princess went_Popocatepetl_volcano<br>Hunter Kidnapped Princess<br>Farmer found_by_accident Hunter<br>Farmer admired_and_respected Princess<br>Farmer realised Hunter Kidnapped Princess<br>Farmer attacked Hunter<br>Farmer fought Hunter<br>Hunter wounded Farmer<br>Hunter ran_away<br>Farmer rescued Princess<br>Princess Did_Not_Know_to_cure Farmer<br>Farmer died_by_injuries<br>Princess went_Tenochtitlan_city | STO;6<br>SCENERY City<br>START<br>Hunter saved_life Tlatoani<br>Tlatoani rewarded Hunter<br>Warrior realised Tlatoani rewarded Hunter<br>Warrior mugged Hunter<br>Warrior went_Popocatepetl_volcano<br>Hunter followed Warrior<br>Hunter had_an_accident<br>Warrior prepared_to_Sacrifice Hunter<br>Tlatoani found_by_accident Hunter<br>Tlatoani realised Warrior prepared_to_Sacrifice Hunter<br>Tlatoani fought Warrior<br>Warrior ran_away<br>Tlatoani rescued Hunter<br>Tlatoani cured Hunter<br>Tlatoani went_Tenochtitlan_city_with Hunter |

# Appendix E

# Report of the Abstract Representation

For problems of space, it is impossible to include the whole Abstract Representation Report created from the Previous Stories in Appendix D. However, representative examples are included in this appendix.

The Abstract Representation is a matrix where atoms are arranged by their number of Tensions and Emotional Links. The range of index representing the space between two words Tensions goes from 0 to 10. The range of the index representing the Emotional Links goes from 1 to 15. All atoms sharing the same number of Tensions and Emotional Links are gathered together in the same cell in the matrix; i.e., each cell can include several atoms.

In the report, each atom is associated with a description of its features (i.e. number and types of elements). For example, the features of the first atom in the position *Tension:0 EmoLin:1*are the following:

-Zero Tensions (represented in the report by the line *FeaTen=> AD->0 Lr->0 Hr->0 Pd->0 Pr->0 Ce->0 Lc->0* where *FeaTen* stands for *Features of the Tensions*, and *AD->0* for *zero Tensions due to Actor Dead*, *Lr->0* for *zero Tensions due to Life in Risk* and so on).

-One Emotional Link of type 2 (represented in the report by the line *FeaEmoLin=> Type1->0 Type2->1 Type3->0* where *FeaEmoLin* stands for *Features of the Emotional Links*, *Type1->0* for *zero Emotional Links of type 1*, and so on).

Possible next actions are indicated as *NexAct=>*.

```
*Tension:0  EmoLin:1
 ** Atom
    FeaTen=> AD->0  Lr->0  Hr->0  Pd->0  Pr->0  Ce->0  Lc->0
    FeaEmoLin=> Type1->0  Type2->1  Type3->0
    EmoLin=>
          A(+3,2):B
NexAct=> C WAS_IN_LOVE_WITH B
    NexAct=> A WENT_TLATELOLCO_MARKET
    NexAct=> B WAS_ATTRACTED_TO D
    NexAct=> A REALISED
    NexAct=> A WENT_TLATELOLCO_MARKET
    NexAct=> B WAS_ATTRACTED_TO E
    NexAct=> A REALISED

 ** Atom
    FeaTen=> AD->0  Lr->0  Hr->0  Pd->0  Pr->0  Ce->0  Lc->0
    FeaEmoLin=> Type1->1  Type2->0  Type3->0
    EmoLin=>
          A(+3,1):B
NexAct=> A WENT_PALACE
    NexAct=> C MUGGED B
    NexAct=> A WENT_HUNTING_WITH B
    NexAct=> A HAD_AN_ACCIDENT
    NexAct=> A REWARDED B
```

** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->0 Pr->0 Ce->0 Lc->0
FeaEmoLin=> Type1->0 Type2->1 Type3->0
EmoLin=>
B(+2,2):C
NexAct=> B WENT_TEXCOCO_LAKE_WITH C
NexAct=> A FOLLOWED B
NexAct=> B WENT_TEXCOCO_LAKE_WITH C
NexAct=> D FOLLOWED B

*Tension:0 EmoLin:2
** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->0 Pr->0 Ce->0 Lc->0
FeaEmoLin=> Type1->0 Type2->2 Type3->0
EmoLin=>
A(+3,2):B
B(+3,2):A
NexAct=> A LOVED C

** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->0 Pr->0 Ce->0 Lc->0
FeaEmoLin=> Type1->2 Type2->0 Type3->0
EmoLin=>
A(+3,1):C
B(+3,1):C
NexAct=> D KIDNAPPED C

** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->0 Pr->0 Ce->0 Lc->0
FeaEmoLin=> Type1->0 Type2->2 Type3->0
EmoLin=>
A(+3,2):B
B(+2,2):C
NexAct=> A GOT_JEALOUS_OF C
NexAct=> A GOT_JEALOUS_OF C

*Tension:1 EmoLin:7
** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->0 Pr->1 Ce->0 Lc->0
FeaEmoLin=> Type1->5 Type2->2 Type3->0
EmoLin=>
A(+3,2):B
B(+3,2):A
A(+3,1):C
B(+3,1):C
C(-3,1):D
A(-3,1):D
B(-3,1):D
Tension=>
Pr(C):D
NexAct=> A LOOKED_FOR_AND_FOUND D

*Tension:2 EmoLin:1
** Atom
FeaTen=> AD->0 Lr->0 Hr->1 Pd->1 Pr->0 Ce->0 Lc->0

FeaEmoLin=> Type1->1 Type2->0 Type3->0
EmoLin=>
B(-3,1):C
Tension=>
Hr(A)
Pd(C):B+
NexAct=> A REALISED
** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->1 Pr->1 Ce->0 Lc->0
FeaEmoLin=> Type1->1 Type2->0 Type3->0
EmoLin=>
C(-3,1):D
Tension=>
Pr(C):D
Pd(D):C+
NexAct=> A REALISED
NexAct=> B FOUND_BY_ACCIDENT D
NexAct=> D ATTACKED C

*Tension:2 EmoLin:7
** Atom
FeaTen=> AD->1 Lr->0 Hr->0 Pd->0 Pr->1 Ce->0 Lc->0
FeaEmoLin=> Type1->5 Type2->2 Type3->0
EmoLin=>
A(+3,2):B
B(+3,2):A
A(+3,1):C
B(+3,1):C
C(-3,1):D
A(-3,1):D
B(-3,1):D
Tension=>
Pr(C):D
Ad(D):A
LasAct=> A KILLED D
NexAct=> A RESCUED C

*Tension:2 EmoLin:11
** Atom
FeaTen=> AD->1 Lr->0 Hr->0 Pd->0 Pr->0 Ce->0 Lc->1
FeaEmoLin=> Type1->8 Type2->3 Type3->0
EmoLin=>
A(+3,1):C
B(+3,1):C
C(-3,1):D
A(-3,1):D
B(-3,1):D
C(+3,1):A
C(+3,2):A
A(+2,1):A
B(+2,1):A
B(+3,2):A
A(+3,2):B
Tension=>
Ad(D):A
Lc(C):B
LasAct=> C REALISED
LasAct=> C LOOKED_FOR_AND_FOUND B
NexAct=> C LOOKED_FOR_AND_FOUND B

NexAct=> C KILLED B

*Tension:3 EmoLin:7
** Atom
FeaTen=> AD->0 Lr->0 Hr->0 Pd->2 Pr->1 Ce->0 Lc->0
FeaEmoLin=> Type1->5 Type2->2 Type3->0
EmoLin=>
A(+3,2):B
B(+3,2):A
A(+3,1):C
B(+3,1):C
C(-3,1):D
A(-3,1):D
B(-3,1):D
Tension=>
Pr(C):D
Pd(D):C+
Pd(D):A+
NexAct=> A ATTACKED D

*Tension:10 EmoLin:9
** Atom
FeaTen=> AD->1 Lr->2 Hr->1 Pd->4 Pr->0 Ce->1 Lc->1
FeaEmoLin=> Type1->6 Type2->3 Type3->0
EmoLin=>
A(-3,1):B
A(+3,2):B
C(+3,2):B
B(+3,2):D
A(-2,1):D
B(-3,1):A
A(-3,1):A
C(-3,1):A
A(-3,1):C
Tension=>
Lc(A):C
Ad(D):A
Lr(A):B+
Hr(B):A
Lr(A):C+
Ce(A):B
Pd(B):A+
Pd(A):B+
Pd(A):C+
Pd(C):A+
NexAct=> C FOUGHT A

# Appendix F

# Example: *The kidnapped tlatoani*.

NEW STORY CONTEXT'S REPORT

```
Initial State:EgS   CteEg-Rf:3   ACAS-Constant:50%   Guidelines.Chances:1
Forbiden Actors:Half Active   Num_actions:34 times_used:85
Novelty=> Stricit 15%(1) High 50%(2) Medium 75%(3)
Detection of end of cycle NO-active.  Logical actions NO-active
Operation Mode: Engaged and Reflective States 2

CONTEXT ***
*** Time => 1     Action: tlatoani BECAME_FREE   Tension: 0
  Charac: TLATOANI   Pos: Texcoco_Lake   Status: Alive

ASSOCIATIVE  STRUCTURE ***
*** Time => 1     Action: tlatoani BECAME_FREE
  Charac: TLATOANI   Pos: Texcoco_Lake   Status: Alive

INDEXES ***
  TLATOANI: 10,15 ASIII-0

TLATOANI possible next actions: ****

*** Impasse : Engage-State with evaluation ...
*** Switching to Rf-S ...
  R$ inserting TLATOANI ACTOR Loc TLATOANI BECAME_FREE
  R$ inserting PRIEST KIDNAPPED TLATOANI Pre TLATOANI BECAME_FREE
*** Switching to Eg-S ...
CONTEXT ***
*** Time => 3     Action: tlatoani BECAME_FREE   Tension: 20
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Pd(PRIEST):TLATOANI+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Pd(PRIEST):TLATOANI+

ASSOCIATIVE  STRUCTURE ***
*** Time => 3     Action: tlatoani BECAME_FREE
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Pd(PRIEST):TLATOANI+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Pd(PRIEST):TLATOANI+

INDEXES ***
  TLATOANI: 2,1 ASI-67 PRIEST: 2,1 ASI-67
TLATOANI possible next actions: ****
  ANYONE REALISED

PRIEST possible next actions: ****
  ANYONE REALISED
  ANYONE FOUND_BY_ACCIDENT PRIEST
```

```
  PRIEST ATTACKED TLATOANI

*** FILTER ANYONE REALISED
*** FILTER ANYONE REALISED
  E$ instantiating TLATOANI FOUND_BY_ACCIDENT PRIEST ReiCha
  E$ Instantiated action deleted ( NoFlow-); trying again.
  E$ instantiating PRINCESS FOUND_BY_ACCIDENT PRIEST Rdm
*** FILTER PRINCESS FOUND_BY_ACCIDENT PRIESTNoFlow-
CONTEXT ***
*** Time => 4     Action: priest ATTACKED tlatoani   Tension: 40
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Pd(PRIEST):TLATOANI+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Pd(PRIEST):TLATOANI+

ASSOCIATIVE  STRUCTURE ***
*** Time => 4     Action: priest ATTACKED tlatoani
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Pd(PRIEST):TLATOANI+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Pd(PRIEST):TLATOANI+

INDEXES ***
  TLATOANI: 4,2 ASI-50 PRIEST: 10,15 ASIII-0

TLATOANI possible next actions: ****
  TLATOANI FOUGHT PRIEST

PRIEST possible next actions: ****

CONTEXT ***
*** Time => 5     Action: tlatoani FOUGHT priest   Tension: 80
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+


ASSOCIATIVE  STRUCTURE ***
```

```
*** Time => 5     Action: tlatoani FOUGHT priest
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

INDEXES ***
  TLATOANI: 5,4 ASI-67 PRIEST: 6,3 ASI-67

TLATOANI possible next actions: ****
  PRIEST KILLED TLATOANI

PRIEST possible next actions: ****
  PRIEST WOUNDED TLATOANI

*** Switching to Rf-S ...
  R$ inserting TLATOANI AFFRONTED PRIEST Pre PRIEST ATTACKED TLATOANI
  R$ Cheking novelty: number of times a sequence happens in other stories
  R$  Seq:1x0 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x4 Seq:6x1 Seq:7x0
  R$ Adequate novelty: guideline set to LOW.
  R$ Evaluating the Tensional Representations ...
  R$ F1-R:4 F2-R:3 F3-R:3 F4-R:1 F5-R:1 F6-R:1 F7-R:5
  R$ Frame:7 PT:TDn Chances:1
*** Switching to Eg-S ...


CONTEXT ***
*** Time => 7     Action: priest WOUNDED tlatoani   Tension: 100
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Hr(TLATOANI):PRIEST
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Hr(TLATOANI):PRIEST
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

ASSOCIATIVE  STRUCTURE ***
*** Time => 7     Action: priest WOUNDED tlatoani
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
```

```
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Hr(TLATOANI):PRIEST
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

  Charac: PRIEST   Pos: Forest   Status: Alive
  Tensions =>
                Lr(TLATOANI):PRIEST+
                Lr(PRIEST):TLATOANI+
                Hr(TLATOANI):PRIEST
                Pd(PRIEST):TLATOANI+
                Pd(TLATOANI):PRIEST+

INDEXES ***
  TLATOANI: 7,3 ASI-70 PRIEST: 10,15 ASIII-0

TLATOANI possible next actions: ****
  PRIEST RAN_AWAY

PRIEST possible next actions: ****


CONTEXT ***
*** Time => 8     Action: priest RAN_AWAY   Tension: 20
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

  Charac: PRIEST   Pos: Popocatepetl_Volcano   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

ASSOCIATIVE  STRUCTURE ***
*** Time => 8     Action: priest RAN_AWAY
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

  Charac: PRIEST   Pos: Popocatepetl_Volcano   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

INDEXES ***
  TLATOANI: 2,3 ASI-60 PRIEST: 2,4 ASI-50

TLATOANI possible next actions: ****
  ANYONE DID_NOT_CURE TLATOANI

PRIEST possible next actions: ****
  TLATOANI DIED_BY_INJURIES

  E$ instantiating PRIEST DID_NOT_CURE TLATOANI ReiCha
  E$ Instantiated action deleted ( NoFlow-); trying again.
  E$ instantiating PRINCE DID_NOT_CURE TLATOANI PSt-
  E$ PRINCE DID_NOT_CURE TLATOANI was not deleted because 1 chances left.
```

```
CONTEXT ***
*** Time => 9     Action: prince DID_NOT_CURE tlatoani   Tension: 40
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
                TLATOANI(-3,1):PRINCE
  Tensions =>
                Hr(TLATOANI):PRIEST
                Pd(PRINCE):TLATOANI+

  Charac: PRIEST   Pos: Popocatepetl_Volcano   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

  Charac: PRINCE   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRINCE
  Tensions =>
                Pd(PRINCE):TLATOANI+

ASSOCIATIVE  STRUCTURE ***
*** Time => 9     Action: prince DID_NOT_CURE tlatoani
  Charac: TLATOANI   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
                TLATOANI(-3,1):PRINCE
  Tensions =>
                Hr(TLATOANI):PRIEST
                Pd(PRINCE):TLATOANI+

  Charac: PRIEST   Pos: Popocatepetl_Volcano   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

  Charac: PRINCE   Pos: Forest   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRINCE
  Tensions =>
                Pd(PRINCE):TLATOANI+

INDEXES ***
  TLATOANI: 3,4 ASI-71 PRIEST: 2,3 ASI-60 PRINCE: 2,1 ASI-67

TLATOANI possible next actions: ****
  PRINCE WENT_TENOCHTITLAN_CITY

PRIEST possible next actions: ****
  ANYONE DID_NOT_CURE TLATOANI

PRINCE possible next actions: ****
  ANYONE REALISED

  E$ instantiating PRINCE DID_NOT_CURE TLATOANI ReiCha
  E$ Instantiated action deleted ( NoFlow-); trying again.
  E$ instantiating PRINCE DID_NOT_CURE TLATOANI PSt-
*** FILTER PRINCE DID_NOT_CURE TLATOANI=LastAct-
*** FILTER ANYONE REALISED
*** Switching to Rf-S ...
  R$ inserting PRINCE ACTOR Loc PRINCE DID_NOT_CURE TLATOANI
  R$ inserting PRINCE WENT_FOREST Loc PRINCE DID_NOT_CURE TLATOANI
  R$ inserting PRINCE REALISED PRIEST WOUNDED TLATOANI PRE PRINCE DID_NOT_CURE TLATOANI
  E$ TLATOANI AFFRONTED PRINCE was not deleted because 98 chances left.
```

R$ inserting TLATOANI AFFRONTED PRINCE Pre PRINCE DID_NOT_CURE TLATOANI
R$ The action PRINCE AFFRONTED TLATOANI was not inserted
to solve the action TLATOANI AFFRONTED PRINCE
because they are the same.
E$ PRINCE ATTEMPTED_TO_TAKE_ADVANTAGE_OF TLATOANI was not deleted because 98 chances left.
R$ inserting PRINCE ATTEMPTED_TO_TAKE_ADVANTAGE_OF TLATOANI Pre TLATOANI AFFRONTED PRINCE
E$ TLATOANI WAS_FOND_OF PRINCE was not deleted because 98 chances left.
R$ inserting TLATOANI WAS_FOND_OF PRINCE Pre PRINCE ATTEMPTED_TO_TAKE_ADVANTAGE_OF TLATOANI
R$ Cheking novelty: number of times a sequence happens in other stories
R$ Seq:1x0 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x4 Seq:6x1 Seq:7x1 Seq:8x0 Seq:9x0 Seq:10x0 Seq:11x0 Seq:12x0 Seq:13x0 Seq:14x0 Seq:15x2 Seq:16x0
R$ Adequate novelty: guideline set to LOW.
R$ Evaluating the Tensional Representations ...
R$ The frame number 1 is smaller than the story in progress.
R$ The frame number 2 is smaller than the story in progress.
R$ The frame number 4 is smaller than the story in progress.
R$ The frame number 5 is smaller than the story in progress.
R$ The frame number 6 is smaller than the story in progress.
R$ The frame number 7 is smaller than the story in progress.
R$ F3-R:2
R$ Frame:3 TT:GoUp PT:TDn Tem-Ten:On Chances:1
*** Switching to Eg-S ...
CONTEXT ***
*** Time => 16 Action: prince WENT_TENOCHTITLAN_CITY Tension: 40
Charac: TLATOANI Pos: Forest Status: Alive
Emotinal Links =>
TLATOANI(-3,1):PRIEST
PRIEST(-3,1):TLATOANI
TLATOANI(+1,1):PRINCE
TLATOANI(-3,1):PRINCE
PRINCE(-2,1):TLATOANI
TLATOANI(-1,1):TLATOANI
Tensions =>
Hr(TLATOANI):PRIEST
Ce(TLATOANI):PRINCE

Charac: PRIEST Pos: Popocatepetl_Volcano Status: Alive
Emotinal Links =>
TLATOANI(-3,1):PRIEST
PRIEST(-3,1):TLATOANI
Tensions =>
Hr(TLATOANI):PRIEST

Charac: PRINCE Pos: Tenochtitlan_City Status: Alive
Emotinal Links =>
TLATOANI(-3,1):PRIEST
TLATOANI(+1,1):PRINCE
TLATOANI(-3,1):PRINCE
PRINCE(-2,1):TLATOANI
TLATOANI(-1,1):TLATOANI
Tensions =>
Hr(TLATOANI):PRIEST
Ce(TLATOANI):PRINCE

ASSOCIATIVE STRUCTURE ***
*** Time => 16 Action: prince WENT_TENOCHTITLAN_CITY
Charac: TLATOANI Pos: Forest Status: Alive
Tensions =>
Hr(TLATOANI):PRIEST
Ce(TLATOANI):PRINCE

Charac: PRIEST Pos: Popocatepetl_Volcano Status: Alive

Emotinal Links =>
TLATOANI(-3,1):PRIEST
PRIEST(-3,1):TLATOANI
Tensions =>
Hr(TLATOANI):PRIEST

```
  Charac: PRINCE   Pos: Tenochtitlan_City   Status: Alive
  Tensions =>
                Ce(TLATOANI):PRINCE

INDEXES ***
  TLATOANI: 10,15 ASIII-0 PRIEST: 2,3 ASI-60 PRINCE: 10,15 ASIII-0

TLATOANI possible next actions: ****

PRIEST possible next actions: ****
  ANYONE DID_NOT_CURE TLATOANI

PRINCE possible next actions: ****

  E$ instantiating PRINCE DID_NOT_CURE TLATOANI ReiCha
  E$ Instantiated action deleted ( NoFlow-); trying again.
  E$ instantiating PRINCE DID_NOT_CURE TLATOANI PSt-
*** FILTER PRINCE DID_NOT_CURE TLATOANINoFlow-
Trying again ***
INDEXES ***
  TLATOANI: 10,15 ASIII-0 PRIEST: 2,4 ASI-50 PRINCE: 10,15 ASIII-0

TLATOANI possible next actions: ****

PRIEST possible next actions: ****
  TLATOANI DIED_BY_INJURIES

PRINCE possible next actions: ****

*** FILTER TLATOANI DIED_BY_INJURIES  Ten(GLn:GoUp)-
Trying again ***
INDEXES ***
  TLATOANI: 10,15 ASIII-0 PRIEST: 10,15 ASIII-0 PRINCE: 10,15 ASIII-0

TLATOANI possible next actions: ****

PRIEST possible next actions: ****

PRINCE possible next actions: ****

*** Impasse : Engage-State with evaluation ...
*** Switching to Rf-S ...
*** Breaking an impasse.
  R$ Attempting to select a next action...
  R$ Deleting (Uninstantiated or Dead) ANYONE FOUND_BY_ACCIDENT ANYONE
  R$ Action selected: ANYONE DIED_BY_INJURIES
  R$ Action intantiated: TLATOANI DIED_BY_INJURIES
  R$ Characters instantiated based on the Context
  R$ Action instantiated: TLATOANI DIED_BY_INJURIES
*** R$ Impasse BROKEN...
*** R$ Testing Preconditions...
  R$ Cheking novelty: number of times a sequence happens in other stories
  R$   Seq:1x0 Seq:2x0 Seq:3x0 Seq:4x0 Seq:5x4 Seq:6x1 Seq:7x1 Seq:8x0 Seq:9x0 Seq:10x0 Seq:11x0 Seq:12x0
Seq:13x0 Seq:14x0 Seq:15x2 Seq:16x1 Seq:17x1
  R$ Adequate novelty: guideline set to LOW.
  R$ Evaluating the Tensional Representations ...
  R$ The frame number 1 is smaller than the story in progress.
  R$ The frame number 2 is smaller than the story in progress.
  R$ The frame number 4 is smaller than the story in progress.
  R$ The frame number 5 is smaller than the story in progress.
  R$ The frame number 6 is smaller than the story in progress.
  R$ The frame number 7 is smaller than the story in progress.
  R$ F3-R:1
  R$ Frame:3 TT:Hold PT:TDn Tem-Ten:On Chances:1
*** Switching to Eg-S ...
CONTEXT ***
*** Time => 17     Action: tlatoani DIED_BY_INJURIES   Tension: 0
  Charac: TLATOANI   Pos: NoWhere   Status: Dead
```

```
  Charac: PRIEST   Pos: Popocatepetl_Volcano   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

  Charac: PRINCE   Pos: Tenochtitlan_City   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                TLATOANI(+1,1):PRINCE
                TLATOANI(-3,1):PRINCE
                PRINCE(-2,1):TLATOANI
                TLATOANI(-1,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST
                Ce(TLATOANI):PRINCE

ASSOCIATIVE  STRUCTURE ***
*** Time => 17     Action: tlatoani DIED_BY_INJURIES
  Charac: TLATOANI   Pos: NoWhere   Status: Dead

  Charac: PRIEST   Pos: Popocatepetl_Volcano   Status: Alive
  Emotinal Links =>
                TLATOANI(-3,1):PRIEST
                PRIEST(-3,1):TLATOANI
  Tensions =>
                Hr(TLATOANI):PRIEST

  Charac: PRINCE   Pos: Tenochtitlan_City   Status: Alive
  Tensions =>
                Ce(TLATOANI):PRINCE

INDEXES ***
  TLATOANI: 0,0 ASIII-0 PRIEST: 2,3 ASI-60 PRINCE: 10,15 ASIII-0

TLATOANI possible next actions: ****

PRIEST possible next actions: ****
  ANYONE DID_NOT_CURE TLATOANI

PRINCE possible next actions: ****

  E$ instantiating PRINCE DID_NOT_CURE TLATOANI ReiCha
*** FILTER PRINCE DID_NOT_CURE TLATOANI ADead-
Trying again ***
INDEXES ***
  TLATOANI: 0,0 ASIII-0 PRIEST: 2,4 ASI-50 PRINCE: 10,15 ASIII-0

TLATOANI possible next actions: ****

PRIEST possible next actions: ****
  TLATOANI DIED_BY_INJURIES

PRINCE possible next actions: ****

*** FILTER TLATOANI DIED_BY_INJURIES =LastAct-
Trying again ***
INDEXES ***
  TLATOANI: 0,0 ASIII-0 PRIEST: 10,15 ASIII-0 PRINCE: 10,15 ASIII-0

TLATOANI possible next actions: ****

PRIEST possible next actions: ****

PRINCE possible next actions: ****

*** Impasse : Engage-State with evaluation ...
*** Switching to Rf-S ...
*** Breaking an impasse.
```

R$ No Previous Actions; looking for equivalent.
R$ No Equivalent Actions found.
*** R$ Impasse NO broken!
*** Flag End_Story is on.

*** NEW STORY:
TLATOANI ACTOR
PRIEST KIDNAPPED TLATOANI
TLATOANI BECAME_FREE
TLATOANI AFFRONTED PRIEST
PRIEST ATTACKED TLATOANI
TLATOANI FOUGHT PRIEST
PRIEST WOUNDED TLATOANI
PRIEST RAN_AWAY
PRINCE ACTOR
PRINCE WENT_FOREST
PRINCE REALISED PRIEST WOUNDED TLATOANI
TLATOANI WAS_FOND_OF PRINCE
PRINCE ATTEMPTED_TO_TAKE_ADVANTAGE_OF TLATOANI
TLATOANI AFFRONTED PRINCE
PRINCE DID_NOT_CURE TLATOANI
PRINCE WENT_TENOCHTITLAN_CITY
TLATOANI DIED_BY_INJURIES

# Appendix G

# Questionnaire

This questionnaire is part of a PhD research in computer-based story generation. Its objective is to know people's opinion about seven narratives presented below. It should take less than twenty minutes to complete.

Age:
Sex:
Nationality:
Last academic grade:

INSTRUCTIONS.
Read carefully each of the narratives presented in Section 1. After each narrative you will be asked to evaluate six different aspects of the text presented. You must rate those texts as frameworks for short stories (rather than as complete stories). You will find at the end a section called "General Evaluation" where you will be asked to number each of the narratives read. If you prefer you can first read all the narratives in the questionnaire to get an idea of the range of all the texts and then evaluate each one.
When you finish send back this questionnaire to the following e-mail address:

compucea@mpsnet.com.mx

Thanks for your help.
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Section 1. Narratives.

The following are seven narratives. Some of them have as a theme the Mexicas (the old inhabitants of central Mexico) and others have fantasy themes.

The capital of the Mexica civilisation (also wrongly known as Aztecs) was Tenochtitlan-city, which by the time the Spanish arrived had a population of 200,000 inhabitants. Their social organisation was very complex. On the top was the Tlatoani (or King), followed by the nobles, warriors and priests. The following layer in the social scale were people like farmers, hunters, etc. At the bottom were the slaves. In the army, the highest distinction a warrior could get was the title of Jaguar Knight or Eagle Knight. They had an advanced trade-system. They used cacauatl (cacao beans) and quetzal feathers (Quetzalli) as an equivalent for money.

Narrative #1
Hunter was an ambitious person and wanted to be rich and powerful.
So, Hunter kidnapped Princess and went to Chapultepec forest.
Hunter's plan was to ask for an important amount of cacauatl (cacao beans) and quetzalli (quetzal) feathers to liberate Princess.
Farmer thoroughly observed Hunter. Then, Farmer took a dagger, jumped towards Hunter and attacked Hunter. Suddenly, Farmer and Hunter were involved in a violent fight. Hunter went in search of some medical plants and cured Princess. As a result Princess was very grateful to Hunter. Hunter and Princess went to the Great Tenochtitlan city.

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

Narrative #2
Charles lacked a city. As a result of hearing of Narbonne Charles wanted Narbonne. Then Aymeri agreed to help Charles. Then Charles and Aymeri rode to Narbonne. Then, Charles attacked the walls of Narbonne, currently controlled by Baufumez, helped by Aymeri. Thibaut and Clarion threw burning pitch down on Charles and Aymeri. Charles and Aymeri retreated. Then, Charles attacked the walls of Narbonne, currently controlled by Baufumez, helped by Aymeri. Thibaut and Clarion threw stones down on Charles and Aymeri. Charles and Aymeri broke into Narbonne. As a result of seeing Blancheflor Charles wanted Blancheflor. Charles succeeded in getting Narbonne. Charles praised god. Charles forgot to reward Aymeri. Charles threw Thibaut into prison. Then Charles planned to obtain Blancheflor for Charles. Then Aymeri refused to help Charles because he was not rewarded. Then Bertrand agreed to help Charles. Charles abducted Blancheflor, currently controlled by Thibaut helped by Bertrand. Because Thibaut was in prison he did not oppose Charles and Bertrand. Clarion opposed Charles and Bertrand in getting Blancheflor. Charles succeeded in getting Blancheflor. Charles praised god. Charles rewarded Bertrand.

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

Narrative #3
Jaguar_knight was an inhabitant of the Great Tenochtitlan. Princess was an inhabitant of the Great Tenochtitlan. Jaguar_knight was walking when Ehecatl (god of the wind) blew and an old tree collapsed injuring badly Jaguar_knight. Princess went in search of some medical plants and cured Jaguar_knight. As a result Jaguar_knight was very grateful to Princess. Jaguar_knight rewarded Princess with some cacauatl (cacao beans) and quetzalli (quetzal) feathers.

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

Narrative #4

Mr Madd was born in Liverpool in 1840. Mr Madd was an inventor. For many years people thought Mr Madd was a crazy man. However, after years of experiments, Mr Madd finally discovered what it was called "gas-xyz". Gas-xyz was able to freeze food. This was important because in those days refrigerators had not been invented yet. Mr Madd went to London to register his discovery. However, in Mr Madd's way to London some thieves stole the tank containing gas-xyz. Mr Madd was worried because, when not used properly, the gas could kill human beings. Mr Madd followed the thieves to Brighton. Mr Madd tried to recuperate gas-xyz. But the horse that was carrying the tank which contained gas-xyz got afraid, made an abrupt movement which produced that the tank be loosened, and the tank went down the hill towards Brighton's school. Mr Madd ran after the tank. Children were playing in the garden. Mr Madd shouted to the children to run. Children thought Mr Madd was playing with a funny long toy. Suddenly, the tank containing gas-xyz crashed into a huge rock and exploded. Nobody was injured. Mr Madd lost the gas-xyz, but Mr Madd was a Brighton's hero. Nowadays, one can find by the pavilion a hidden small plaque which, due to a spelling mistake, says "Thanks Mr Mad".

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

Narrative #5
Although at the beginning Princess did not want to admit it, Princess fell in love with Tlatoani. For long time Tlatoani and Lady had been flirting. Now, openly they accepted the mutual attraction they felt for each other. Princess hated Lady.

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

Narrative #6
Once upon a time there was a lady of the court named Jennifer. Jennifer loved a knight named Grunfeld. Grunfeld loved Jennifer.

Jennifer wanted revenge on a lady of the court named Darlene because she had the berries which she picked in the woods and Jennifer wanted to have the berries. Jennifer wanted to scare Darlene. Jennifer wanted a dragon to move towards Darlene so that Darlene believed it would eat her. Jennifer wanted to appear to be a dragon so that a dragon would move towards Darlene. Jennifer drank a magic potion. Jennifer transformed into a dragon. A dragon moved towards Darlene. A dragon was near Darlene.

Grunfeld wanted to impress the king. Grunfeld wanted to move towards the woods so that he could fight a dragon. Grunfeld moved towards the woods. Grunfeld was near the woods. Grunfeld fought a dragon. The dragon died. The dragon was Jennifer. Jennifer wanted to live. Jennifer tried to drink a magic potion but failed. Grunfeld was filled with grief.

Jennifer was buried in the woods. Grunfel became a hermit.

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

Narrative #7
Jaguar_knight was an inhabitant of the great Tenochtitlan. Princess was an inhabitant of the great Tenochtitlan. From the first day they met, Princess felt a special affection for Jaguar_knight. Although at the beginning Princess did not want to admit it, Princess fell in love with Jaguar_knight. Princess respected and admired Artist because Artist's heroic and intrepid behaviour during the last Flowery-war. For long time Jaguar_knight and Princess had been flirting. Now, openly they accepted the mutual attraction they felt for each other. Jaguar_knight was an ambitious person and wanted to be rich and powerful. So, Jaguar_knight kidnapped Artist and went to Chapultepec forest. Jaguar_knight's plan was to ask for an important amount of cacauatl (cacao beans) and quetzalli (quetzal) feathers to liberate Artist. Princess had ambivalent thoughts towards Jaguar_knight. On one hand princess had strong feelings towards Jaguar_knight but on the other hand Princess abominated what Jaguar_knight did. Suddenly, the day turned into night and after seconds the sun shone again. Princess was scared. The Shaman explained to Princess that Tonatiuh (the divinity representing the sun) was demanding Princess to rescue Artist and punish the criminal. Otherwise Princess's family would die. Early in the Morning Princess went to Chapultepec forest. Princess thoroughly observed Jaguar_knight. Then, Princess took a dagger, jumped towards Jaguar_knight and attacked Jaguar_knight. Jaguar_knight was shocked by Princess's actions and for some seconds Jaguar_knight did not know what to do. Suddenly, Princess and Jaguar_knight were involved in a violent fight. In a fast movement, Jaguar_knight wounded Princess. An intense haemorrhage arose which weakened Princess. Jaguar_knight felt panic and ran away. Thus, while Tlahuizcalpantecuhtli (the god who affected people's fate with his lance) observed, Princess cut the rope which bound Artist. Finally, Artist was free again! Princess was emotionally affected and was not sure if what Princess did was right. Princess was really confused. The injuries that Princess received were very serious. So, while praying to Mictlantecuhtli (the lord of the land of the dead) Princess died.

*** Based on the narrative you have just read, evaluate the following aspects:

-Narrative flow and coherence:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Narrative structure:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Story content:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Suspense:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-Overall quality as a framework for a short story:
a)very good b)good c)adequate d)poor e)very poor
Answer:

-How much do you like this narrative?
a)a lot b)quite a lot c)a little d)not a lot e)not at all
Answer:

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Section 2. GENERAL EVALUATION :

Number each of the narratives in Section 1 assigning number one to the best and number seven to the worse.

1. Narrative # (the best)
2. Narrative #
3. Narrative #
4. Narrative #
5. Narrative #
6. Narrative #
7. Narrative # (the worse)

Would you like to make any comments about the narratives you have read?