

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 further 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 establish 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 \rightarrow [Act B, Act N]

Context 21 is similar to Context 1, so MEXICA assumes that

Possible next actions: Context 21 \rightarrow [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 \rightarrow 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 \longrightarrow [Act O]

Context 32 is similar to Context 12, so MEXICA assumes that

Possible next actions: Context 32 \longrightarrow [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] \longrightarrow 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 than 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.