

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 fit 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 referring 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 Karmiloff-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 seem 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.