Illustrating a Computer Generated Narrative

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Abstract

This work describes a computer model that generates visual narratives. It is part of a research project on narrative generation. A visual narrative is defined as a sequence of pictorial-scenes; each scene contains characters, locations and symbols representing dramatic tensions. A computer generated plot is transformed into a visual narrative by converting each textual action into a pictorial scene. We present details of the composition process and explain how the graphic elements employed to produce a coherent narration are generated. We describe the questionnaire that we employed to evaluate the system, discuss the results and outline future developments.

Introduction

Narrative is a fundamental manifestation of human culture. "Most scholars now see narrative… and a host of rhetorical figures not as 'devices' for structuring or decorating extraordinary texts but instead as fundamental social and cognitive tools" (Eubanks 2004). Traditionally, the word "narrative" has been understood as a kind of synonymous of written text. However, many forms of storytelling (and knowledge) are visual; that is, "what we see is as important, if not more so than what we hear or read" (Rose, 2001:1). The use of images in the construction of narratives has given origin to the concept of Visual Narrative. Thus, following McCloud, in this work visual narrative is defined "as juxtaposed pictorial and other static images in deliberate sequence, intended to convey information and/or to produce an aesthetic response in the viewer" (McCloud, 1993).

The processes involved in the codification and understanding of visual stories have been the subject of study in the field of psychology for some time (see e.g. Arnheim, 1969) and have firmly established the links between thought and perception. The human ability to organize our experiences in the form of stories or narrative structures has been called Narrative Intelligence (Blair and Meyer, 1997). Narrative Intelligence has also been defined as "the human ability and perhaps even compulsion to make sense of the world through narrative and storytelling" (Mateas and Sengers, 1999). In this way, "Human narrative intelli-

gence might have evolved because the structure and format of narrative is particularly suited to communicate about the social world." (Dautenhahn, 2001). Thus, we envision Visual Narrative as a form of Narrative Intelligence.

Because of its importance in shaping human experience and knowledge, it is not surprising that AI researchers have developed a substantial amount of work related to understanding stories and on how to generate them. One of the common aspects of these efforts is its inherent interdisciplinary approach. Research on AI and narrative has drawn on ideas and theories from different fields such as art, cultural studies, drama, psychology and more recently design. As result from this interdisciplinary work, we can distinguish three main results: Narrative is now recognized as a source for informing System Design; research paradigms and methodologies that address complex questions have been developed and validated; the relationship between AI, Computational Creativity and the Humanities has proven enriching and useful.

The work presented in this paper is part of a research project in narrative generation. We have developed a computer model of creative writing called E-R; a program called MEXICA (Pérez y Pérez and Sharples 2001) is an implementation of such a model. The purpose of this work is to expand our plot-generation model with mechanisms that allow illustrating its textual outputs to produce visual narratives. We refer to this new module as the Visual Narrator. This paper describes our first prototype. Although it is possible to find computer systems that generate or evaluate images (e.g. Norton et al. 2011; Colton 2011), or systems where a visual portrayal of characters plays an important role (e.g. Riedl et al. 2008; Cassell 2001; Rickel and Johnson 1999) as far as we know this is the first plot generator capable of illustrating its own output. It is worth noticing that, as antecedents of this work, we published a paper that employs animations to represent computer-generated daydreams (Pérez y Pérez at al. 2007) and a grammar that generates pre-Hispanic images (Álvarez et al. 2007).

Our computerised storyteller has the following characteristics. It generates fictional narratives about pre-Columbian cultures. This seems just adequate because "The history of sequential art could be track to pre-Columbian picture

manuscripts since they were pictorial representations painted over strips that convey a story" (McCloud, 1993:9). The system includes 16 predefined characters, amongst them: *Tlatoani* (the ruler), *Jaguar Knight, Princess, Enemy, Fisherman*, and so on. It also includes 9 possible locations, e.g. *Chapultepec Forest, Popocateptl volcano, Tenochtitlan City*. The system generates a sequence of actions representing plots; the following lines are an example: *the Enemy kidnapped the Princess; Jaguar Knight found the Princess; Jaguar Knight and Enemy fought; Enemy ran away; Jaguar Knight rescued the Princess*; and so on. Once the narrative has been finished the system substitutes the sequence of actions with predefined texts. So, the action where the Knight and the Enemy fought in the previous example is substituted by "Suddenly, Jaguar Knight and Enemy were involved in a violent fight". The same happens for all actions.

One of the core characteristics of our computer model of creative writing is the idea that plots can be represented as groups of emotional links and tensions between characters that progress over time (Pérez y Pérez 2007). The current version of the storyteller system includes two emotional links, brotherly love and amorous love, and seven dramatic tensions: when a character is killed (Actor dead); when the life of a characters is at risk (Life at risk); when the health of a character is at risk (Health at risk); when a character is made a prisoner (Prisoner); when two characters are in love with a third character (Love competition); when a character hates and loves another character (Clashing emotions); when one character hates another character and both are positioned in the same location (Potential danger). Each time an action is performed within the story the current set of emotional links and tensions is updated. Thus, our storyteller not only produces plots but also generates detailed information about the emotional links and tensions between characters for each action in the tale.

The Visual Narrator recollects all these information to generate a visual narrative. As mentioned earlier, in this work a visual narrative is defined as a sequence of pictorial-scenes. A scene is a composition made up of images representing one or two characters, a location and a tension. So, the Visual Narrator transforms a plot into a Visual Narrative by converting each textual action into a pictorial scene. The process of composing a scene involves:
1) Building characters. We provide the system with a group of primitive graphic elements that represent different parts of the character's picture. Primitives include body parts, clothes, accessories and emotional and tensional facial expressions. We developed a grammar that drives the construction of the image.
2) Choosing a glyph that represents the core active tension in the story. We have defined a set of glyphs that represents each of the possible tensions within a story.
3) Choosing an image that represents the current location of the characters involved in the action. We provide the system with images representing all possible locations within a story.
4) Putting together all these elements in a scene.

These four points summarise the core characteristics of the Visual Narrator.

Following the theory of narrative from the structuralism point of view (Seymour, 1997), every narrative has two elements: a discourse (the means by which the content is communicated, the set of actual narrative statements) and a story or what is portrayed (the content, events, characters and context or setting). The text is produced by one person and is meant to be read by another; the proper understanding of the narration, requires that both share the same code (Acaso, 2009; Eco, 2005). However, "any text can be interpreted infinitely" (Eco, 1991). In Peirce's words, this is considered as the Dynamical Interpretant: "The Dynamical Interpretant is whatever interpretation any mind actually makes of a sign" (cited in Atkin, 2008:66). In this way, our main concern in this work is to evaluate if the code produced by our computer model satisfies (at least partially) this requirement of proper understanding of the narration. That is, if the visual composition produced by the computer model resembles similar ideas to those produced by its textual counterpart.

This paper is organised as follows: the second section describes the features of the pre-Columbian iconography relevant for this project; the third sections provides details of the composition process; the fourth section describes the evaluation of the system; the fifth section includes the discussion.

Characteristics of Pre-Columbian Iconography and graphic conventionalism

In the following lines we describe some of the graphic elements and conventions used in pre-Columbian codices that inspired the creation of our visual narrative. For this work we mainly considered the Boturini Codex (Galarza J. and Libura, 2004) and the following codices from the Borgia group: Vaticanus and Laud (Galarza, J. 1997), Borgia and Nuttall, (Mohar, L. 1997) and Moctezuma (Lopez A. 1999).
1) *Human figures and objects*. In the codices human figures are line drawn in black and white, in an abstract-graphical iconic level. Their body positions, either sitting or standing, are always represented in profile, facing right or left and never in a front view. Objects and animals are drawn employing the same graphic conventions.
2*) Social Hierarchy*. Pre-Hispanics had a very complex and hierarchical social structure, which was represented in their codices. A strict dressing code and the use of specific ornaments show their status within the group. Attires, ornaments, a stick held by human hands, or triangle tiara crowning a head are symbols representing a high rank within the hierarchy. Hairstyle is another sign of social status, gender and role distinction. Priests are always represented with the whole body or parts of their face painted in black and their hair tied back in a ponytail. A regular representation of women's attire is a *huipil* or skirt and a *quechquemetl* or bust over her waist. In certain codices it is

common to illustrate women showing their breasts. In this way, an image depicting a subject wearing a *tilma* or cape and sandals indicate that the person is a member of the nobility; by contrast, wearing a loincloth without sandals indicates that the person belongs to the group of common people.

3) *Locations*. Locations are represented by a chain of iconic images. For example, the representation of Chapultepec forest is composed by a stylised image of a hill with a grasshopper on the top and a wavy line coming out from its base. The pictogram could be read as "The big hill of the grasshoppers, where the water springs".

4) *Representing emotions and death.* Pre-Hispanic artists depicted emotions in their works. For example, in the Boturini codex there is a passage that shows a group of people crying, wearing dirty clothes. The action of crying is represented by stylised tears in the eyes of the characters. Such tears have an amorphous wavy shape that ends with a circle or oval. In this case, the weeping, reinforced by the dirty clothes, conveys a message of suffering. Other codices, like the Borgia and the Vaticanus, employ mouth and eyes gesticulations to produce richer facial expressions. Finally, a human image with her eyes closed represents death.

We would like to point out that our visual narrative is inspired by pre-Columbian iconography. However, we do not attempt to reproduce it or contribute to its understanding. We leave that to the experts in the area. We only employ such iconography to provide a framework to our research in computational creativity. Thus, some of the images presented in this work are free interpretations made by the authors.

Composition Process

The following lines describe the four process involved in the composition process.

Character Generation

Characters' portraits are the result of bringing together 9 layers of basic images or primitives (as we also refer to them). Each layer groups similar elements. Layer zero includes left arms; layer 1 includes bodies with legs; layer 2 includes heads; layer 3 includes eyes and emotional expressions; layer 4 includes hairstyles; layer 5 includes clothes; layer 6 includes right arms; layer 7 includes ornaments; layer 8 includes weapons and tools (see figure 1). Layers can include any number of primitives, although in some cases it is important to have at least one. The amount of different portrayals that the system can create depends on the number of available images. We have 4 types of characters: males standing, males sitting, females standing and females sitting. All figures can be painted facing east or west. In this work we only present males and females standing and employed 272 primitives.

We classify images in two types: universals and specifics. Universals are used in the construction of any character while specifics are only employed in the construction of those personae they were designed for. In other words, some features might appear in all portrayals while others are specific to a single character. For example, every person can use a shell but only the fisherman can have a fishing-net.
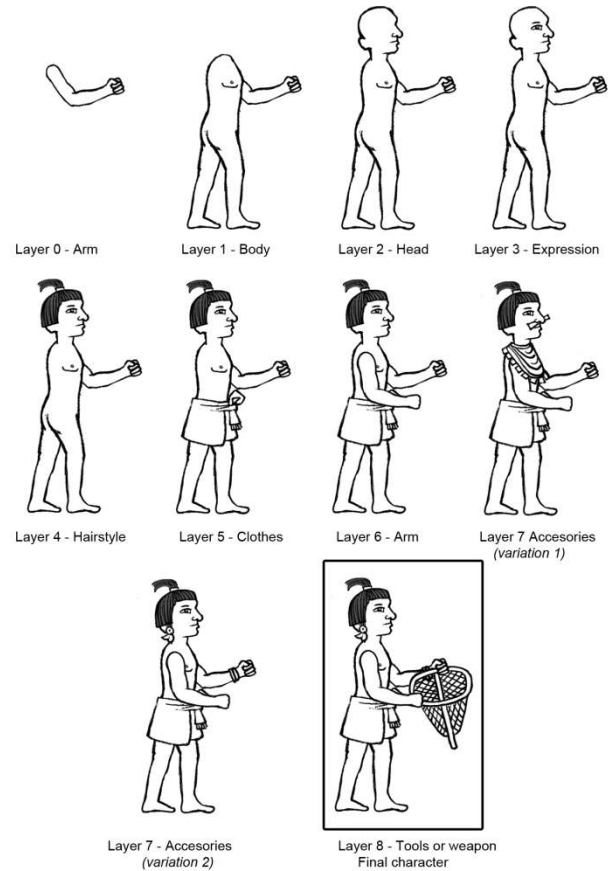

Figure 1. Construction of the character fisherman.

Thus, the Visual Narrator portrays a character by selecting one image from each layer and then painting all them in a canvas. For this work we implemented such a selection process as a random function to provide variety and surprise. In future versions we might include some constraints that help to select the images based on the necessity of the narrative. The user of the Visual Narrator can define in a text file a set of rules to associate one image in a concrete layer with others in different layers. In this way, it is possible to associate particular types of clothes with particular types of ornaments, or extended arms with specific weapons, and so on. For the experiments in this work we defined 25 rules. Figure 1 illustrates the process of characterising a fisherman; it shows two possible options for representing accessories. Figure 3 shows the portraits of a Jaguar Knight, a Princess and an Enemy.

The Visual Narrator depicts characters with emotional expressions. Our automatic storyteller generates information regarding emotional links and tensions between

characters. In this work we only represent tensions. Thus, a person can be responsible of triggering a tension or can be a victim. For example, if the enemy kidnaps the princess, the Enemy triggers the tension Prisoner, and the Princess is the captive. We refer to the former as the giver and to the latter as the receiver. As part of our work we have developed giver and receiver facial emotional expression for each of the possible tension that can be triggered during the development of a narrative. Examples of these expressions are wide open eyes, a wide open mouth and tears (e.g. figure 5a shows a princess crying).

The Visual Narrator analyses the narrative in order to determine which tensions should be represented in the scene. Deciding what tension to characterize is a complex task because the Visual Narrator must figure out which of the active tensions is the most appropriate to be represented in the current scene, for how long it should be visually represented, when it is necessary to reintroduce a tension, and so on. In this way, our implementation resembles those flip-a-face books or board books, where a person can create several different characters combining different predefined elements. Various videogames employ similar tools. Thus, the Visual Narrator models some of the decisions that humans takes to represent emotional characters when using flip-a-face like tools.

Building a Scene

Scenes are comprised of three elements: a location, characters and a glyph representing a tension.

We have 9 possible locations: Texcoco Lake, Popocateptl Volcano, Tlatelolco Market, Palace, Tenochtitlan City, Temple, Chapultepec Forest, Jail and Uncivilized Land. The representations of these locations are inspired by pre-Hispanic codices. For example, figure 5 shows the representation of Chapultepec Forest. Chapultepec means grasshopper's hill in Nahuatl; notice on the right of figure 5 the stylised image of a hill with a grasshopper on the top.

As a result of performing a story-action, one o mores tensions can be triggered or deactivated within a narrative. For example, if the Enemy wounds the Jaguar Knight the tension life at risk is triggered. We have designed glyphs to represent them. Figure 2 shows some examples. Currently, a scene only includes a single tension. When several tensions are active at the same time, the Visual Narrator needs to choose one to be painted in the composition. So, we have assigned them ranks. The following list shows the tensions ordered from the highest to the lowest rank: Health at Risk, Life at Risk, Actor Dead, Prisoner, Potential Danger, Clashing Emotions, Love Competition, Prisoner Free. In this way, the system includes in the scene the tension with the highest rank.
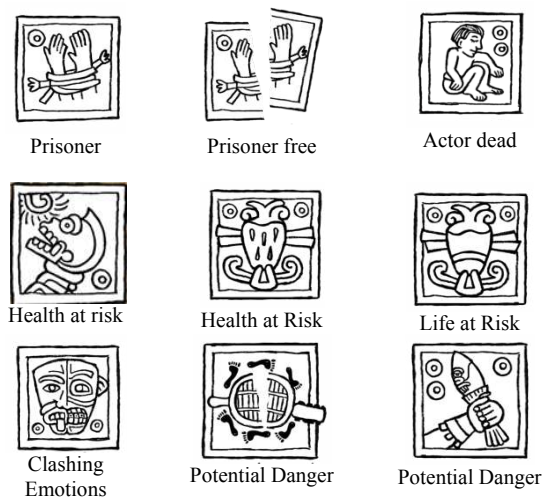

Figure 2. Glyphs representing tensions

Thus, a scene is comprised by a location on the back, two characters facing each other, and in the middle of them a glyph representing the core tension of the scene (see figure 5). The Visual Narrator employs the text to define which characters are participating in the scene as well as its location; it also employs internal representations to establish which tensions should be used.

Evaluation

We were interested in evaluating if the code produced by our system satisfied (at least partially) the requirement that both, author and reader, shared the same code. Thus, the goals of the survey were: a) To evaluate the degree of proper understanding of characters and scenes; b) To establish if the sequence of scenes communicate a clear and congruent narrative.

To perform the test the Visual Narrator illustrated a brief narrative generated by our plot generator; then, we asked a group of people to evaluate it. We developed a questionnaire that was answered by 44 persons: 91% Mexicans, 7% Spanish and 2% Guatemalans. 66% were females and 34% males. 5% had a PhD degree; 25% had a master degree; 52% had a bachelor degree; 18% had other types of degree. The questionnaire was elaborated and answered in Spanish. The questionnaire was divided in three sections. The first section showed three images of different characters developed by the Visual Narrator (see figurer 3). For each picture subjects were requested to perform the following tasks: 1) to answer if they recognized the character portrayed as pre-Hispanic ; 2) if they did, to select which of the following options described the best such a character: Tlatoani, Enemy, Jaguar Knight, Princess, Female Peasant; 3) if they did not recognize the character as pre-Hispanic, to briefly explain why.
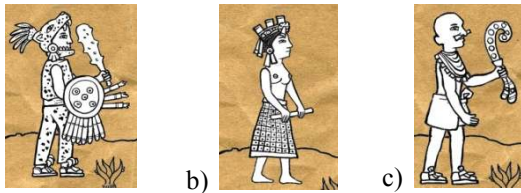
a) ![Jaguar Knight] b) ![Princess] c) ![Enemy]

Figure 3. Portraits of a) a Jaguar Knight, b) a Princess and c) an Enemy.

The second section showed two glyphs (see figure 4). Subjects were instructed that pre-Hispanics employed such glyphs to represent concepts. Then, they were asked to describe what they thought each glyph symbolized.

a) b)

Figure 4. Two glyphs representing a) Actor dead and b) Life at Risk

In the third section subjects were presented with an individual scene (see figure 5a) and then with the whole sequence of three scenes (see figure 5), all they developed by the Visual Narrator. Subjects were requested to describe what they thought the individual scene denoted; after that, they were asked to describe what the sequence of scenes denoted.

Evaluation of Characters' Representation

Figure 3a characterises a Jaguar Knight. To the question if they recognized the character portrayed as pre-Hispanic 95% of the subjects answered yes and 5% answered no. To the request of choosing the best description of the character depicted in the figure 3a, 93% selected the option Jaguar Knight 2% selected the option of *Tlatoani* and 5% did not answer the question.

In figure 3b the Visual Narrator characterised a Princess. To the question if they recognized the character portrayed as pre-Hispanic 89% of the subjects answered yes, 9% answered no, and 2% did not answer the question. To the request of choosing the best description of the character depicted in the figure 3b 63% selected the option Princess, 25% selected the option peasent, 2% selected Tlatoani and 10% did not answer.

In figure 3c the Visual Narrator attempted to characterise an Enemy. To the question if they recognized the character portrayed as pre-Hispanic 75% of the subjects answered yes and 22% answered no. They did not identify the character as pre-Columbian due to the type of ornaments that the character was wearing and some of his characteristics like his baldness. In fact, some subjects identified this character as Egyptian. 2% did not answer the question. To the request of choosing the best description of the character

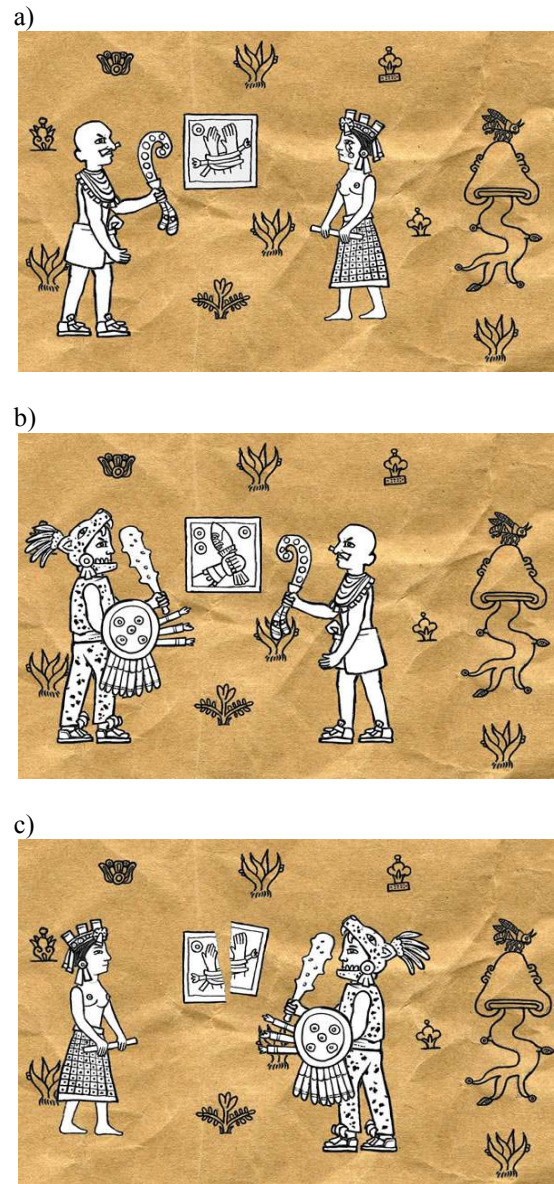depicted in the figure 3c 41% selected the option Tlatoani, 36% selected the option Enemy, and 23% did not answer.

a)

b)

c)

Figure 5. Three scenes generated by the Visual Narrator

Evaluation of Glyphs

In this section two glyphs were presented to the subjects and they were asked to describe what they thought each image symbolised.

Following the pre-Hispanic tradition, the Visual Narrator employed figure 4a to represent death. None of the subjects associated the picture with passing away. Partakers associated the following meanings to the glyph: 36% of the participants described a quiet man (meditating, praying or dreaming); 18% described a man that is thinking, which is related to the former description; 18% related this glyph to the idea of life (birth, harvest, vintage or a foetus in the

womb); 13% detected the presence of graphic elements associated to the numeric system of the pre-Hispanic civilization and therefore linked this glyph to a date; 15% gave different interpretations, such as someone seating, learning, a young person.

The Visual Narrator employed figure 4b to represent that the life of a character was at risk. As in the previous case, subjects associated different meanings to this graphic element. 48% related this glyph to the notion of death; interesting enough, 30% of this group elaborated their descriptions of death with notions like worship and rituals, the sun (which was a god between the pre-Columbian civilizations) and fights between life and death. 43% of the 44 participants associated the glyph with fear to the divinity, danger, fight between good and evil. These descriptions are closer to what the glyph intended to represent. 9% did not answer.

Evaluation of Scenes

In the last section subjects were presented with a complete scene (see figure 5a). The Visual Narrator built it from the action Enemy kidnapped the Princess, which triggers the tension Princess prisoner. 70% of the participants described the scene as representing lack of freedom, submission, slavery, capture, kidnapping and conquest; 13% related it to confrontation between two groups or tribes, and the conquest of territories; 13% linked it to concepts such as anger, macho, bulling; 4% related it to other themes, e.g. conversation between characters, or did not answer. In most cases the male (referred to mainly as the Enemy or the Tlatoani) was identified as the antagonist and the female (referred to as the Princess and sometimes as the Peasant) as the Victim. 36% of all descriptions involved an explicit interaction, mainly as a dialog, between the male and the female characters.

Finally, subjects were presented with a sequence of three scenes (see figure 5). The Visual Narrator developed this sequence from the following actions: The Enemy kidnapped the Princes; Jaguar Knight fought against the Enemy; Jaguar Knight rescued the Princess. 75% of the participants described the sequence with the same o similar group of events; 25% described the sequence with different accounts. 80% of the subjects made in their report an explicit reference to the main roles of the characters: the Enemy was the antagonist, the knight was the hero and the princess was the victim (9% made an implicit reference to the Enemy but an explicit reference to the other two personae). 20% did not make references to their roles.

Discussion

The first section of the questionnaire provides a feedback regarding the automatic construction of characters. Most of them are clearly identified as pre-Hispanics although a few characters' features seem to produce a degree of confusion. For example, a number of subjects commented that charac-

ters are portrayed with occidental facial features. In the case of the enemy, his baldness seems to puzzle some people.

Figure 3a is easily identified as a Jaguar Knight. In the case of figure 3b, most subjects identify the image with a princess, although one fourth of the participants identified it with a peasant. This situation suggests that participants are not aware of the meaning of some pre-Hispanic symbols, e.g. the use of two hands holding a stick to represent social status. Figure 3c was the most confusing. Most people identify it as a Tlatoani and a slightly minor amount of people identify it as an Enemy. A possible cause of this situation is hinted by one of the participants. This person reports having difficulties in identifying the character in figure 3c. He explains that the image lacks majesty to be considered a Tlatoani and, at the same time, lacks aggressiveness to be considered an Enemy. Therefore, this person concludes that the image is closer to represent a priest.

Thus, these results suggest that the process employed by the Visual Narrator for building characters works adequately. The grammar allows constructing characters that clearly can be differentiated by people and which, in general, are associated with what they attempt to represent. That is, the system is capable of producing original images that satisfy the requirements associated to particular characters. Nevertheless, it is necessary to improve the graphic elements to solve problems like the ones just described. An important issue that arises from this analysis, and which will be repeated in the following lines, is the fact that people are not familiar with some important pre-Hispanic symbols. That is the case of the image of the princess and the stick held by her hands. This point will be discussed later.

The second section of the questionnaire provides a feedback regarding the interpretation of the glyphs. From the beginning, glyphs were designed to be part of a scene. However, we are interested in knowing the type of concepts that they evoke when they are not presented within a visual context. None of the subjects associate figure 4a with death. This situation is understandable because the use of the eyes closed as a symbol of death is particular of pre-Hispanic civilizations and a not well known fact between the population that answered the questionnaire. However, the glyph clearly triggers lost of associations that make sense to us.

On the other hand, figure 4b represents that the health of a character is at risk (i.e. the character is wounded or ill). Although an important number of subjects associated it with death, a similar number associated it with concepts close to health at risk. In fact, we can think that death is also a concept close to the intended meaning. The reason why the second glyph was better interpreted than the first one probably has to do with the fact that this second glyph was designed by the authors of this work. That is, it does not belong to the pre-Columbian tradition. Thus, glyphs seem to fulfil its function of evoking concepts and ideas

although, again, we have the problem of a lack of knowledge about the significance of pre-Columbian symbols.

The third section of the questionnaire provides a feedback regarding scenes. In the first case, the majority of subjects interpreted figure 5a as expected. Thus, the composition, i.e. the interaction between the characters, the glyph and the location, seems to be working appropriately.

The majority of the descriptions of the sequence of the three scenes (see figure 5) provided by the subjects are alike the text generated by our storyteller. That is, participants interpreted the sequence as expected. In the same way, the role of the three characters in most of the participants' narrations equals the intended role.

Three glyphs are employed in such a sequence: the first represents that a character is a prisoner (a tied pair of hands); the second represents a Potential Danger, i.e. one characters hates other (a hand holding a flint knife); and the last represents that a character that was a prisoner has been released (a broken prisoner's glyph). The three glyphs were designed by the authors of this work. From our point of view, the first and third glyphs can easily be interpreted. However, the intended meaning of the second one is at least not obvious if not obscure. Nevertheless, the context provided by the three scenes seems to give to the user enough information to correctly interpret it. This is an interesting result that illustrates the importance of the context.

This brings us back to issue about the lack of knowledge of pre-Hispanic symbolisms. We are interested in achieving a good communication with those interested in the Visual Narrator. At the same, we would like to be as faithful as possible to the pre-Hispanic traditions, which were the inspiration of this work. So, we need to find an adequate balance. The first step is to keep on researching about the role of the context in the interpretation of visual narratives. The results in this work seem to suggest that we might be able to employ unknown symbols that, with the help of an adequate context, can be interpreted as intended by people.

One of the most interesting characteristic of the whole project is the use of emotional links and tensions between characters. The Visual Narrator employs this information to depict emotions in its characters. It is interesting to notice that 23% of the subjects make comments about the emotional states of characters with descriptions that include words like anger, surprise and sadness (or crying). This result seems to suggest that characters' portraits express emotional states. However, we need to perform a deeper evaluation of this aspect.

In this way, the Visual Narrator is capable of constructing a short visual narrative (three scenes) that, in general terms, is understood by a group of human evaluators. The primitives employed to build characters' portraits, and the composition process seems to be satisfactory. This result suggests that we are walking in the right direction. There are several challenges in front of us. The most important is

to provide the Visual Narrator with mechanisms that allow more freedom during the composition process.

Most people that answered the questionnaire are unfamiliar with the meaning of pre-Hispanic iconography. Therefore, for them it might be difficult to comprehend this kind of visual narratives. However, it is this lack of prior experience that provides a great opportunity to better understand the mechanisms required to generate satisfactory visual narratives.

In summary, we have a plot generator system called MEXICA which is based on the E-R Model of creative writing. MEXICA is capable of illustrating its own narratives. The illustration process consists in analysing the dramatic tensions of the narrative and, employing a grammar, composing a sequence of images that represents such a narrative. This paper reports on how the grammar is employed to create the images. It is worth noticing that any system based on the E-R Model can employ the Visual Narrator. It might be necessary to modify the image-base; but the grammar and the process for analysing active tensions can be used.

We expect that this work will contribute to a better comprehension of this fascinating area.

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