

Comics 2D Art Editor: Composing Panels with Dynamic Perspectives

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ABSTRACT

Emphasizing perspective on a computer based comic autonomously generated is problematic since it requires common sense and creativity to choose the best shot. A factor known of influencing shot on cinematography, sequential art and used on previous computer based related works is Emotion. Focusing on the Emotion of the characters, we will frame panels varying zoom and angle, according to the emotional intensity and its semantic tags, respectively. Comics are a sum of all parts, its panels, and hence must be performed an overview to each comic page and re-weight of its panels will prevent repetitiveness but preserving the emotional arc of the story. Comics 2D platform provided the comic Software Development Kit and emotional information support necessary to develop two plug-ins: one responsible for the emotional rules and other for the final visual appearance. Two questionnaires were performed: one oriented toward the emotional rules, their existence or not, and the second to cultural-oriented styles, generated from data collected from an ad-hoc study performed by us. The results collected from the first were significant, showing the introduction of our enhancements had impact, while the second revealed interesting socio-cultural information about the subjects but requires a more in-depth study.

Categories and Subject Descriptors

I.3.3 [Computer Graphics]: Picture/Image Generation – display algorithms; D.2.11 [Software Engineering]: Software Architectures – languages. : <http://www.acm.org/class/1998/>

General Terms

Algorithms, Design, Human Factors.

Keywords

comics, perspective, emotion, socio-cultural background, autonomous generation

1. INTRODUCTION

Comics are world-widely known as books of comic strips or cartoons, often relating a sustained narrative. On its many years of existence, this product has been able to adapt to its time, a characteristic that guaranteed its survival through all kind of social cultural revolutions and gave origin to an uncountable variety of comics.

It is imperative to retain the following: how to create comics (sequential art) is not written on any manual and never will. Its conception is a direct result of the knowledge and background of the artist, of assimilation of concepts and techniques. One of those concepts is perspective. Like in movies, it is important to provide the biggest impact possible to a scene yet the choice can be though since the same scene can be pictured from different views, even if its focus – most of the times, the main and secondary characters – is the same.

Emphasizing perspective through an autonomous comic generation can be problematic when there is no real control on the camera. Hence, our work is included on the problematic of: “How to generate a comic autonomously?” The problems raised by this question are vast, but we decided to focus our work on perspective. To do so, will require the identification of conceptualisms and composition of scenes regarding camera shots: camera approach and its shooting angles, in particular. Our first and main hypothesis is to verify if the introduction of perspective will increase the satisfaction of readers when compared with previous comics without perspective. We found also interesting how cultural backgrounds might affect the preferences of the readers on comics, hence our second hypothesis will explore if different combinations of perspectives can be more or less interesting for readers depending on their reading habits.

On section 2 we will show how perspectives are captured in movies and comics, the most commonly known comic styles in their raw essence selected as our role-models and how other existing autonomous systems generate comics/sequential art. Next to the exposure of these concepts, section 3 will detail the conceptual model on which they are included, followed by the implementation notes on section 4. The resulting outputs from our prototype were evaluated through online questionnaires and their detailed results and evaluations are on section 5. The final conclusions of our dissertation and future work are on section 6.

2. RELATED WORK

To sustain the statements on section 1, we will explore the related work to ours by: describing how to create the illusion of perspective in movies and comics; define the most influent styles used in comics as start point to our research and later analyze other comic generators on what is their functionality.

2.1 Perspective in Movies and Comics

Movies and comics have more similarities than they appear on first sight, as they are both story-telling methods. The shooting of scenes is usually supported with the creation of storyboards, providing a great base to camera perspectives, lights and other set elements (1).

2.1.1 Zoom shots

Some of the expressive techniques used in cinema, and also storyboards, can be applied in comics as well, guiding the attention of the reader (2).

There are three main shots focused on featuring relevant character(s) or object(s) and as they can have many variants (see Figure 1), they can be included in three main categories.

- **Full framing:** shot that captures the body of a person in its entirety approximately equal to the height of the screen (3); it also provides the context of the story, enhancing the story by showing a large amount of background that is where the action is taking place (4);
- **Medium framing:** shot framing the human figure from the waist up (3) and communicates action (4). It is almost a close-up. A variant of this framing is the American framing where the character is presented from a little above the knees to the head. Its denomination dues to the need of picturing the guns of the characters, common on western comics (5);
- **Close-up framing:** shot taken very close to the subject, so that it fills most of the frame. In the case of a person, it usually includes the head and the upper part of the shoulders, or another portion of the body (3) in order to focus on the face, mainly the eyes since they are what communicate emotion the most (4). The artist expects from the reader to suppose the existence of a full body figure and deduce the posture recalling his memory and experience (6).



Figure 1 - Full, Medium and Close-up framing respectively. In Nick Two-Vests (7).

2.1.2 Camera Angles

The feeling obtained by the reader varies due to different perspectives (6) and it is the obligation of the author choosing the angle or viewpoint from which picture the subject the best way possible in order to pass on the pretended emotion (3) (see Figure 2).

- **Straight on, or eye-level:** The camera is located at eye-level in relation to the subject;
- **High angle, or angle down** - The camera is positioned above the subject and shoots down at it (3). This angle is commonly used to make a character appear fearful (8) by making it smaller and placing the viewer in a position of visual dominance and authority. Looking down on an object has less insight of the features of the object (9).

- **Low angle, or angle up** - The camera is positioned below the subject (3). This angle makes the character appear threatening (8) by making it look bigger, enhancing the perception of the features (9).



Figure 2 - Straight-on (top left), High (top right), Low (bottom) angles. In Nick Two-Vests (7).

Comic Styles

Different angles and zoom shots can be used to create an enormous variety of combinations, which are part of what is usually denominated as *Style*. The constant communication and sharing between artists deeply influenced their way of picturing the world and ended up generating an explosion of styles, without restraining the artist to local market (10). We will focus on the three mostly widely known styles: the European, the American and the Japanese comics.

2.1.3 European Comics

European comics are far more diverse than the single-genre umbrella might imply, with titles covering everything from comics for children to history to science fiction to erotica. What ties them together is the attitude: comics are taken far more seriously by the mainstream in Europe than in America or Britain, and consequently there exists a huge, diverse well-respected industry where comic artists are revered as celebrities. There is also a recognizably European graphic style that features clean lines and color washes, with its roots in the famous work of Hergé (in Tintin) and René Goscinny and Albert Uderzo (in Asterix) (11). From an ad-hoc evaluation of two European comics – “Tintin and the Picaros” (12) and “Asterix in Corse” (13) – suggest a strong tendency for full body and straight-on shots.

2.1.4 American Comics

American comics are deeply influenced by the world and its culture nowadays. The information flux and the cultures mixture on the American soil generate a great influence in the comic industry. Furthermore, many comic publishers are embracing the art of Japanese comics, contributing for a worldwide diversity and never detaching from its symbols and patriotic roots. To perform the ad-hoc evaluation, as we did on

European Comics, we rolled back to the 80s, where influences were still shy, and observed one of the most famous comic books in the American history: “Batman - The Killing Joke” (14). The medium shot was the most observed and close-up the less. As mentioned in section 2.1.1, medium shots include a subcategory denominated as American shot created in order to capture guns carried by cowboys. Because American Comics tend to focus greatly in action and less on details, close-up shots are less common. The straight-on angle was the most observed, like in European Comics.

2.1.5 Japanese Comics

One of the reasons the Japanese comics spread rapidly around the world results from the use of techniques that amplify the sense of reader participation, a feeling of being part of the story, rather than simply observing the story from afar hence the frequent use of wordless panels prompting readers to assemble scenes from fragmentary visual information and small real world details frequently used as an appreciation for the beauty of the mundane (10). It is interesting and important to denote the evaluation obtained from the ad-hoc results when compared with the American Comics. The close-up shot was the less observed, unlike what expected, and straight-on angle was the most observed angle. Their similarity is due to the comic used for the evaluation – Astroboy (15)–, made by Tezuka, the father of modern manga, deeply influenced during his childhood by the well known American film producer and animator Walt Disney.

The information collected from this ad-hoc study, about angle and zoom, is on Table 1.

Table 1 - Results from the ad-hoc evaluation.

	European	American	Japanese
Zoom(%)	close-up: 29 medium: 8 full: 63	close-up: 17 medium: 45 full: 38	close-up: 20 medium: 27 full: 53
Angle (%)	straight-on: 83 high: 5 low: 12	straight-on: 59 high: 27 low: 14	straight-on: 61 high: 23 low: 16

2.2 Comic Generators

There are comic generators that deal with perspective, each with different and interesting approaches. The most common comic generators are available on the internet and consist on drag and dropping the images from given libraries into empty panels. If we enter the field of autonomous comic generators, in Jacqueline Preuß et al. thesis “From Movie to Comics, Informed by Screenplay”¹ the comic of a movie is generated with the support of a screenplay input, with the possibility of minor image adjusts to be done post generation. Shamir et al. (16) gives the user main positions within the 3D environment from where the user can take screenshots of the viewport and capture the actions. Comic Chat (17) applies two different zoom shots – full and close-ups – as it wants. As for Comics 2D (18), it possesses few of the concepts of perspective, centering its concern on keeping its comic elements in the panels it generates.

¹ From Movie to Comics, Informed by the Screenplay, <http://1.21gw.de/?q=node/10> (in 2008-16-12)

3. A MODEL FOR PERSPECTIVE IN AGENT-BASED 2D COMIC GENERATION

Attending to the concepts collected from the related work on section 2, we will build a conceptual model based on them.

3.1 Basic Comic Structure: Panel and Scene

On the beginning of section 2, we related movies and sequential art on which comics are included. It is imperative to understand how we can provide the information necessary to autonomously generate them by isolating the composing elements of comics. McCloud gives some insight on this matter: “Comics require us to make a constant stream of choices regarding imagery, pacing, dialogue, composition, gesture and a ton of other options and these choices break down into five basic types: choice of moment: deciding which moments to include in a comics story and which to leave out; choice of frame: choosing the right distance and angle to view those moments and where to trim them; choice of image: rendering the characters, objects and environments in those frames clearly; choice of word: picking words that add valuable information and work well with the images around them; choice of flow: guiding readers through and between panels on a page or screen.” (10)

The “choice of frame” and “choice of image” are both oriented toward the visual appearance of the comic regarding panels (or frames) as individuals, composed of characters, a background and balloons associated to a character if it is speaking.

3.2 Perspective Introduction

These are the elements necessary to represent a common comic panel but alone they are not enough to represent a panel. The way views are captured, or, in other words, how this “choice of frame” is done, is used to emphasize emotion in a panel. So, every graphical elements of the panel – characters and background –, must be affected by those (Figure 3).

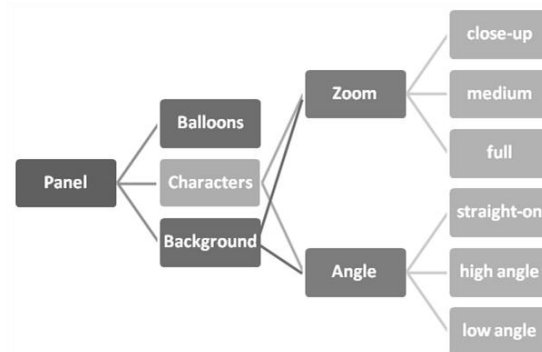


Figure 3 - Conceptual model for a panel with perspective.

Both “choice of image” and “choice of frame” concepts give us some enlightenment on the strategy we may use on an autonomous process: by looking at all the elements of a panel (“choice of image”) and perform a visual treatment on how we want to represent them (“choice of frame”). Although a comic is not a panel but a set of many; it is necessary to make a “choice of flow” when treating a scene or comic page, look at all its panels and on how they combine and flow as a whole.

This can be interpreted as a pipeline process: first we will look at the elements of a panel, then after the analysis to its entirety we run through all the elements that compose it and make a decision of framing that will affect panel, and finally we will look at the scene by verifying how it flows and, by combining all scenes, we will obtain the final result: the comic.

3.3 Panel

At this point, we know how can process a comic page through a pipeline process. We looked for works focused on perspective selection, yet what we found was mainly applied on 3D environments (19) (20) (21) (22), all with a common factor: Emotion. On section 2 we saw zooms and angles are commonly used to emphasize the mood or emotions of the character(s).

Emotions can be defined according to: facial expression and intensity value (23). According to the “Facial Action Coding System”, there are seven basic universal emotions, each with a family of facial expressions: anger, fear, sadness, disgust, happiness, surprise and contempt (24). In our model, the angle to be used corresponds to the dominant emotion on the panel, a criterion based on human perception and often used on similar camera capturing works (19) since people tend to focus on the highest intensity visual element due to the change of awareness it provokes on them (25). Figure 5 resumes the described approach relating emotion to angle.

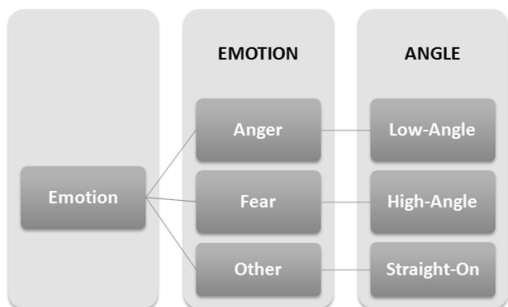


Figure 5 - Relation between the facial expression and angle.

As already mentioned, aside the facial expression, an emotion also has intensity, interpreted as a measure of the emotions. Previous works (22) linked the values high, medium and low intensities, with close-up, medium and full zoom, respectively. This association happens due to the closer the camera is, the more aware the viewer is of the emotion on the characters (4). Every intensities in a panel contribute for the emotional involvement of the viewer on the scene (19):

$$x_{intensity} = \frac{character_{intensity}}{n_{characters}}$$

In order to obtain the average value above, we gave Low, Medium and High intensities the values 1, 2 and 3, respectively. The result obtained conditions the zoom decision: the higher the intensity the closest the camera is, while the lowest the furthest (22). Because the equation above might not result on integer values, intervals were created for each category (Table 2).

Table 2 - Intensity intervals connection with zoom choice.

$x_{intensity}$	zoom
1; 1.5	Full
1.5; 2.5	Medium
2.5; 3	Close-up

Figure 6 sums up the approach relating intensity to zoom.

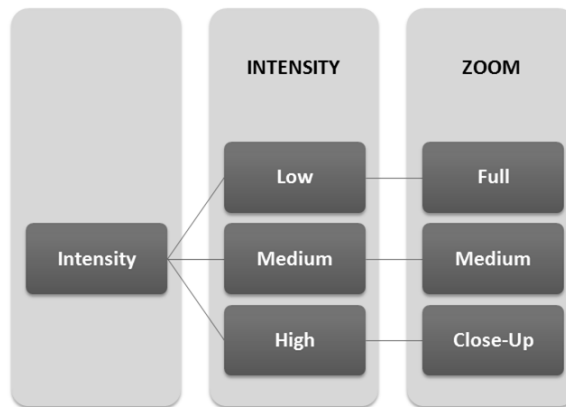


Figure 6 - Relation between the intensity of emotions and zoom.

Depending on the angle and zoom shot combination, different combinations are expected.

3.4 Scene

However comics are not to be seen panel by panel but page by page, in other words, in comics the whole is more important than the sum of all parts.

3.4.1 Balancing

Commonly an artist obtains feedback from drawing the comic page draft: the layout. This planning can be compared with own: we first look to a panel and afterwards to a scene. According to our model now, it is possible to obtain the same zoom for every panel. An artist can decide to do a page using the same zoom to every panel on a page to convey certain effects (such as parody and slow timing) (26). Repetition gives origin to similarity between panels, promoting the coherency among them (27). However, in some cases, the overuse of repetitive images may cause a lack of rhythm, disturbing the way the eyes of the viewer flow through the page (28) or even become boring, hence variety is essential to satisfy the natural appetite we have for change (27). In order to prevent the lack of variety, the criteria we used is: if the same zoom value is chosen in more than half the number of panels of the scene, then one or more panels will need to change their zoom value. To this process we called Balancing Process and consist on promoting or demoting the zoom values of the panels. If the zoom value must be changed, it will choose the closest next value on the intensity scale. This balancing of decisions is performed on zoom but not on angle because by changing angles we would be breaking the rules previously established to angle.

3.4.2 Stylization

We already studied how to attribute the many zoom and angle options according to the emotions displayed within each panel and how to evaluate the comic page generated in order to create a balance between the decisions made upon perspective. The method we found to give it user input is by providing mechanisms that allow the story emotional arc to be exaggerated or diminished through a Stylization Process, which is not mandatory of the comic generation (Figure 6).

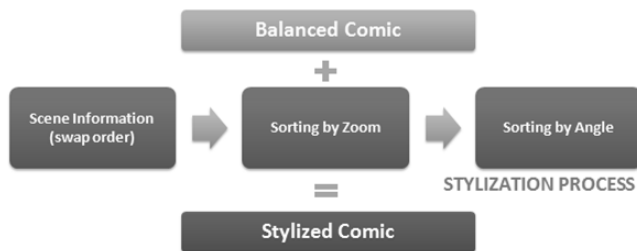


Figure 6 - Connection between the Balanced Process and Stylization Process.

The Stylization Process consists on guaranty the values of zoom and angle specified will be applied to the generated comic pages. As Figure 6 shows, our Stylization Process does three types of sort: a swap, a zoom and an angle sorting. On the zoom sort, the panels will be ordered by their intensity value and so close-ups will be grouped first, medium next and full for last. This transition attempts to emulate real life filming. So, if we want to promote or demote a panel regarding its zoom, we will proceed to its closest value, equivalent to the next position a camera would do if moving back or forward: Close-up ↔ Medium ↔ Full. The angle sorting is ordered by the semantic values. If the changes to be performed on the panel angle, would be done according to the tilt camera movement: High ↔ Straight-on ↔ Low. These criteria on both zoom and angle will define the attributes of the panels from a scene, post stylization process.

4. IMPLEMENTATION

On this section we will describe the algorithms used for the implementation of our model and the platform on which they were included.

4.1 Comics 2D Software Development Kit and Architecture

The base platform that we will be using is *Comics 2D*. Its **Software Development Kit** (SDK) uses emotional information of the characters to build its panels yet it generates a comic without perspective variance.

4.1.1 Introducing Comics 2D

The *Comics2D* platform creates visual summaries for story-based applications with autonomous characters, using an automatic composition method. The components that compose this platform are: Comic Strip Description Language (CSDL): markup language describing the plot; Content Library: stores all the images to build the panels visually; Realizer: analyses and transforms the comic strip specification into a concrete visual representation by providing the CSDL to the plug-ins of the platform. The comic creation process is made in phases to be completed in the Realizer, resulting from the sum of the pre-

processing and post-processing of each key nodes of the CSDL (*comic, scene, panel*) and the processing of the panel itself. The Panel Process is where all the plug-ins responsible of building the panels will be active and these are the Panel, the Character and the Balloon Plug-Ins and they have access the Content Library. This Library is previously generated by **Comics2D Library Editor**, capable of generating a .xml based library that lists and defines every character, background and object that can be used on the .csdl script.

The SDK and the Library were essential to develop our project and after this brief description of both, we provided the base and necessary information for our implementation to be understood.

4.1.2 Extending Comics 2D

Due to the composition of Comics2D, we created two plug-ins: the **Reviewer** and the **Art Editor** Plug-Ins, and integrate them on the previous architecture (Figure 9).

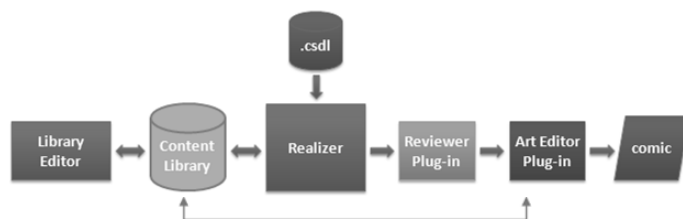


Figure 9 - Comics2D Art Editor architecture.

The Reviewer Plug-In processes the information according to our conceptual model while the Art Editor Plug-In performs the edition of images from the Library if necessary. Due its phased architecture, we were able to fit our processing after the scene is processed, since we need to analyze panels and scenes like we specified on our conceptual model on *section 3*. Our plug-ins also uses the Content Library. While zoom can be easily achieved by resizing an image, angles are not. There is no possibility to simulate angles from simple image editing since we are working with a 2D environment and, furthermore, the Library Editor is not an image editor. In order to provide the angle information a new parameter to the .xml Library called **View** containing the values: straight-on, top-down (high angle) and bottom-up (low angle). The **Emotion** list was also edited in order to guarantee the minimum requisites our conceptual model demands (see *section 3*). Next we will present the core of our work – the Reviewer and Art-Editor plug-ins.

4.2 Script Processing by Reviewer Plug-in

Is in the Reviewer Plug-in angle and zoom decisions are made and weighted, according to the rules on the conceptual model on *section 3* (Figure 10).

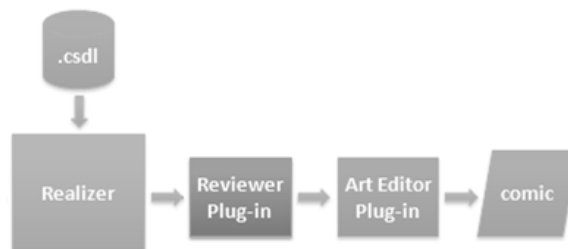


Figure 10 - Reviewer plug-in on Comics2D Art Editor architecture.

We had to modify the existing Panel class (present on Comics2D SDK and responsible of storing the panel attributes) and added the parameters zoom and angle in order to store the correspondent information. This will allow the next plug-in from the process – the Art Editor Plug-in, responsible for the appearance of the panels, – to easily obtain the values to execute, but not before the Reviewer Plug-in decides what those values are. First it examines the emotions displayed on every panel as described on *section 3*:

1. *The character within the panel presenting the highest emotion intensity will be chosen and its emotion will be used on the angle selection;*
2. *The average value of intensities within the panel will be used on the zoom selection.*

This algorithm provides us enough information to fill in the perspective related parameters of the Panel class and invoke from the Library the heads and bodies of the characters correspondent to the angle obtained and position both correctly according to their Docking Points. The matchHeadBody function searches the head and body part that match the emotion and orientation of the character and the angle of the panel.

To prevent repetitiveness, as mentioned on *section 3*, a *Balancing Process* is executed and obliges the panels to be re-weighted if its zoom value is changed: if the decision says the zoom will be smaller, then the intensity should drop and, hence, subtracted its value; if the inverse situation is verified then intensity will be incremented (*Table 3*).

Table 3 - Transition costs for zoom change.

<i>panel intensity</i>	<i>panel zoom</i>	<i>intensity transition cost</i>	<i>transition to zoom</i>
1; 1.5	<i>full</i>	<i>1.0</i>	<i>medium</i>
1.5; 2.0	<i>medium</i>	<i>-1.0</i>	<i>full</i>
2.0; 2.5	<i>medium</i>	<i>1.0</i>	<i>close-up</i>
2.5; 3	<i>close-up</i>	<i>-1.0</i>	<i>Medium</i>

Thus at this point we gathered enough and balanced information for a posterior visual processing. But, on *section 3*, we stated on how it would be interesting for the user to have some power upon the decision made on the process and so the transitions above will be revisited later during the Stylization process. The interface allows the user to select from within the interval 0.00;1.00 a value. All processes occur normally, although followed by the *Stylization Process* using the values. This way we are able to maintain the emotional intensity arc of the story.

The values specified on the interface are equivalent to the amount of each type we will use per comic page or scene that will have to be divided by the number of panels that compose the scene. After determined the number of panels per type, of both angle and zoom, we have the necessary information into our processed comic. Determine the panels will edit in order to satisfy the new panel distribution is the next task and, at some point, it resembles the *Balancing Process*: we will need to order the panels according to their importance (detailed on *section 3*). Initially a swap can be performed to solve the following: if we have a tie case, where the average of intensities are the same within a group, whether from zoom or angle, and the panels are

grouped according to the number of the panel, then the panel to suffer the change will always be the last from the group and consequently most of the changes will be performed toward the end of the scene. By swapping the initial order of the panels and sorting zoom and angles according over it, we will prevent predictability on the choice performed by this process.

Once we have the new order, we compare the number of angles and zooms we have per scene with the values given for both on the “Manual Settings”. If any of the panel parameters needs to change in order to fit the input that was given, a transition cost must be applied to the panel, similar to the specified on *Table 3*.

After this process is completed and the new values set to the correspondent panels, the Art Editor plug-in will process the panels and translate them graphically.

4.3 Image Editing by the Art Editor Plug-in

Posterior to the execution of Reviewer Plug-in, the **Art Editor Plug-in** is responsible for the edition of the image elements on each panel and it implements three main operations: **resizing**, **adjusting** and **cropping**, by this order. It also have access to the Content Library.

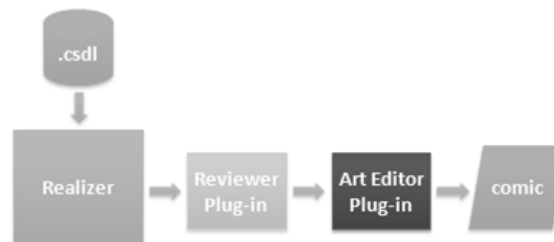


Figure 1 – Art Editor plug-in on Comics2D Art Editor architecture.

4.3.1 Resizing

The **resizing algorithm** in the Art Editor plug-in has the function to adapt the images that compose each panel. It uses its information, collecting the values from zoom and angle attributes, previously defined by the Reviewer Plug-in. Depending of what it collects, this plug-in will have to perform different actions: if the angle is different from “straight-on” it does not need to access the Library and redefine the location of the image to use; if the zoom is other that a full shot, the image will be internally resized to a bigger scale.

When the change of angle is done, the reference to the image on the Content Library of that character on that panel will be updated. Zooming requires the internal size of both head and body of the characters to be increased depending of the zoom chosen by the Reviewer: if medium, the internal size value of the characters will double, if a close-up it will be three times bigger than the original full shot, the “default” approach of Comics2D. Resizing is also applied to the background as it is to the characters, although, if the panel is a close-up, a smooth **Blur filter** will be applied, disguising eventual imperfections in case its image has been stretched and even simulating the effect cameras do when focusing on a close object and blurring the more distant ones. The blur type used was the box blur filter; it

uses a 3x3 convolution matrix:
$$\begin{matrix} & 1 & 1 & 1 \\ 1 & 1 & 1 & \\ 1 & 1 & 1 & \end{matrix}$$
 . After the filter is

used, it was applied to a copy image that will be part on the comic, preventing damaging the original one.

4.3.2 Position Adjusting

Resizing the characters brings a problematic: the characters, whenever resized, are positioned with their new size on the same position their full body was. Once the zoom is applied, both parts, head and body of the characters, can be misplaced. Notice the images are resized from the position of the comic generated by the Comics2D platform defined to them. What had to be done is to verify the distance between head and body docking points and move one of the parts, in our case, the head, toward the center of the top of the body, the neck. The second step to do is to adjust the character positioning within the panel since resizing may overlay both characters. A **character adjusting algorithm** will move the character, whom location is closer to the center of the panel, toward on the opposite direction of its gaze, away from the center. It is irrelevant if they intersect borders or the bodies of the character, occurrences commonly sighted on comics.

4.3.3 Cropping

The characters, on the previous version of Comics2D, were fit in the panel fully – both head and body –, but because of the zoom, the head or body of character might cross the panel borders. Thus, it is the **cropping algorithm** function to detect the intersection and cut the image by the border. The cropped image will be saved in the generated comic strip location and not on the location of the source in the Library; otherwise the image would be damaged or incomplete during further generations.

After finalized its execution, the Art Editor plug-in returns the fully modified and adjusted comic page. Comics 2D platform is responsible to assemble this information and build the comic, our final output.

4.4 Interface Enhancement

To make it all happen, the interface of our Comics 2D Art Editor displays all the necessary information to generate the output according to the given CSDL script, not before the user selected the style it will apply and return on the output, that will be the comic.

5. EVALUATION AND RESULTS

5.1 Description

In order to justify our hypotheses (*see section 1*), two questionnaires were distributed online on artistic and non artistic communities. Questionnaire One aimed mainly toward the comparison between comics with and without perspective selection rules. As for questionnaire Two, we focused our questions toward cultural-oriented styles, generated with the values from our ad-hoc evaluation process (*see section 2.2*), and prove their accuracy. 200 subjects answered validly to Questionnaire One and 47 to Questionnaire Two. Both questionnaires never revealed what their objective was so the subjects would be the less influenced possible and the conditions they were answered were constant, in other words, each subject had to answer to all the questions and they were always presented with the same order. Hence, our tests will have Repeated Measures and will use ANOVA on our evaluations that follow.

5.2 Analysis of Questionnaire One

The next table (see Table 4) contains the results for the question regarding the visual appeal for the same comic page (story-wise) generated with *None*, *Random* and *Balanced* styles and classify them in a scale of 1 to 7.

Table 4 - Results regarding the rule-based style used.

	None	Random	Balanced
Mean	3.035	3.185	4.535
Standard Deviation	~1.96	~1.83	~2.23

As we performed significance tests on these results, we verified they were positive, meaning there is in fact a difference between using any of these styles, being the *Balanced* the most visually appealing to readers and *None* the less. The Mauchly's Test value for significance was greater than 0.05 and we could assume sphericity. Through the Test of Within-Subjects Effects, $F(df, error) = 0.730$ and the significance value is $p < 0.001$. Because p is less than 0.05, we can conclude our Rules are significantly different considering these results. We could assume these would be the results on every context, however, due some costumes and ways of thinking are very specific from country to country. Is this reflected on comics at some point? Because on this questionnaire we asked as well which the location of the subjects on the world was, we were able to separate the results above per regions: North America, Europe and Asia (*see Table 5*).

Table 5 - Means grouped by region of the subjects regarding the rule-based style used.

	None	Random	Balanced
European Mean	~3,45	~4,09	~4,85
North American Mean	~2,63	~3,47	~4,07
Asian Mean	2,6	3,4	5,4

Every mean regarding the *None* style is always more negative when compared to the other styles. Still, its European mean is slightly more positive, close to be considered “interesting” (close to 4) by the majority. The fact is possibly due to the use of full shots, that compose this style, to be for many decades one of the main characteristics of European comics (*see section 2.2.1*). Still about Europeans, the comic page generated with the *Random* style did not get a much better classification than the *None* one, but, on the American group, the mean for *Random* gets a close to “interesting” classification, not at all far from the *Balanced* style. As for Europeans, they classified the *Balanced* style as their top preference. This fact might be related to “the bigger the better” North American perspective on things: as long the change is noticeable it is indifferent if rules exist or not. The Europeans however tend to have deeper criticism sense and value aesthetics a lot more.

The Mauchly's Test value for these groups resulted on a significance greater than 0.05 for all group and we could assume sphericity was met. By performing the Test of Within-Subjects Effects, we obtained $F(df, error) = 43.655$, $F(df, error) = 34.521$ and $F(df, error) = 10.4$ for Europeans, North Americans and Asians cultures respectively, and $p < 0.0001$ for the first two and $p = 0.009$ for Asian culture (all below 0.05), it means all the differences of the Rules, regardless of the culture we choose, are significant.

5.3 Analysis of Questionnaire Two

The objective of the first set of questions is to verify and enforce the results obtained on questionnaire One (*see section*

5.2). The results are on the next table, being 1 the highest rate of the scale and 3 the lowest (Table 6).

Table 6 - Results of the rule-based style used.

	None	Random	Balanced
Mean	2,19	1,89	1,91
Standard Deviation	~0,74	~0,84	~0,86

Here we see tendency is directed to the styles (*Random* and *Balanced*) which use newly implemented Rules and *None* style achieved the lowest rate as expected from the questionnaire One. The *Random* and *Balanced* means are very close, as it can be observed the previous table. It was expected that, just as on questionnaire One, the *Balanced* style would be the top preference of the respondents since rules are being used to generate the comic page displayed on the test, fact that should increase the intensity of the emotions and actions happening on each panel. Several factors could be pointed to explain the difference but the main cause would be the story, which differs on both questionnaires. While we were aware this situation could happen, the change of story was intentional. We could have simply switched the order of the comics that were displayed on the first test, although this way we could not only prove our system made a difference, and that the results could be maintained despite the story used. Even if the *Random* and *Balanced* means are close, they are visibly best preferred by the respondents than the style with no rules.

On the second set of questions on questionnaire Two, we displayed four different comic pages telling the same story each one generated with different styles: *Balanced*, *Japanese*, *European* and *American* (see section 2.2) and asked the respondent to order them according to their visual preference, being 1 the most favorite of the set and 4 the less. The results are on the following table (Table 7).

Table 7 - Results regarding the rule-based style *Balanced* and the culture-oriented styles used.

	Balanced	Japanese	European	American
Mean	2,64	2,76	2,49	2,11
Standard Deviation	~1,28	~0,93	~1,01	~1,15

The top rated style is clearly the *American* and the *Japanese* style the worst rated. To get a more accurate display of results, we separated the rates according to the subjects reading preference: 26 were American comic readers (Table 8), 14 Japanese comic readers (Table 9) and 6 other comics readers.

Table 8 - Classification of the results regarding the rule-based style *Balanced* and the culture-oriented styles used by American comic readers.

	Balanced	Japanese	European	American
Mean	2,73	2,65	2,69	1,92
Standard Deviation	~1,31	~0,89	~1,01	~1,09

The table above shows the top preference of American comic readers is the *American* style and that the values we collected from the ad-hoc process (see section 2.2.2) for the *American* style might be related to the visual preference of the American readers.

Table 9 - Classification of the results regarding the rule-based style *Balanced* and the culture-oriented styles used by Japanese comic readers.

	Balanced	Japanese	European	American
Mean	2,85	2,77	2,23	2,15
Standard Deviation	~1,31	~1,09	~1,09	~1,14

Contrary to the expected, the *Japanese* style got the lowest mean and the *American* style the highest. The *Balanced* and *Japanese* means are similar so we might say the preference of Japanese comic readers approaches the *American* and *European* styles the most instead of the values we collected initially for the *Japanese* style (see section 2.2.3). However, while we could redefine the values used on the *Japanese* style, we can also make a mistake by doing so, since the number of respondents that preferred Japanese comic books over the others were only 14, previously stated. European comics barely achieved votes and, for that reason, it was not possible to evaluate whether the European style was or not accurate to the values we collected from our ad-hoc process.

To test the significance of these evaluations, we performed a Mauchly's Test on the styles from this set of questions and verified the significance was greater than 0.05 and sphericity assumed. By performing a Test of Withing-Subjects Effects, we verified that $F(df, error) = 2,453$ and $p = 0,07$, greater than 0.05, hence our results cannot be considered significant. However, 0.07 and 0.05 are not far distant which might mean on a further and more extensive test using these same conditions we might obtain significant values regarding these styles. In short, both questionnaires had very interesting and significant results, not only on the rules and features we implemented but also on a socio-cultural perspective.

6. CONCLUSIONS AND FUTURE WORK

To include perspective on an autonomous comic generation on a 2D environment can be problematic since we cannot change perspective as a 3D environment would allow. This affirmation guided us to our problem: "How to provide perspective to an autonomous comic generator system and what is its impact on readers?" and consequently to our first hypothesis: "The introduction of perspective will increase the satisfaction of readers when compared with previous comics without perspective." And our second hypothesis: "Different combinations of perspectives can be more or less interesting for the readers depending on their reading habits."

To do so, we had to combine all the components of perspective, the zoom shot – full, medium or close-up – and camera angle – straight-on, high and low angles –, to better represent an action or emotion, and also analyze how the combinations (or Styles) of these several components were applied by the three trendiest comic styles known: the European, the American and the Japanese comics.

By using the Software Development Kit and features of the Comics 2D platform, we could extend both its Library with the required information to select its images according to their angles. Including a zoom value in the Library will not be necessary since that component will be handled the Art Editor

Plug-in. It and the Reviewer plug-in, processed on the inverse order, are the responsible to return the output comic strip according to the values given by the user. The algorithms on the Reviewer set the values to the attributes of angle and zoom to each according to its rules, while Art Editor interprets that information editing each panel individually if necessary by resizing and cropping both characters and backgrounds.

To evaluate our hypothesis and its results, two questionnaires were elaborated: the questionnaire One aimed mainly toward the use of rules on the perspective choice and questionnaire Two was focused on the styles determined through our ad-hoc process. The results collected from our two questionnaires were encouraging, in particular questionnaire One, showing the introduction of our enhancements had impact and significant, revealing simultaneously interesting socio-cultural information about the respondents. Questionnaire Two was not as significant although with a more in-depth study more accurate and interesting data could be collected. While both of our hypotheses were not fully satisfied, the first and most important one was, answering to our problem, and so we can conclude the existence of perspective on autonomous generated comics have substantially more impact on readers than if there is no perspective at all.

7. ACKNOWLEDGMENTS

Our thanks to ACM SIGCHI for allowing us to modify templates they had developed.

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