ISSA Proceedings 2002 – Mapping Visual Narrative As Argument In Interactive Media

Introduction

History, art, and science are a few areas of study whose knowledge is regularly delivered through informal educational settings (Bloom and Powell, 1984), particularly in museums. Carrying out one of the primary missions for most museums, to educate its audience, individual installations must be designed to accurately convey a clearly specified body of information, within a limited timeframe to a diverse, often international audience. Two major concerns drive design: First, designers and content experts are usually most concerned that the information conveyed through the installation is accurate and understandable to the audience. Key concepts and relationships among related factors in the particular topic area must be clear to primarily non-expert audiences. In addition to these basic information design considerations, designers are also well aware that the audience's engagement with an installation is voluntary, and the installation typically competes for the museum goer's engagement with the other activities, displays, special shows and installations offered by the museum. Marketing experts typically consider a museum's target audience to be primarily recreational audiences – the same population choosing among a variety of leisure-time activities, including professional sports, movies, family parks, and so on. Even museums targeting children, in which cases the educational purposes are pointed, concern themselves with making the museum experience larger and more eventful than learning in the classroom setting. For reasons of attendance and funding, museums take seriously the entertainment factor in any installation. Thus, designers of museum installations are quite concerned with attracting and maintaining a visitor's attention in order to impart the intended historical, artistic, or scientific knowledge.

The specific role that visual elements contribute to a user's grasp of a narrative conveyed through multimedia technology is not fully explored, but research has been conducted in many diverse areas, including textual narrative in literature (Nodelman, 1988; Witek, 1989; Sillars, 1995), visual narrative in art (Holliday, 1993; Kupfer, 1993; Lewis, 1999), narrative as cognitive framework (Bruner, 1991; Beloff, 1994; Graesser, 1981), and as a rhetorical act (Voss, Wiley, & Sandak, 1999) in psychology, as a logical guide in the designed world (Buchanan,1989), and as a networking and logical model in computer science (Bers and Cassell, 2000; Sengers, 2000; Dautenhahn, 2001).

Aristotle (Kennedy, 1991) identifies the narrative as one of two types of argument, the other one being the enthymeme. Generally, a narrative can be understood to consist of the following:

– a context from which the narrative emerges: a beginning point in time, space, or condition

– a sequence of actions performed by agents (characters) which move the story towards a culminating point

– an ending, closure point, denouement

1.1 Narrative framework as cognition

In almost any venue we might imagine, telling stories predominates as a means of sharing experiences and knowledge. Narrative is believed to be a fundamental cognitive means of organizing human experience and making meaning of it (Bruner, 1990; Polkinghorne, 1988). When considering information conveyed through text, it is believed that information delivered in a narrative versus other text forms (e.g., expository format), is easier to read, write, summarize, and remember (Graesser, 1981; Mandler & Johnson, 1977). According to Goldman, O'Banion Varma, and Sharp (1999) using a recursive network model to represent narratives allows "a systematic method for analyzing the causal relations among states and events in narratives" (Trabasso & van den Broek, 1985). It is possible a narrative structure reflects more closely the way people perceive events as they occur through their lived experiences (Graesser and Riha, 1984). Although a cartesian view of mind and body continues to hold sway in science, exploration into environmental conditions and physiology of the brain, in particular, suggests that cognitive capabilities are not entirely genetic or "hard-wired" in the brain. Human predisposition for narrative is believed to be at least partly due to enculturation – well before children encounter formal schooling they are exposed to narrative structures through diverse sources: the retelling of family histories and events, bedtime storytelling, community socializing, as well as through television and other media.

When reading a narrative, readers mentally form a situation model or "movie" of the information it conveys. The quality of the narrative can be measured by features that support the story of the information (Leinhardt, Stainton, Virji, & Odoroff, 1994, in Voss, et al., 1999): coherence, completeness of the information, causality, chronology, and contextualization. In a study which manipulated these factors, Voss, et al., found that coherence/chronology was crucial to 64 participants' perceptions of narrative quality. On the other hand, incompleteness, or the quantity of evidence given in the cases had a lesser effect on the readers. Omission seems to not affect peoples' ratings of narrative quality, nor their subsequent guilty ratings.

In her analysis of Indian palm-leaf books which include both text and images, Williams (1996) also notes the importance of sequence in establishing causation and in shaping interpretations of what happens in the narrative. Remarking on the differences between text and graphic narrative, she notes that although words can create "a stronger causal certainty than do images," other components, "such as Aristotle's categories of character and spectacle, are… often less ambiguous in a picture than in verbal narrative" (110). In a visual narrative, the descriptive capacity of language is replaced by characteristics of the image, "by color and line, which follow their own systems of metaphor and associated meaning" (111).

1.2 Visual narrative

Biblical parables, mythical tales, and historical and literary accountings have provided rich topics for artists throughout the ages, expressed through diverse media including painting, tapestries, photography, sculpture, and Greek pottery (Kupfer, 1993; Lewis, 1999; Stansbury-O'Donnell, 1999). They have been widely studied by art critics and historians as a means of understanding and appreciating those works. From simply the weight of evidence available across cultures and time, we can see that people have "discovered" the usefulness of sharing knowledge and perpetuating beliefs through visual narrative. But to a great extent, the utility of visual narratives relies on the interpretive skills of the audience. However, in literary studies Belloff notes that). Furthermore, the older, "high art" forms garner more respect than "low art," such as comic books and illustrated children's books (Witek, 1989; Nodelman, 1988).

Clearly, when compared to text there are significant differences in the ways in which visuals can convey a narrative. Perhaps most obvious, graphics can more efficiently convey a more complex set of information at a glance. Everyone is familiar with the adage, "a picture is worth a thousand words" although psychologist, Halla Beloff (1994) has noted the visual – graphical texts – have generally not received the status and attention of verbal text in Western universities, which privileges verbal discourse. Furthermore, she argues for the richer interpretations supported by visuals when compared to “words [that] are not only pedestrian but provide closure” and “seem to sum things up” (499). The either-or case is not so simple, however, as experts in visual rhetoric, have problematized the valuing of visuals over text, reminding us that the intended effectiveness of visual texts – not just that they clearly and easily convey a mass of information, but that the information conveyed delivers the message the sender intended – is dependent on a number of context-related features, including, but not restricted to things like the relationship of the graphic element to the accompanying language, the order in which it appears, the quality of the rendering.

In addition, effectiveness is also dependent on the audience: Gender, cultural background, ethnicity, level of domain expertise, and age all affect the way a person “reads” a graphic. In the da Vinci example, a viewer would more easily appreciate and understand the value of the scene being illustrated if she knew who the depicted people were and their relationships and shared the sense of aesthetic of 16c Italy, knew about clothing, and embraced the role of these women in the Bible, and so on. But a more general grasp might be acceptable because myths and social beliefs are typically circulated in a society from multiple sources, and thus the purpose of a painting like this might be to help perpetuate the stories or beliefs and expand on ways the viewer understands that knowledge works.

Of course, this information could have been shared through language, as well, which could, in a non-hypertext environment, support a linear, more explicitly hierarchical and more specifically determined narrative. Because words can explicitly convey causal relationships among tangible as well as abstract entities, a progression of actions and results leading to the conclusion Beloff’s criticism that words sum things up could be viewed as a clear advantage in many information-sharing situations.

1.3 The familiar and the unfamiliar

When the user encounters an unusual visual, one whose meaning is based upon “seeing” it in an atypical context or one that violates an established visual pattern, then she must spend more time making meaning of it. This suggests several possible characteristics about the audience: possibly one sharing similar cultural knowledge and schemata with the designer; possibly, possessing higher analytical skills; and/or broader experiences resulting in more contexts to "try out" with the visual. As Beloff notes from Freud's reading of da Vinci's *The Virgin and Child with Saint Anne*, in which the two mothers – Mary sitting in the lap of St. Anne – overlook a playing baby Jesus, "it is logically necessary to uncover the symbolic value of the forms because they so clearly go beyond the straightforward and the conventional" (496). This also means the viewer may not "get it." If the audience member lacks the appropriate context for informing a reading of the visual, the point may be lost. When that point is part of a larger visually constructed argument, then the viewer's confusion may have a larger impact on the overall message.

1.4 The designed environment

From the study of design, Richard Buchanan (1989) suggests we view technology, or the designed object, as an interactive "rhetorical problem" (p.92), in which the ideal level of utility of the designed object can be best conceptualized by keeping its purpose, needs and characteristics of the intended audience, and context of its use in the forefront during the design process. He describes design as an architectonic, or a process of rhetorical decisionmaking, the results of which guide users through the created world – the designer, through design communicates to the user. The communication includes utility, and the designed object reifies a particular way of understanding the person and the created world (and, usually less directly, advances a view of the world in general). When the potential user becomes an actual user of the designed object, then the designer's communicative act becomes complete. It is through argument – "technological reasoning," character, and emotion – that designs effectively communicate to users.

Despite the impressive power of multimedia technologies – high resolution graphical interfaces, the ability to handle a seemingly infinite range of color, high-fidelity sound, breathtaking processing speed, vast memory, and other features that make sophisticated information delivery possible – designing museum installations primarily based on the capability of the technology at the time has not proven effective (Friedlander, 1995). In related web design research probing the interrelationship between text and graphics, Wright, Milroy and Lickorish have observed that using animated graphics with textual information can impair comprehension or retention of the content (1998). When readers were tested on content after reading text with animation preceding it, they found that the graphics may pull readers in, but when viewed concurrently with the text, their test scores dropped. Wright points out, however, that this kind of finding exemplifies the problem with seeking broad guidelines for information design – there are typically many factors involved in using graphics effectively in multimedia environments, and, thus, it is more appropriate to expect to develop guidelines for more narrowly defined conditions and the need for more context-specific, localized testing.

2. The Show: Gray Matters

Gray Matters: The Brain Movie is a collaborative production developed by Carnegie Mellon University's STUDIO for Creative Inquiry (Carnegie Mellon), the joint University of Pittsburgh/Carnegie Mellon Center for the Neural Basis of Cognition, and the Carnegie Science Center. The interactive show, which has been viewed now by thousands of people "combine[s] immersive and interactive techniques to create a 'theater of the brain'." Briefly, the show was designed to be projected on a planetarium dome – a map of the "brain's surface with pulsating neurons" so that each neuron corresponded to an audience member's seat. In the interactive parts of the show, each audience member, playing the role of a neuron, used a two-button handset to activate various behaviors on the screen and, collectively, "become" a brain (Brain project website, 2002). The interactive process implemented in the show was one of "global behavior emerging from local decisions" (Dannenberg and Fisher, 2001). For most of the activities in the interactive system, the audience had to work together to accomplish a variety of entertaining feats or to solve problems. This design paralleled the way scientists believe the brain works, as individual neurons collectively "give rise to thought" (p. 2). Thus by participating in the interactive show, audiences would learn how the brain functions – not just through the content, but also through the very mode of their participation.

Prior experience recommended the designers exert control over the user's attentions to the multimedia installation rather than the user-driven mode more typical of surfing and hypertext user interactions (Friedlander, 1995; Roy, 1995). Friedlander recommends using a "spine" to interconnect the multitude of information, scenarios, and interactions comprising the museum's information (p. 169).

Overall, according to the project's design team the show's purposes included:

– communicate scientific information about the human brain to the public
– convey the excitement and importance of contemporary brain research
– enhance the educational process through advanced, group-interactive

technology
– broaden distribution through portable presentation and interactive technology
– engage the target audience in development of the presentation
– further interdisciplinary dialogue between the arts, sciences and humanities

3. Evaluation and user testing the show

The process of producing the installation was a complicated orchestration, involving more than 50 people over three years, and was recursive, including extensive usability testing and audience feedback for dual purposes: The Center for Innovation in Learning, charged with ongoing evaluation of the project as a whole, and usability testing in particular performed regular testing once blocks of the show were developed enough to test for the audience's understanding of content and enjoyment. Although both kinds of testing shared objectives, the ongoing evaluation was built into the design process as a mechanism to ensure that the science conveyed in the show was accurately depicted. Usability testing was concerned with the content of the show, testing audiences' perceptions in order to inform the design of the show, as well as testing the interactive "scenarios" audiences engaged in and the control boxes used to participate. One part of the usability testing focused on the way in which images are perceived by the brain, the "scenario" comprised of a journey of the image's first perception by the eye to electronic pulses in different parts of the brain. It is this part of the testing that this paper discusses.

The design of the test was fairly straightforward – to take the information organized by the designers' into a visual narrative of how this brain process works, and to see how well participants' "reading" of the graphics mapped onto it. We presumed the closer a "fit," the better the participant understood the brain science being communicated.

3.1 Brain Project narrative

In order to provide the Brain Project designers with feedback on viewer interpretations of the basic images of the project, as well as their semantic or narrative interconnections, thirty-one participants took part in an exploratory study in which they viewed and gave their responses to thirty-three storyboard images drawn from the project (see handout). In the study, images were viewed in the same order as that of the website presentation. In addition, the designers' narrative for the online images was used as a basis for comparison with the students' interpretations. Participants told a story of what they were seeing which was mapped against the designers' narrative to see how closely they matched and to pinpoint potential problems or "holes" in the narrative thread.

3.2 Testing the storyboard

Keeping the overall assessment strategy in mind, the following measures were used:

Characteristics of visual information and of narrative that were particularly important to this project were the richness of information, which tended to be descriptive, and the coherence, or ability to keep the viewer following the narrative. In these cases, omissions, abrupt changes or shifts caused breaches in the participants' ability to follow along.

– *level of understanding of the neuroscience concepts*
some concepts were descriptive
some concepts were more process-based concepts were dynamic
– *ability to follow the narrative thread of the show (coherence)*
like process-based concepts, this was dynamic

Participants were shown the images in two passes, in the order in which they were presented in the storyboard, but omitting images directly related to the interactive sections, which were tested separately. In the first pass, the participant looked at the images in sets of approximately five pictures each, and was asked at the end of each set to describe the story the pictures told. Participants were allowed as much time as they wished to inspect the pictures but once viewed, they could not review them. In the second pass, the participant was directed to elaborate on specific, potentially troublesome images. This time, the participant was allowed to look at the image before and after the main one. One experimenter interacted with the participant while another took notes on the participant's responses.

At the end of the viewing session, participants were given another opportunity to voice confusions, point to particular images, say what they had not had a chance to say in the two passes. After this, participants were asked to respond to a questionnaire asking them to rate their level of neuroscience knowledge and to rate the images along different dimensions (see attached Questionnaire sample).

3.3 Participants and materials

Approximately two-thirds of the subjects were recruited from the Carnegie Mellon campus at large and one-third from the Psychology Department's Human Subjects

Pool. The majority of the study population was made up of undergraduate students. Those recruited from the general campus community were paid a small fee for their participation which ranged from 1/2 to 3/4 hour. Subjects from the Human Subjects Pool received one course credit for participating.

Participant recruitment was restricted to people who had not taken courses in neuroscience. The participant profile as drawn from the post-questionnaire (see below) shows participants assessed their level of knowledge about the brain to be somewhat below an average rating of three on a one-to-five-point Likert scale.

1. Compared to most people, how much do you know about the human brain?	2.82
2. Compared to most people, how much do you know about the human eye?	2.9
3. Compared to most people, how much do you know about the biology represented in these images?	2.66

Although a general adult audience includes those who may not be college-educated or whose science education may be limited or out of date, the market surveys for museum attendance show adults attending children's museums tend to have some post-high school education, are interested in education, and interested in fostering their children's education.

3.4 Summary of results

By and large, the feedback on the quality of the images from the verbal responses and the post-questionnaire (see attached) was positive. Viewer ratings for the overall quality of the images averaged 4.04/5. We believe this is a particularly strong rating in light of the age and cultural experience of the respondents, who encounter sophisticated computerized graphics regularly in their own schoolwork, or in leisuretime, for example, when surfing the Web. Responses were comparable to ratings from younger participants in other tests.

Also, most participants followed the sequence of images in a meaningful way. We measured this by examining a few milestones: In the first one-third of the storyboard sequence, most participants – 83.9% (26/31) – understood the "camera" was zooming in on the eye, and not the fish. Of those who were confused – 29% (9/31) – approximately one-half self-corrected their initial impression.

In the middle part of the sequence, 81% of the participants understood that the brain process being illustrated involved signals or impulses of some sort traveling through different parts of the eye or brain. Many people 54.8% (17/31) mentioned the layered or multi-celled structure of the eye. Viewers varied as to what kind of impulses they thought they were –24% (6/25) called them electro-chemical impulses, 16% (4/25) called them data or information, and 8% (2/25) called them energy. Finally, 32% (8/25) thought the impulses were light.

From images #9 through 16 – when the light has hit the back of the retina and impulses travel forward from the rods and cones to the bipolar and then the ganglion – many participants expressed confusion over the direction the signals traveled. Many people – 58.1% (18/31) – detected a change in the direction of travel, but of that group, fully 83.33% (15/18) expressed confusion over that change in direction.

In the final one-third of the images (when the impulse travels from the soma to the axon terminals), most people said little beyond expressing a general sense that they were continuing to zoom in or that the signal was continuing to travel as it had been. Many people – 59.8% (17/31)– were confused by the abrupt transition between the final shot of the interior of the axon and the zoomed-out image of the multiple axon terminals (#29 to 30). However, most people – 80.7% (25/31) mentioned the "coming full circle" effect the final image had on the narrative aspect of the sequence of pictures. (The final image illustrated the back of the brain where, up to that point, the processing they had been viewing took place.

3.5 Rough transitions and coping with confusion

Two transitions people mentioned most often as problematic were the ones between images 4 and 5 and between 29 and 30. The first transition, in which 22.6% of people expressed confusion, goes from a close-up of a single fish to an image of the eye with a light beam going into it (although a few people wondered which direction it was going). The second transition, in which 54.8% of participants were confused, zooms out from a final shot of an impulse traveling through the axon, to a field of terminal buttons. The transition involving abstract images elicited twice as many responses of confusion as the one in which familiar images were shown. We hypothesize that rough transitions involving familiar images are more easily filled in by the viewer, and are, thus, less critical to "fix" than the rough transitions involving more abstract images. Likewise, a number of important concepts could not be fully illustrated without using a complete set of images. We caution interpretation of problems with transitions as specific problems, but, instead, as information on how viewers perceive.

We also noticed that people mentioned colors often, especially when they were trying to make sense of the abstract images. Comments like, "not really sure [what that was], you showed an obvious gap between orange and blue . . . something transferred over the strands of blue–energy or light–not sure . . .” In fact, 58.1% (18/31) of the participants noted color when they described the storyboards and, of these, seven people (38.9%) expressed confusion when the color of the ganglion changed from one storyboard to the next. It seems reasonable to expect consistent color mapping becomes a more important design issue as the abstractness of the images increases.

4. Summary of results

4.1 General descriptions

1. Participants rated themselves slightly below average in their knowledge of the human brain, the human eye, or the general biology principles represented in the storyboards.

4.2 How well did the audience understand the neuroscience concepts presented in the pictures?

1. Over half (58.1%) of the participants noted the change in the direction of the light impulse from the initial intake of light towards the back of the eye, then out towards the rods and cones, to the axon, etc., but of those people noticing the change in direction, most (83.33%) expressed confusion over it. There was no indication that any of the participants understood the “backwards” nature of the retina.
2. Over half of the participants (54.8%) noted the layered or multi-celled organization of the eye
3. Most people (80.7%) mentioned the visual processing area of the brain illustrated in the final image

4.3 How well does the audience follow the sequence of images?

1.In the first ten storyboards, most participants (83.9%) grasped the direction of the show, with some people (29%) initially expressing confusion.
2. Of those 29% initially expressing confusion, over half of them eventually “got it.”
3. Many people (59.8%) were confused by the transition between the final shot of the interior of the axon and the zoomed-out image of the multiple axons (#29 to 30).
4. Most people (80.7%) understood the meaning of the final image

4.4 How well does the audience like the images

1. Participants rated the overall quality of the images as moderately high (4.04/5)
2. Overall, participants expressed moderately positive (3.59/5) emotional responses to the storyboards
3. Participants rated themselves as somewhat likely (3.39/5) to see the show
4. Participants rated their level of engagement in the storyboards as somewhat high (3.69/5)

4.5 Possible implications?

1. Abrupt transitions of familiar images may not confuse people as much as abrupt transitions of abstract images.
2. Over half (54.8%) of the participants mentioned color in their descriptions, particularly as a means of following from one storyboard to another.

5. Conclusion

Our participants were able to recognize and appreciate descriptive information in the images even if they did not have the precise technical language to express the parts they were seeing accurately. For example, they were able to appreciate the retina was multi-layered, although many did not know it was the retina, per se, they were looking at. In terms of the scientific information the designers wanted to impart, this could be viewed as only partially successful. For this kind of show, in which technical language allows more precise and accurate understanding of the knowledge being imparted, a combination of language and visuals were necessary and used in other parts of the show to support this. However, if viewed as a supplementary source of information, one in which students could be highly engaged, the ability to name the parts could be expected to be picked up elsewhere – in the classroom, in a supplementary text, in a short lecture.

Following the direction of the impulses was sometimes a problem when participants were tracking the impulse from one still image to another, particularly in the middle section, when viewers were in the most abstract section of the show. They were quite adept at remembering the position of the impulse from one frame to another, remembering the colors and highlighted areas of the ganglion and other cell parts, and then combining those observations in an attempt to figure out the direction of movement.

The major limitation of this study lies in the difference between looking at still and animated images. We suspect that some transitions, direction problems at the local level, and overall emotional response may have been affected by the lack of animation. The transitions that may have been rough, but were made clear in later images may have suffered from the viewers taking their time with the rate of viewing the images. The pace in the animated show would, of course, be the same for each viewer and in some cases would quickly provide context for a puzzling transition.

Obviously, the observations in this study are specific to this project and not statistically tested. However, many of the observations noted here suggest fruitful areas for further research. In particular, prior neuropsychological work on pattern matching applies here and might warrant further testing in a multimedia environment. Visual narrative could possibly convey information that is less culture or language-bound, thus studies into international differences in semiotics will also prove useful in the future.

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