Interactive comic transitions using smartphone sensor based narrative driven interaction

Master Thesis: Exploration of restrained reading progression to engagement with narrative elements

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ABSTRACT

Previously interactive comics studies have explored the limitations of comics. Its observed that gamification is a form of multi-modal enhancement, which these studies have applied. As a means of addressing this observation, this study investigated an addition of multi-modal impact on interactive comics, through a Non-branching interactive comic artifact. The artifact applied smart-phone sensor technology to apply more input options to form an interaction driven narrative. The objective was to explore the utilization of the smartphone medium's capabilities for interactive comics; activating more of our sensory system to achieve this. The study was a Game Design evaluation building on methods such as Engagement Mapping Method, and Non-ISO style Usability and User experience assessment. Results point to a conditional potential for this approach to interactive comics. Results suggest that while Multi-modal enhancements can increase engagement, more engagement in itself does not necessarily result in a better experience. The initial observation and the results together are discussed at the end of this paper.

Keywords

Multi-modal, Non-keyboard input devices, Sensor Technology, Cogninitive Sciences, Engagement Mapping, User Experience, Non-branching Interactive Comics

1. INTRODUCTION

While ultimately this thesis is about interactive comics, it is necessary to establish the premise of the discourse. During the initial stages of the thesis, it became clear that there are certain assumptions this study will have to make, to fit within scope. So first the premise must be established as briefly as possible. Meaning this is also an abbreviation of the conjecture, just focusing on the essential parts for this study.

- Multi-Modal learning
- What Multi-Modal learning studies could mean for memory
- Memory Strategies that support this conjecture
- How comics and interactive comic studies fit into the above.

Firstly, Multi-Modal learning is the principle that multiple perception and cognition channels applied to a lesson, grant higher quality of learning. Understanding that multi-modal learning gives better quality of learning, can be summed up as understanding and memory. The conjecture in this study's observation is that the more neural connections one can make long lasting, the more ways one can relate and comprehend on abstract levels. This includes memory strategies such as a "mind-place", where one tries to link a memory with that which one wishes to remember. Not unlike the way synesthesia can be described, as a link between different sense. Combine this with neurological rewards, and potentially even genetic disponibilities, this opens an endless mass of studies. And finally considering this: Take a closer look at comics and the previous studies to form a hypothesis assuming this conjecture is largely correct. How to get there is the next part.

If a novel is utilising the Modality called Input Output or I/O, then reading is our base. Then a structure can be added to the story and this results in different genres, such as crime, comedy etc. At some point there is an addition of graphics, symbols, etc. and they evolve the written word from a simple language of vowels and consonants to thoughts, speech, and more abstract concepts, and at some point it becomes a graphical novel, and eventually a comic. Just by adding modalities and this eventually changes the format.

This means that a comic is just a memory either real or fictional, which is written down and has multiple layers of

modalities, recognizable as a comic. This can briefly taken further to cartoons, cinema, music, theatre etc. How the modalities are mixed and matched and how many layers are applied is essentially, a way to define media and or formats. In fact the thesis' argument goes as far as to claim, people have been doing this likely since the written language have been used analytically, even if the people were or are partially of fully unaware of it. An example of this will be given in a later section of this paper.

But before then Let's establish what the thesis' observation is made out of, and why this premise above is required: The previous studies of interactive comics, are trying to explore how to evolve comics. What sets them apart is which modality they apply. One looks at the Social aspect, another looks at choices. Through Co-operative comics, and branching story-lines respectively. This pattern is something that can be observed in the concept called gamification. Considering the above, one can conclude that gamification is a form of multi-modal enhancement, likely identified as gamification because video games apply a large number of modality layers simultaneously, and aims to trigger our reward system. Yet understanding gamification as a form of multi-modal enhancement, allows the possibility to consider the evaluation options more widely, more on this later. Finally it is observed that digital comics largely moving into smartphones, as any other digital copy of a book, now moves from one medium to another, curiously this means that the limitations of the medium have changed what is possible. This is where an identification of a research gap can begin to form. Consider: There are modalities that can be applied in digital technologies in conjunction with comics, some which haven't been studied yet. However, in order to get there, it's important to understand what a comic is, such that the study is actually investigating comics, and not a video game, or a new format entirely. This idea of defining comics from a sensory or multi-modal approach isn't new Hague (2014, see summary). It's important to note that the conjecture of this paper goes a bit further and argues this approach is valid for all formats.

2. ABOUT COMICS THEN AND NOW

For validity's sake there must be a certain level of resemblance of a comic in an artifact about interactive comics, so it is important to know about them; what makes a comic a comic, and what makes an interactive comic remain a comic. The most simplistic answer is that it's just a story with drawings, but that is an inadequate description and a gross simplification, and it will need clarification to avoid getting lost in a more general use of interaction in similar applications i.e. one cannot assume constrictions of the comic genre more important than the constrictions of the application. For clarity the use of the word genre instead of medium e.g. "comic medium", as within media-technology the word medium refers to a context in which comics, games etc. can exist i.g. phones, desktop computers, physical space and so on, to avoid confusion this paper refers to the comic medium as the comic genre. And reserve the words form and style to their meaning in comics.

2.1 Comics as a genre

Comics first emerged in different cultures in different ways, the western appliance and style also differs greatly from the Japanese, Chinese and Korean forms, and there are within the western world also a discrepancy between the European tradition and the North American. Among the Differences we find Shulz' The Peanuts, as well as Asterix, Tintin, Superman, Spider-man, Batman, The Flash, Teenage Mutant Ninja Turtles, and so on. Each of these have been influenced by how the market has manifested in the USA and overseas in France, Belgium etc. This has obviously influenced their style, and while they influence each other in contemporary time, where something works in one style then another style adopts it and vise versa. There is ultimately a few things which is common for all. The most obvious two are comedy, and drawings. They are called comics in English precisely because they are entertain as a form of comedic relief, they could also have their name as they are derived from the comic strip in news papers which was the comedic relief among the news. Curiously this element of comedy is also present in most styles of the Japanese mangaka(manga creators). Scott McCloud has given a breakdown in his book Understanding comics, and how they work to provide a perception the written word alone cannot. In fact this is an example of a book being mono-modal, and a comic book being multi-modal. Everything from panelling, to symbols, sound effects visualised, size and use of the gutter, framing and composition, all define comics as a genre - a multi-modal genre. Additionally Hague, 2014, has systematically analyzed and described research in cultural and media studies, it should be Hague also referenced McCloud, 1994, 2000, in his treatment, of the the question of defining comics. Although, the point here is that defining a comic is no simple matter, yet it leaves an understanding that the definition that should matter for this study, should line up with the paper's initial conjecture of modalities, and this follows McCloud's description well. In a traditional sense this is what makes up a comic, and this hasn't changed significantly by 2023, although there are examples that self consciously break with the traditions, such as interactive storytelling, motion comics, and Rysjedal's research. Working with interactive comics, means any interactive approach, needs to still satisfy the basic components of a comic, albeit a comedic element can seem difficult to deliver upon with certainty. Other elements such as the construction of the gutter, panelling size, sequence, and the cinematographic concepts should be considered carefully and with attention to each element's respective relevance and impact. Additionally the appliance of new elements must not ignore what can be learned from Ian Hague's work. This also means that images and comedy with text isn't the only requirements, which is why the internet phenomenon named "memes", are not comics, though a comic can potentially become a meme.

2.2 Comics going digital

It's a well known fact that comics for many years have been shifting in and out of popularity, and for various reasons. The emergence of widespread digital media, the variety of media and its' intertwined symbiotic relationship with the world wide web. Initially Scott McCloud's analysis concludes that scalability of economies can simply outgrow the world in which the market exists McCloud, 2000. There are some solid arguments, but ultimately it seems obvious, that scalability of markets has turned out a bit differently than predicted: Ultimately comics fight with other markets over the same costumers' attention, time, and resources, as well

as competing comics, artists etc.

While conditions in the late 90's and early 00's were significantly different, the overall point, evolving comics to be more appealing is still relevant.

2.3 Existing work on Interactive Comics

As a reminder: Comics take advantage of panelling, perspective, composition, and other elements to express events the reader can imagine with senses. This is not exclusive to a digital medium as opposed to the printed. A Comic as a genre is wide spread as digital comics, and from this point digital interactive comics. (See jshiga, 2010). 'Digital' is an important word, as interactive comics essentially can exist in a printed medium. Albeit we must assume interaction as not requiring any form of reactive response that edits the environment in which it exists. e.g. an input that actuates a sound or otherwise. With this in mind printed interactive comics could be any analogue implementation of logic: choice. This comes in the form of branching comics, which exist in a printed form as choice to flip the page in different directions, revealing different panels changing the story. In the digital form this is less limited as the number of choices isn't restricted to the physical space Soares de Lima et al., 2013. Besides branching comics, there are other ways to consider interaction, one of which is co-operative comics, which can be seen as the pinnacle of connection between creator and reader Andrews et al., 2012. Although this form of comic can be argued is closer to a table top role-playing game, than a comic, while undeniably employing elements of both. The main discrepancy between the two would be that a game can be won or lost, which a comic cannot. When considering the most noticeable applications of interactive comics, an observation can be made:

While some publishers have apps, such as MangaPlus from the Japanese publisher Sueshia and Viz Media, they remain mostly comics "MANGA Plus by SHUEISHA", n.d. To find something more innovative we, could look at webcomics in general, something Sueshia has since followed suit on. The concept is to have a shared medium for publishing, much like Youtube is for video "WebComics | Read Manga & Comics & Anime Online - Web Comics®", n.d. The common denominator even for the interactive comics that exist comes back to the lack of multi-modal expansion of the comic genre. The thing that comics do well, isn't fully exploited. Or seemingly hasn't been attempted, but if the latter is due to failed attempts in that case why, or because none has tried, is irrelevant. What seems to be the result is research gap. Specifically smartphones have sensor technology, which hasn't been applied to interactive comics in a consistent manner, and the inconsistent examples there are few of. A study of Digital interactive comics, which is pushing the defining traits that actually does some sensor technology, can be found in Frozen Moments In Motion, by Fredrik Rysjedal. It's important to note that this approach falls outside interactive comic notion and breaks with certain principles of the comic book, but also reveal some level of arbitration in how a comic can be defined. When for instance applying gyroscope input, it's in the form of a parallax effect, it doesn't actually satisfy the constraint of being a naratively driven interaction, and this makes the work inconsistent in the use of sensor technology. In terms of certain concepts, Rysjedal does also arrive at the same conclusion in terms of the comic, despite breaking with some concepts.

> "Juxtaposed panels and their layout give the art form a distinct identity that distinguishes it visually from other art forms. Another aspect is the collective visual relationship between panels that are presented together on a page or in a spread. Their composition and expression, both contextual and graphical, affect the overall reading experience. A third aspect that would be lost is speed, because our eyes can read a juxtaposed sequence much faster than when we click through a sequence panel by panel. This also relates to a fourth aspect: by placing panels next to each other, readers are free to create their own reading pace and flow. This freedom would be lost. These four aspects could be considered big losses when seen from the perspective of traditional comics."

Rysjedal, 2019

This does demand a bit of attention, locking the view to panel transitions for reading progression also breaks with the reasoning behind juxtaposition, this is a compromise that has to be made. However, it doesn't mean that it should be neglected, or ignored. And it does raise questions, this paper simply cannot address. The important thing is to make the compromise because it is necessary, not to argue it is irrelevant. Remember the goal is not to derive a new format or genre, but adding to the comic-genre by applying narrative driven interactions.

2.3.1 The state of digital comics

First question to ask, why aren't interactive comics with smartphone sensor technology everywhere? One possible explanation could be seen in the following:

While sensor input in it self isn't new, and can be viewed somewhat as a gimmick, there might be two counter arguments for their lack of existence:

Firstly, a creator will need to expand his skills to include programming, or require the market to change or add the extra level of complexity to include people with this skill, which cause a diminishing return on profit once again. Secondly, a lack of tools a creator can use without specialised skills or external corporation etc.

In both scenarios, it could be caused by the tools and skill's required, and then it's a scalability issue, but it cannot be ruled out that the conjecture and premise are wrong, or need context. So this is a question that maybe possible to answer, perhaps this study cannot answer it fully, but perhaps it can reveal where to look. It might be beneficial to look at Engagement Mapping Methods for this.

2.4 Sensor technology appliance

While sensor technology in interaction that includes gyroscope, magnetometer, accelerometer and lightsensor hard-

ware in smartphones, isn't in itself an innovation, or unprecedented. Looking at its' effect on interactive comics is a different story, considering that Rysjedal's work doesn't satisfy the constraint of not deriving a new genre. Here are a few potential appliances:

Number one: Transitions. Applying input to satisfy a condition causing a change to the panel and progress to the next panel. Considering the panels and possibly their flow, has a few considerations that could challenged by this approach.

Number two: Interacting with each panel, either substituting the need for another panel with subtle changes to a single panel, and or embodying the events of the panel through embodied interaction i.e. the reader mimics a physical or tactile motion to advance a sequence of events.

Number three: Combining one and two.

Number four: fourth wall breaks asking you to perform a certain task. There's a precedence for non-interactive children's television, which encourages the viewer to count, or answer questions, despite the non-interactive nature. It's taking advantage of the lack of cognitive disparity for children, who isn't aware or just ignorant to the fact that the characters on screen is a recording, and cannot be interacted with. Yet there are examples of similar interactive conversation, in which an avatar can have a similar effect, in adults who get immersed into the conversation despite knowing they are interacting with an intelligent agent, or AI-interface for a language model etc.

Number five: Branching stories based on interaction or choices. This one could be split into two sub-types: One is by applying Machine Learning or Artificial Intelligence, to vary the story elements based on what, how, and the duration you interacted with something. Or the second option, to have direct actions performed through interaction, regardless of it being a prompt with a choice, or a hidden condition. The outcome of either such interaction would branch the storyline. Important for both is that the action performed must be applying sensors which isn't just touch input derived from traditional touch screen manipulation e.g. zoom, tap, swipe, unless this had a direct association something in the current panel.

Obviously, number Five has a quite complicated scope, and it raises some unnecessary complexities that must be considered, although the data acquisition potential is considerable. Four is full of possible scenarios, where the data-set can become obscure, and it requires some level of variability, to explore fully, which quickly can lead to an experiment scale and iteration creep. Three is a similar, in the sense that it requires both 1 and 2. Two has some limitations with the requirement of the art consistency, which is an infeasible amount of time that is required to accomplish for the author of this paper. Which leaves us with One, which is a simple application, adequate for exploring the sensor application with as little alteration of the comic genre as possible, and is less restricted by it's connected story elements e.g. a use of the light sensor can affect the environment alone, and doesn't need to be combined with a pretending action, that may be depending on the lighting conditions around the reader.

Finally there's a need to address Soares de Lima et al., 2013 they define Branching narratives and Non-branching from an algorithmic perspective.

> "In branching narratives, all the possible story lines are predefined by the author, and the system is prepared to represent them in the best possible way."

This paper challenges this definition in the sense that multiple variations of the same comic where any event changes anything later in the story, is not actually Non-Branching, while their use of the phrase isn't invalid. The potential for confusion must be clarified. In this paper a non-branching comic has 1 predefined story line, the interactions do not change this. Soares de Lima et al., 2013 are also transparent about trying to create a new form, which in this paper classifies as outside the project's definition of a comic.

3. DEFINING THE SCOPE

There is a research gap in the appliance of sensor technology to interactive comics, which is that there's a lack of information as to how the addition of sensors present in a smartphone on its own would influence the user experience. In realising this, the contribution which can reasonably addressed by this paper, should be exploring the application of sensor technology in smartphones in comics, we also have identified a few ways of applying sensor input, and of those it seems most suitable to be looking into transitioning through sensor interaction as a narrative mechanism.

Which leads to the finalized problem formulation:

Which leads to the following Problem Formulation: How are perception, user experience and engagement influenced with the application of smartphone sensors in interactive comics?

Ideally this would address the following:

1) understanding the effect of sensor technology applied to interactive comics
2) informing the effects of narratively driven interaction upon user experience in interactive comics when the proprioceptoric, and touch senses are introduced.
3) investigating the engagement types of applied interaction, and their connection to different sensory perception.
4) if the conjecture can be supported.

3.1 Hypotheses

When we have considered all of the above we get to the following hypothetical scenarios:

> **Null Hypothesis (H_0)**
> There are no signs in measured in engagement and or in user experience caused by the addition of sensor based narrative driven interactive transitions in comics.

> **Alternative Hypothesis (H_a)**
> There are signs in either measured in engagement or user experience caused by the addition of sensor based narrative driven interactive transitions in comics.

This would entail the following:

If H_0 cannot be rejected, then it might weaken the conjecture or outright reject it. If H_0 can be rejected, it could show support for the conjecture, without necessarily being able to say in what way.

4. METHODOLOGY

Investigating the hypotheses, will need to look into both engagement and user experience. The choice to look at Engagement is based on the overwhelming lack of ways to measure fun, and retention. I refer to appendix A, for the breakdown of these issues in detail.

There are two primary pillars in this experiment, number 1 Engagement and willingness to keep reading, and number 2 an in-depth evaluation of the experience. A consideration to use Contextual Probes by deploying the artifact has been considered, however this prompts some potential issues with Engagement Mapping especially consistency, and known limitations of the method.

4.1 Engagement Mapping

Looking at engagement mapping as described in 'sure, I would like to continue' Schoenau-Fog and Bjørner, 2012, it has a few benefits that suits the different aspects comics according to Hague, 2014, as well as McCloud, 1994, 2000. Specifically it acknowledges that in computer games there are different kinds of players, this no different than people who enjoy different movie genres etc. And this is naturally also something that applies to comics. It's publicly known that feuds have existed in the past, between DC or Marvel etc. Even so, this is not what is meant by different kinds of comic readers. What is actually meant is that once different applications of modalities are applied, just as some comic artists use one element for his style, this applies to sensor input also. Which means we would expect to find that people, associate the experience with previous experiences, and Gamefeel in general. For the latter please note the unpublished work of this study by GustavDahl uncited. The point is that it's important to avoid a large number of inexplicable variables, which has more to do with the implementation quality, the type engagement the reader finds pleasant or describe as feeling bad, without knowing a bit about why. And this is what engagement mapping allows us to examine. There is already a real risk of contamination of data by the implementation quality, which would require a level of polish which is infeasible.

Some of the other issues with Engagement Mapping as a direct application and as a measure of retention and fun etc. can be summarized to the point that the method is quite intrusive, and can potentially lead to pollution the data. By having to interrupt the experience the facilitator of the experiment is disrupting the experiment, which can be distractive to an unknown degree, and research in this area is lackluster to say the least.

As a result 2 changes will be made to the Engagement Method Mapping:

- Instead of only asking if the participants wants to continue, they will instead be given the option to stop the experiment at any point. It is argued that if they wish to stop then there is an absolute loss of retention and engagement. By extension of this change they will be asked if they wanted to continue, if and when a participant completes the comic, in both cases they will perform the quick reactions. But they are slightly loaded to avoid repeating some of the mistakes the original study highlighted.

- The second change will include the experiment to have no interference from the facilitator, but if the reader doesn't choose to opt out, it is considered a continuation. What is lost in short term memory evaluation of the transitions should be, compensated by a survey. However, to simply assume that the reader would have continued on, wont tell anything about why. So crucially as suggested in previous work, asking after each level if the player wants to play the same level again, might be deducible from a randomization with an appropriate counterpart for a comic.

In addition to these changes. By looking at different types of readers in a randomized setting, there will be a possibility to deduce exactly which kinds of modalities are being the cause of reason, thus allowing to inform the choice to stop or continue.

By randomization we can also try to eliminate the risk of order of experience when using the same people to test the control and the sensor input, while keeping the circumstances the same. Considering the cognitive science concept Umwelt, there is a shift in the traditional notion of this, towards thinking of Umwelt as much more momentary, which means smaller samples require more consistency to be comparable, when humans are involved.

Then if readers are interested in different things then it might be possible to still keep track of their individual changes in engagement, as well as informing the effect. It's perhaps also possible to take a closer look at the role of the extra modalities, to see how this fits. In terms of an ISO usability test this means we will satisfy some form of information in physical demand as well as the task itself, although its important to emphasize that such a usability test, while beneficial is extending the scope beyond control, but that doesn't mean it's impossible to identify these markers with outside the ISO standard. Some of the reasons for not reconstructing the reactions using card-sorting to get more comic related reaction cards include: The ones used in 'sure, i would like to continue' Schoenau-Fog and Bjørner, 2012, are representative enough, conducting a sort is time demanding and the more changes are made the less valid the method becomes, and 54 cards across 6 categories already nicely reflect 6 ways of looking at modalities and user-ability markers. Finally,

the paper also suggest using a the participants native language to overcome, misunderstandings of what the reaction cards represent, which means the recommendation will be followed, and the sorting will be done with danish translations of the original cards.

By looking at these differences between the randomized data, it is possible to compare the modality change across different reader types, and by asking them for an anchor point it should be possible to adjust for most thinkable variables. And constants can cancel each other out, but one has to be careful not to cause the data to be too similar due to constants, such that the results get affected towards a larger P-value. One reader might be very uninterested in almost all the modalities applied in a classical comic, but quite excited about embodied interaction options, and thus impact the data differently, unfortunately this also means that to be accurate on a generally significant level the study would have to be quite large, but it also means that it might be possible to identify a significant result on a higher more abstract level, if the study is later scaled up. It's also clear that the use of randomized data can reduce the burden for this quite dramatically provided there's no experience bias of importance in the evaluation. While it would be ideal to repeat the experiment several times over several week to identify things like these properly, this would still include some level of familiarity with the experiment, which can lead to the very experience bias in the first place. Using engagement mapping method and disengagement mapping will support a level of consistency when randomizing. But this cannot stand alone, as the method doesn't look at the extend of how engaged people are. As a result by looking at multiple aspects the answers should be possible to address the hypotheses. I.e if the individual deltas are significantly large and dissimilar enough, and there are significantly visible patterns among those who prefer the sensor input option, and how long time they've to spend on each version adjusted for each individuals reading speed.

4.2 Surveys for gauging User Experience

Suppose there is a scenario where none of the test participants elects to stop the test, in either the control case nor the artifact. There would be a need for some way of continuing the process. While this argument is similar to the that described in Schoenau-Fog and Bjørner, 2012 , the conclusion is somewhat the opposite in terms of asking to stop vs. asking to continue. By asking a question by the end of each experience about willingness to continue, the urge to stop is information that will not be captured, provided that the level of engagement can fluctuate, denying people to express the disengagement, could be a loss of information. So being able to stop the test of a version will be less artificial than waiting or asking them routinely, assuming if they haven't stopped then they are not disengaged and wants to continue. The downside to this is that the tester will need to be aware of this, and cognitive focus might prevent the tester to make this call, however the disengagement isn't complete, is the counter argument here. Yet such a question (end question), will still be needed to identify things present in both versions, as the engagement data would otherwise be assumed. A user might want to finish something, this cannot be extrapolated beyond the end of the story. While the end question could add some clarification to the question of the two versions effect, there is still a possibility that the two data set will be indistinguishable from each other, but this is an issue the original method also has. Consider that people don't read equally fast, or are of equal abilities, then for both games and comics it's impossible to detect, however a fixed "checkpoint" rather than a periodic fixed interval for the question, will make sure that reading speed isn't limited to the same point of no return being passed or not. To get some better insight into the experience and the reasoning, the addition of surveys can aid in this aspect. This will make it possible to ask the participants directly which version they preferred, rank the different transitions, as well as elaborate on why. Assuming a comic chapter isn't terrible long, and that the transitions may be repeated, these transitions should also be quite fresh in memory, provided the participants know what they did and didn't do, and correctly identify their inputs' impact.

4.3 Artifact Design

4.3.1 Art production

The Art for the comic is partially generated with Midjourney, using reference images of myself, repeated prompts, and keywords for the public domain; for instance the "in the style of" made use of Paul Terry who's work is in the public domain. And the characters and story were based on Sir Arthur Conan Doyle's Sherlock Holmes and Characters in his work A Scandal in Bohemia, which are all in the public domain. As it turns out, AI-generators have limitations, that in normal circumstances for comics don't pose and issue, but the moment props needs to change ownership, and consistency becomes relevant when perspectives have to change, things start to go against the principles established earlier. Therefore the AI-Generation got more and more reduced, and Adobe Photoshop, and Adobe Illustrator was used to create vector panels, and keep the fidelity of the art when scaling was needed. Another choice to handle consistency was to do all the compositing in negative space, and use an Orthographic camera setting to simulate 2D. This technique could have been used to make interaction that would fit motion comics, with a parallax effect, however, this doesn't serve the narrative process. There are other technical advantages to this approach such as being able to use ray cast in Unity3d, to interact with scene objects that existed independently from the the other background.

4.3.2 Briefly about modularity

Designing the Hierarchy system with mixins, made it possible to keep a dynamic and modular system where a comic, chapter, page, and panel ultimately rely on the same classes, which enables the use of mixin prefabs and situational behaviours. What this means is that the class UniversalPanel implemented an interface with extension methods, that made the panel self register when it needed to be known. It also made it possible to simply change or turn off behaviours such as various implementations of transitions, while the pattern wasn't complete, it allowed for reusing the comic scene for the control, where the the UnviersalPanel Component could simply be disabled. It also means that it was possible to reuse the same feed forward behaviour which changed automatically depending on the active panels settings. The benefit is that changes can be made quickly, with no risk of a brittle classes. For the sake brevity this won't be explained in detail.

The Hierarchy structure then means that each panel and transition and sequential representation is controlled via drag and drop in the inspector like this:

4.3.3 The two versions

This gives us 2 versions:

For the Control there were the following ways to control: Pan, zoom, and reset to beginning. The camera send out a raycast to register which panel it was looking at and thus registering time spend on the panel. If the reader had a raycast hit on the final panel, a button would appear where the user could proceed to the end question.

For the Interactive Comic version there where the following ways to control: Tap anywhere, Tap on a specific object in the panel, Drag an object, prop or otherwise, and release it within a specified distance to a target point ignoring negative space. Swipe a 10th of the screen size in any direction, Shake the phone using a Queue buffer to find and register large enough changes in the accelerometer maginitude. Gyroscope and Magnetometer as composite to rotate the phone around nadir-zenith in the real world. Cover the front camera/light sensor(using a buffer based on a Queue of lux values) to determine if the light had been blocked. Blow or talk into the microphone limited by amplitude buffered, and FFT Frequencies, although the latter wasn't fully utilized. Composite of Light sensor and Microphone where multiple sensors were used.

When a sensor condition was fulfilled the UniversalPanel would access its Mixin Interface to call "TriggerTransition()" that would allow any object relying on the transitions to find any panel and if trigger transition that frame would return true, then do something, like the CameraSequencer class moving its x and y coordinates to match the x and y coordinates of the next panel, and then update the which panel, page, chapter, and comic where current.

For each new transition to be made a new mixin would simple be created and represented as an enum and int in the UniversalPanel class. While having the corresponding component(s), added to the panel. This makes the change of a transition pure drag and drop for existing transitions.

Finally this means that Data Acquisitions could be drawn without influencing the transitions. The pattern isn't fully implemented, so there has been some use of persistent data using singletons to keep data between versions before saving to a .csv file on the android device. The Files would utilize the number of files in the folder to automatically increment to a new file without overwriting the data, when a new test participant would start. This also allows to see in the data which order the participants had the versions in, and how long time there was spend on each version.

For the Interactive version only there was a guide intended as feed forward. All dialogue is added as a z-layer in front of the comic, this is a prefab and thus the story is ensured to be identical in both versions.

All interactions where directly or indirectly mentioned in the comic story, to create the narrative link, the addition of the guide was made without testing if this would be required, and is as such based on the assumption that a description would need a visual reference.

Figure 1: Composition technique in unity

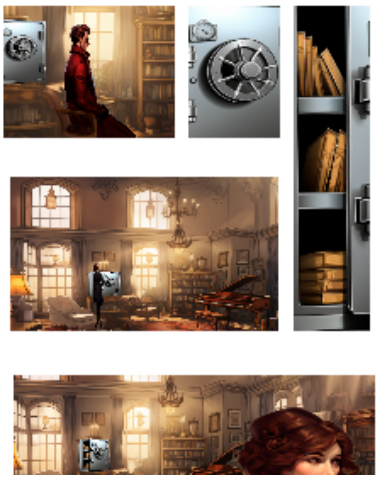

Figure 2: early iteration of the comic

5. EXPERIMENT

6. DATA

6.1 Data processing

Overall the the sample size is too small to find any significant answer, however the group is well diverse ranging in age from 27 years old to 88 years old. Across all testers, 50% preferred the Interactive Version, 37,5% preferred the classic version while 12,5% preferred neither, 12,5% corresponds to a single respondent. Of those who preferred the Classic version, reasons given was mostly based on the difficulty of reading, not surprisingly suggesting this is more important than the accuracy of the interactive transitions. However, a theme among all seemed to be that it was more difficult to read along with the interactive version for a few different reasons.

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Cite people

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Initial review of the data made an impression that the engagement were indeed increased but at the expense of being able to follow the narrative, so its possible to conclude that preferences for the classic version would be represented in these testers engagement mapping predominantly. This is not the case. In fact the criticism of the readability and the disengagement was generally consistent that strong engagement were only achieved among two testers, one of the testers in both scenarios, which means there's only 1 tester or 12,5% of the testers who had a strong engagement for 1 of the versions only, this tester had the strong engagement in the interactive one. As a result one must turn to the answers on record when interviewing the participants in the end. One important finding here is that the more difficult the input becomes, requiring split attention or high levels of motor skills, in turn decreases the perceived accuracy, not helped by some lack of polish. Overall the Interactive transitions were rated overwhelmingly positive. Pair this with the survey answers and interviews:

> "I was so concentrated doing what I was asked that I forgot to read the story."

- Tester pseudonym Jonas.

> "Some of the interactive elements were fun to use (drag elements, tap on elements, rotate telephone). The elements also worked less misplaced than in the classic version, when one knows that it is something one can tap or drag. A few points off due to some of the panels which weren't as a standard [fully] inside the screen view."

- Tester pseudonym John.

In the interview John elaborates:

> "I think one of the reasons I liked those[drag elements, tap on elements, rotate telephone and cover light sensor] better, and I think that the reason that I like those and not the other ones, is that there you don't really take focus away from the story, whereas when you shake it, then you have find, where you were in the story."

- Tester pseudonym John.

When asked if if this meant that John felt like he lost his reference point because he was looking at the phone and not the story, and if this was because he couldn't keep focus on both things, John simply answered "Yes, precisely." This was a common theme. And that is looking past the fact that people might be influenced in general by existing solutions using tutorials rather than live guidelines in past experiences, though this is more of a guess based on consistent, feedback on the guide being hard to understand, and observations made that some testers tried to interact with the virtual representation of the phone in the guide, and not the story counterpart. As well as survey answers.

> "I am just saying that the experience of interacting with the story, is so riveting that if I got the opportunity to read comics I like, or maybe i would even be willing to explore comics that I don't know, because that i would have the option to interact with the story, then I would buy an app which could support this interaction, I actually think it would be worth paying money for, and I think it would be an app i would use actively for half an hour when i don't know what else to do. Then I would probably read a comic and play my way through the story instead. Because i think its a more immersive version of the story."

- Tester pseudonym Jack.

Off record Jack also said that it would be enough for him to read a boring story, because the engagement was there.

6.2 Results

The conclusion to all this must be that if the medium becomes the object of cognitive attention focus, instead of the comic, engagement might be gained, but at the expense of the story which has lost focus. This can be summarized in bullet point form as:

- Readability is a compulsory element, and zoom and screen size are common strong influences
- Engagement definitely looks like its increasing the user experience, but not unconditionally
- Engagement increase in itself does not override the experience of ease of use and readability
- Engagement can not be said to be exclusively positive if attention is split

6.2.1 Hypotheses Evaluation

Under these circumstances it's clear that the null-hypothesis can't be rejected in its current form, without any meaningful statistical analysis. Despite this there is striking tendency towards rejecting it. However, a revision is advised regardless, to include the findings regarding the cognitive impact upon the modalities implementation, which acknowledges the importance the cognitive attention tenet, which suggest that engagement as directly causal for a positive user experience is conditional to a degree.

6.2.2 Additional Remarks

No statistical tests were made on individual components as the data samples don't appear to be large enough, after looking at engagement scores. The amount of data aspects to look at is too vast to fully compile down within scope, but one solution might be looking at the data sets with machine learning approach, considering feature extraction or feature selection and some classification analysis. Additionally a Wilcox Test have been considered and attempted used, and seems like a good fit for the data. While the H_0 isn't rejected, the conjecture doesn't seem reasonable to reject either.

7. CONCLUSION

7.1 Discussion

7.1.1 Wider Perspective

7.2 Future Work

Had I known about these "Precise technique tracks dopamine in the brain | MIT News | Massachusetts Institute of Technology" (n.d., instruments) developed at MIT before the project started it would have been interesting to look into the connection with modalities and dopamine, which is something I hope future studies will look into, although how these might elevate a project will require additional research into instruments capabilities.

8. ACKNOWLEDGMENTS

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