MIKAEL ERICSSON DUFFY
DRAWN TO LIFE
Exploring real-time manipulation of the digitally represented surface in comics on smartphones and tablets

Svensk titel:
Livliga bilder
En forskning i realtids-manipulation av den digitalt representerede ytan i serier på smartrtelefoner och läsplattor

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Interaction design
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ABSTRACT

This research thesis is an exploration into what possibilities lie beyond the representation of analog material when it transcends into the digital realm. Specifically, how printed comics can be altered in realtime by creator-allowed user interaction, when adapted for presentation within the digital sphere of mobile smartphones and computer tablets. Using legacy computer-game techniques like parallax scrolling with modern digital layer filters, device sensors and applying them in realtime to the comic creators digitally layered content, alternative forms of presentation arise.

This is an investigation into the comic creator’s will of allowing possibilities of added depth perception, interactivity and alternative visual narratives in their comic, manga or graphic novels when employing new techniques based on sensor data input from a reader, like accelerometer-, gyroscope- or eye-tracking sensors. Several different techniques are evaluated. The focus is mainly on the context of creators of comics or manga who use digital tools and layer compositions when producing their work. Several aspects of the user-centered experience are also explored.

Although mainly an interaction design project, most of the design methods are used from a service design approach, emphasizing co-design techniques like interviews, observations and user tests. The results are digital prototypes and proof-of-concepts featuring technology tests that support final design conclusions.

The results will show both enthusiasm and reluctance from test subjects towards the new technologies presented. The professional craft of comic, manga and graphic novel creation has a deeply rooted aesthetic and production cycle in its history of the printed form. It could be difficult to alter its standard, reverence and nostalgia in the eyes of its readers and creators, when pursuing the digital format and narrative possibilities of the future. A video explaining the project’s “Drawn To Life” technology is available online.

KEYWORDS

2D, 3D, animation, comic, eye-tracking, graphic novel, HCI, infinite canvas, interaction design, manga, mobile device, parallax scrolling, user experience, UX, service design, sensor, tablet, touchscreen

1 http://www.duffyfilm.com/drawn-to-life/
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Makoto Yamasaki  
Max Weiland

members of Creative Carnivale / Sketch Jam

&

students and teachers at Serietecknarskolan
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1. INTRODUCTION

Digital evolution has transgressed our need for many physical media products of the past and replaced it with an evolved necessity for digital alternatives in the present. Today, we see it in how printed comics, books or magazines are converted into kilobytes of vectorized data and CD’s are compressed into megabytes of mp3’s. As opposed to their physical counterparts, digital media solutions are immaterial, intangible and instantly available online. A positive side effect of this transformation, is how the progressive digitalization of physical media automatically reduces usage of raw materials and energy (Fig 1.). Surges in public consumption of digital devices equally bring negative attributes, like digital device redundancy and infra structure supporting recycling of disposable technology (Kuniavsky, 2010). The digital devices we depend on in our everyday lives have now become central unified hubs for all our media content. They act as consumption portals, simplifying purchases and offering vast libraries of downloadable cross-platform content. As the technical limitations of portable devices are quickly diminishing in regard to processing speed, screen fidelity, format efficiency and memory size, we consequently increase our consumption of media content online due to the convenience, lower prices, subscription services, extensive variety and immediate availability.

Due to the popularity of reading applications on mobile devices and tablets, it has consequently become inevitable for analog books and comics to become available in a digital version or format. Through data compression, one physical book can be replaced by a smaller digital device that contains thousands works of literature or an infinite amount if accessed online in real-time (Moggridge, 2007). We have now left the physical realm and entered a hybrid world of devices that contain and offer any media, distributed and made available to consumers through online shops and digital cloud storages like Apple’s iTunes and Google Play.

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<td>97%</td>
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<tr>
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<td>403</td>
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<td>24%</td>
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<td>112</td>
<td>6%</td>
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<td>Forest products value</td>
<td>U$ billion</td>
<td>246</td>
<td>10%</td>
<td>70%</td>
<td>33%</td>
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Fig. 1: Statistics of forest materials from the Food and Agriculture Organization of the United Nations 1980-2010.
A new consequence to this digital migration, is the potential new experience that comes from converting, evolving and enhancing the old analog material before it enters the digital realm. As an example, once a book is transferred to a digital format, one advantage is that we can search for any phrase or quote instantaneously without the need to manually skim through each page to find our result. In terms of the more graphic mediums of comics, manga and graphic novels, there are an abundance of possibilities due to the nature of their graphic narrative and the shared techniques with film and animation (McCloud, 2000).

Since the introduction of larger computer tablets with high resolutions, like the recent Apple iPad 3 and 4 with their “retina display” (Fig. 2), many of the earlier limitations and disadvantages of mobile device’s low resolution screens are gone. There is a motivation for content deliverers and artists to embrace the format and present their art and narratives without any of the former advantages of the printed page’s precision and fidelity (McCloud, 2000). Although dependent on rules and frameworks, the digital format is endless in opportunities. As the next potential mainstream delivery platforms are defined, they are restricted only in the limitations of knowledge of its potential users and the adaptability used of the artist to embrace and migrate themselves from an analog production environment.

Fig. 2: Comparison of the dot resolution in the human eye vs the Apple iPad’s Retina Display (edited).
2. BACKGROUND

This following section will detail the reasons, topic and outlines that define the project and exploration of this thesis. To understand the motivation behind the chosen theme, it is essential to tell the story of its origin and describe an earlier related project that shared a similar agenda. A project that was heavily focused on the act and instigation of motivating collaboration within a manga creation community. Its development and existence explains the present focus on comic-centered creation, manipulation and delivery systems. In this current project and thesis, the focus has now shifted from creator-to-creator interaction to creator-to-user interaction. The following background section will be discussed from a personal perspective due to this project being a continuation in theme from a previous subject.

2.1 UNIME

In early 2013, I completed a service design project in collaboration with fellow students Kentaro Ono and Yuka Fukuoka when studying at Tama Art University in Japan. Our project resulted in a digital prototype aimed at helping Japanese manga artists collaborate, structure and distribute their work within an university location context, using a web-based infrastructure platform, emphasizing communication and planning. The prototype name has its origin in the two phrases “unite” and “me”, symbolizing the encapsulation of the system they describe, the creative self finding his or
her function within a greater cause. The final working prototype\(^2\) became a social website user experience where individuals could create their artistic alter egos, present their skills, start art projects and find appropriate collaborators. User tests showed that participants were positive to the service system, but had trouble understanding the user interface (UI), navigation and functions. Even though the concept received criticism for UNIME slowly transforming from service design towards system design and specific infrastructure components supporting a more complex service, the feedback was overall positive.

It became natural to continue a similar themed project in Sweden within a local specific context to connect them thematically. It made sense to apply it in Malmö, in a setting that correlates with the artistic cultural climate, specifically the independent comic creation by rogue factions of artists, a local comic creation college and groups of manga / comic enthusiasts.

### 2.2 The collaborative aspect

As UNIME had a central core relating to collaboration between creators of comics and manga, the aim is to similarly explore mutual agreed creative space, specifically the surface where creator and user meet on mobile devices like smartphones or computer tablets. There can be a mutual understanding between the deliverer of the material (creator) and the receiving party who read the comic on the device (end user) of allowed interaction on digital devices. As the boundaries of images and framing no longer have to be static or analog, it is fascinating to explore this digital context.

Even though the system and rules of narratives in comics are made by the artists, the users can change the given circumstances through their form of use, if they are given an opportunity to alter the way they read a given narrative. As an example, currently on many digital comic readers, the users can change the order and direction of pages based on their preference. Manga is usually read by turning pages from left right, while many western comics and graphic novels use the opposite approach (Tatsumi, 2007). This is easily set by a programmable software switch in a portable digital reader application for comics, like \textit{CBR Reader}\(^3\) (cbrreader.com, 2013). This is one of the many agreed rules that are bent and modified when adapted into the digital format, but are accepted by reader and creator alike as beneficial, because it is an adaptable feature. What other rules and definitions could be chosen to better suit a modular digital format? Similar to the UNIME project, this approach can be seen as a thematic form of agreement, much like collaboration. Hence, a suitable extension of the previous project.

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\(^2\) http://unime.duffyfilm.com

\(^3\) http://www.cbrreader.com/
3 MOTIVATION AND AIM

This research project will specifically explore how readers and comic artists, interact on the space or surface of digitally represented comics, graphic novels or manga. It examines the possibilities of content delivery and the emotions that surface in readers, when static two dimensional (2D) comics and their building blocks, become dynamic and user controllable in realtime. It also investigates how the creators can allow or limit these possibilities for the user.

Personal experience within film work automatically gears this project towards researching subjects that relate to the art of storytelling and the manipulation of narrative content. Many digital comics available on digital platforms have yet to offer any exclusive narrative or interactive qualities over the typical comic content available in print today. Some exceptions are certain free online comics like Hobo Lobo Of Hamelin4, Soul Reaper5, Unsounded6 (Cope, 2013) and MS Paint Adventures7, that push the envelope in favor of digital comics online. These can be considered interactive media, as they use several user-controlled techniques found in interactive online websites (Preece, Rogers & Sharp, 2002) and games (Salen & Zimmerman, 2004).

These comics can feature alternative endings, sound effects, background music, interactive characters and animated cutscenes. Independent interactive online comics are examples that act as inspiration, as to where other comics might follow in the future. As of yet, most mainstream comics and manga that are delivered digitally are simple and exact digital representations of their analog counterparts, the printed, bound and published paper format. There might also be an incentive in keeping the traditional comic narrative intact and alive, to prevent the death of an art form (Eisner, 2008).

Like much traditional and established narrative media with a large user base, it would seem more likely that new digital narrative mutations would have a hard time competing for popularity. In Reinventing Comics: How Imagination and Technology Are Revolutionizing an Art Form (McCloud, 2000) McCloud states that the ultimate goal for any art form should be to find a durable solution, a mutation that will help the medium survive into the future.

Will Eisner writes in Graphic Storytelling And Visual Narrative (2008):

“Digital technology has begun to compete with print, so mastery of this tool is now worth the creator’s attention.”

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4 http://hobolobo.net/
5 http://www.soul-reaper.com/
6 http://www.casualvillain.com/Unsounded/comic-index
7 http://www.mspaintadventures.com/
Eisner’s book was first published in 1996, considering that statement, there might not remain many years until the analog print process and its precious worldly materials needed for its production, inevitably become too much of an costly enterprise, as well as an environmental burden.

The traditional followers of printed comics might welcome the introduction of new types of comics and technologies, if they would bring enough convenient and impressive features to entice them. Publishers of printed comics may soon no longer afford to compete with the digital alternatives (McCloud, 2000), considering the rapid development of digital mobile devices the last couple of years and users having one device that does multiple duties replacing other devices (Moggridge, 2008).

As a contrast, independent comic distributors can effortlessly adapt, exploit and pursue digital distribution, while sustaining demand with limitless ease and quickly turning a profit. Today, there is minimal cost in online bandwidth and cloud storage, there is no need for physical production or printing costs, so they can quickly reach out to millions of potential readers without delay.

The popularity of smartphone and tablet comic reader applications like ComiXology8 (iconology inc., 2013), with its broad selections of affordable digital content, “day-1”9 releases of digital comics at the same moment a printed version is available and new narrative features that enhance the reading experience, is quickly becoming a upstart competitor in the mainstream distribution world.

3.1 Research questions

This thesis has investigated and explored how creators and readers of comics or manga can adapt, create or allow interaction of their work when it is presented on the current generation of portable devices, like smartphones or tablets. It has also explored how their craft and intellectual properties can be marketed and sustained digitally on these devices or similar content delivery platforms. The thesis touches upon the existing preconceptions and problems of the proposed exploration or interaction, specifically the comic creators’ aptitude for academic craft and rule-sets (Groensteen, 2007). As this topic is vast and expanding, this thesis has been limited to addressing these specific research questions:

“How can the creator of a digitally represented surface in a comic, allow interaction of narrative content in real-time to the reader?”

Additional question:

“How can the creator control digital distribution of their work through the above explored interaction?”

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9 Day-1 = matching release dates for products marketed on several platforms or different formats.
3.2 Target group, area and definition

Focus has been limited to the readers and creators of comics / manga that read or deliver content on smartphones and tablets. These need to have the technical configurations that allow the project designs to function within its proper context. Specifically for user tests, these need to be users or potential users of the Android OS (Google, 2013) on tablets and smartphones using web-browsers that can display and perform javascript code.

The target group within creators of comics and manga is based on ages between 16 to 25, which were the ages of a selection of students represented while conducting initial research\(^{10}\) at Serietecknarskolan\(^{11}\) in Malmö, Sweden. Most of the final prototype user tests have been held with this user group in mind for recurring results. The research has not been limited to themes, specific genres of narrative or graphical styles of comics.

As many readers of comics and manga still prefer the printed page format (McCloud, 2000), the research has required creators and readers that prefer, intend to switch or are open to evaluate digital platforms in their consumption of comic content. Manga has been discussed where relevant because of creators’ tendency towards certain graphic styles and layouts (Strömberg, 2007).

Geographically, the project revolves around certain independent artists of comics and manga within the cities Malmö and Lund in the south of Sweden. Research data has been acquired in regard to the creators delivery system for comic content to the reader and opinions of readers on comic software in use. The cultural aspects of comic usage and patterns have been excluded (east vs west, manga vs americanized comics etc), even though there are contextual specific situations in the project which relate to the art of manga.

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\(^{10}\) Free-for-all interview day with students and F. Strömberg at Serietecknarskolan, Malmö [15/03/2013]

\(^{11}\) Translated to english: “College for comic artists”
4. CONTEXT

4.1 Comic creators using digital tools

There might be an uneven condition in today’s practices among the artists of comics and manga, referring to the tools and approaches they use in creating their work. All comic creator students interviewed at Serietecknarskolan in Malmö were taught the classic arts of hand drawing, sketching and painting on analog paper, a format that has been used for many centuries of storytelling (McCloud, 1994: 2006). Only few of the interviewed students preferred using newer digital tools for flexibility and speed. Their use of digital drawing surfaces (Wacom boards) in combination with software like Photoshop CS (Adobe, 2013), Manga Studio (iconology, 2013) and Easy Paint Tool SAI (Systemax, 2013), give them impressive workflow possibilities through digital processing, pencils and paint.

Comic artists who embrace digital tools, motivate the idea of a purpose for digital dynamic comic surfaces. The artists who effectively use layers in digital compositing tools as a foundation of building their work, can work non-destructively, with unlimited steps of memorized repair-points or “undo’s”. Layers allow separation of an image’s various composited building blocks. In analog terms, think of digital layers as sheets of paintable glass.
that are stacked upon each other, allowing the artist to build the composition piece by piece, without having to merge the paint or permanently overwrite an underlying component or detail. Since the final digital image containing all layers is still 2D, the layers can be extracted for separate use, much like animators use separated art to animated film and cartoons. The foundation of artists who use digital layers when working, were therefore a central component in this exploration and a pivotal participant in bringing the project to life.

4.2 Comic readers using mobile devices

Much of the population in the developed countries have purchased a smartphone or computer tablet of some kind in recent years (Moggridge, 2008). Many have owned multiple devices and tablets are gaining in popularity after the successful introduction of the Apple iPad. An integral part of these embedded portable systems, are their continuous online access to the internet and cell networks (Cooper, Reimann & Cronin, 2007). This has allowed users to download or purchase media and use it instantaneously on their device. As comic and manga readers were possible future consumers of the technology explored in this thesis, they acted as an important user group within the projects context. Their consumer habits, attitude towards usage of new technologies and delivery formats, partly determined the exploration outcome, technology usability and distribution possibilities in the future.

Fig. 5: Digital comics presented on various portable devices
4.3 Stakeholders

These were the main acting participants within the project that would have possible gain advantages from the outcome or results. According to Preece, Rogers & Sharp (2012), stakeholders are the affected parties that have direct or indirect influence over a service or system's requirements. In this case, the participants followed the chosen profiles of having both user and creator side interests as artists versus readers creating or consuming comics, manga or graphic novels. Many had experience of using mobile digital devices and a selection of the users enjoyed content through digital content delivery platforms. The stakeholders that mainly focused on analog creation or consumption within this area of research, acted as control groups for putting the ideas into perspective. As they had little experience of the digital approach required for this project, they served as optimal insight into the possible reactions of users that might adopt this digital technology in the future (Goodwin, 2009).

4.3.1 Nosebleed Studios

Information of this independent group of artists was gathered through interviewing a local authority on the subject of comics, Gunnar Krantz¹³. Nosebleed Studios is a quartet of artists and publishers who specialize in Swedish manga. The studio is split up between locations in Lund and Stockholm, Sweden. Nosebleed Studios responded with great interest in helping evaluate a new form of delivery format for comics and had been researching other systems and content delivery formats in the past. During this project they used online web-blogs as promotion for some of their releases, although they preferred the printed novel format for distribution. They evaluated some of the project prototypes and provided certain adapted intellectual property towards the project agenda. The first was a layered composition that was adapted for use in the first prototype. This was meant to evaluate the potential of digitally layered art and adapting a suitable workflow, in regard to content delivery.

4.3.2 Serietecknarskolan

This is an educative academic authority dedicated to comic creation and artistry, located in Malmö in Sweden. Members of Nosebleed Studios teach classes at this college and two of the project advisors, Gunnar Krantz and Jakob Dittmar, also teach here since many years back. Fredrik Strömberg, the author of Manga: Japanska serier och skaparglädje¹⁴ (Strömberg, 2012), is the principle at the school, and allowed visits on free-for-all friday meetings. Interviews, observations and user tests were conducted here. Many of the students are highly determined fans of independent comics and manga. They showed enthusiasm towards newer technologies and acted as a springboard for determining the level of fidelity and functions in early prototypes.

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¹³ Interview with Gunnar Krantz at Malmö University [27/02/2013]
¹⁴ English translation: "Manga: Japanese comics and the joy of creation."
4.3.3 **Creative Carnivale & Sketch Jam**

This is a local social activity group consisting of students, professionals and enthusiasts that meet up once a week at a local rented location and thrive in the practices sketching and illustration. Sketch Jam is completely open to any possible interested individual and free of charge. Since most participants in Sketch Jam are a variety of users who use mobile, devices, digital tools, as well as being creators of analog material, they were a perfect focus group for user tests and feedback. They also consist of many avid comic and manga fans with broad knowledge of the subject.

4.3.4 **Makoto Yamasaki (Adobe Japan)**

During the final presentation of UNIME in Japan, a researcher from Adobe Systems Ltd. (Japan), Makoto Yamasaki, came to discuss the project, as they had identified a similar problem area within manga collaboration social networks and shared a similar subject of research. He invited the project members to participate in studies and workshops that Adobe were conducting in Japan. During the initiation phase of the current thesis project, Mr Makoto was contacted about the prospect of being an advisor. He acted as a creative reflector, giving professional feedback, insight and experience, regarding how the software business is continuously adapting to new technology.

4.3.5 **Simon Lundmark (Södra Innerstads Tidning)**

A freelancing comic artist that does weekly comic work for a local newspaper. During a mentoring session with Tony Olsson\(^5\), information was received about Simon’s experience in making comics while having a open-minded approach to comic creation and delivery formats. He agreed to participate in interviews, user tests and potentially construct some specialized material. He is agnostic in his choice of techniques and platform, but prefers to sketch by hand. He agreed to give insight and discussions about his work as a professional in the comic business.

4.3.6 **Max Weiland**

A local freelance professional illustrator and artist who prefers to work within the analog realm with physical canvases, pens and brushes. He acted as a control group member, to properly evaluate the project technology from an outside perspective. Having little use of the digital delivery format, he acted as a control group member and give insight into how possible future conveyors or adaptors, might approach the technology.

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15 Discussion and mentoring with Tony Olsson at Kranen, Malmö University [05/03/2013]
5. THE CREATOR PERSPECTIVE

This selection of design theories are discussed from a dualistic perspective, as many creators and end users share the same interests and their roles interchange. The user and the creator are separated into two chapters of design theory to keep their separate conditions in perspective. It would be likely that most creators of comics also read and enjoy other creators work, that they are in fact themselves, users. Many readers might also be inspired to instigate an artistic endeavor over time. In effect, the design theories presented support both viewpoints.

In this first section, various theories and technologies will be discussed and explained that are the foundation of the design from the creator perspective. They will be followed up with the user perspective. Within the service design methodology, this project’s creator perspective focus would be similar to the backstage process, supporting the part of a service or design solution that is hidden away from the user, while the frontstage process would be similar to the user perspective focus, the part that the user experiences directly (Stickdorn and Schneider, 2010). The distinction of creator and end user will at times cross over to being determined as the artist, creating the content and the reader, as the person using the tablet’s interactive surface and reading the comic material.

5.1 Human-Computer Interaction (HCI)

HCI is the foundation that defines our usability of mobile devices and screens from a background framework of cognitive experimental psychology (Shneiderman & Plaisant, 2005). As an interaction designer working from both a creator and user mindset, an understanding of HCI is vital in order to grasp the possibilities and functions of mobile devices like smartphones, computer tablets. On these devices, the screen estate and its user interface (UI) are the link to how users acknowledge functionality and interactivity (Dix, 2004).

From the perspective of comic artists and readers, the screen of the device is the representation of the printed paper in comics. From a perspective regarding digital comics, the smartphone screen can be seen as moldable layered digital paper. Smartphone or tablet screens do not come with the tangible sense of analog printed books, the project has explored what possibilities could come from breaking the common representation of analog simply converted to digital. Dix (2004) acknowledges that although many users unilaterally use similar devices and share human capabilities, we are individuals with specific different needs that cannot be ignored.

5.2 The infinite canvas

In Understanding Comics (McCloud, 1994) and Graphic Storytelling and Visual Narrative (Eisner, 2008) we are presented with the idea that a printed comics canvas is represented by sequential art through visual
borders that define the beginning and end of the frame in which a narrative takes place. The infinite canvas introduces the idea that there is no longer a need for canvas borders in the digital realm. We do not need to jump between narrative frame to frame within a defined page that simulates a printed page. The frame could have continuous endless space in which a narrative can continue until the story ends. There is no need to limit direction or size. This infinite canvas is the basis of the project’s ideas of bending rules and representation of comics on tablets. Why do we still flick our fingers in order to simulate the turning of printed pages on a digital device? The infinite canvas is already used as description of the space surrounding certain webpages online were we can freely move around as the screen scrolls from side to side when we scroll the page. Seemingly, the page never ends, the narrative continues endlessly. If the infinite canvas were scrolling infinitely, at some point there might be a narrative object out there by the artist, reminding us that the creators power over the narrative is now limitless (Eisner, 2008).

5.3 Parallax scrolling

This is a technique that originates from early animated films in the 20th century (Lutz, 1926). It is the practice of displacing transparent celluloid backgrounds in between frames to allow a sense of camera motion depth to an animated scene. It was improved and perfected in Walt Disney productions of the 1930s, through the use of the multi-plane camera (Thomas & Johnston, 1995), a camera on rails that moved in between frames towards or away from sliding glass plates with sheets of painted celluloid. The effect has also been called motion parallax (Hii, 1997).

Parallax scrolling has since been popularized in mainstream animation and computer games, due to its sense of adding depth, scope and motion to the often static screen space. It is the illusion of perceived animated depth when separate drawn layers move over each other with a slight delay in motion or increased / decreased speed percentages per layer (Lewis, 2004). When animating a picture layer containing a landscape in a direction from left to right, you can create a sense of depth by moving a picture layer of a cloud slightly faster (Hii, 1997). You could call it an optical or visual illusion, through the years it has also become more of an aesthetic technique used in many games, animated films and now through desktop backgrounds in the Android OS (Google, 2013).
Commerially in games, parallax scrolling first appeared in the coin-up arcade game *Defender* (Williams Electronics, 1982) when used to create the illusion of a rudimentary moving star field in the background (Burnham & Baer, 2003). As computer hardware improved, the effect got more featured and increasingly advanced (Collins, 1998). Even when games entered the 16-bit era, it is similarly used in *Sonic The Hedgehog* (Sega, 1991) to move the background at blazing speeds by repeating textures. Today, the technology it is often featured in “retro”-themed games like in *Rayman Origins* (Ubisoft, 2011). The hardware acceleration available in current computers, game consoles, smartphones and tablets, allow simultaneous combinations of 2D and 3D layers with high complexity. In effect, today real and complex modeled 3D space is used to artistically simulate the illusion of the vintage 2D parallax scrolling technique.

Parallax scrolling acts as an crucial attribute to explore and include as a feature of this project. The concept of using it as a technique within the artist to reader interaction, is based on how it would be possible to bring to life, many of the static frames and artwork used in comics on smartphones and tablets. The idea revolves around applying the parallax scrolling effect to the digital layers of the artists artwork in realtime and allowing the reader to manipulate all or singular layers through their user input. It might be through touch, kinetic movement or intangible sensor algorithms like eye-tracking. It could be controlled by infra-red light, sound or online network activity. It can be a subtle effect of interaction or with striking vividness. The important part of this design element, is how the lifeless and static, can be “drawn to life".
5.4 Layers and frames

The parallax scrolling effect described above is solely dependent on its dynamic moving layers. When working with layers in a digital compositing software context like *Photoshop CS* (Adobe, 2013), layers are invisible until painted or sketched within the visible canvas. In order to animate the static layers of a comic frame or picture, they would need a requirement of calculated 3D depth distance between each of the layers that contain visible graphics. They would have to be organized in an order so that movement of the layer that will have the illusion of being closer to the reader, will be the top layer in the composition. If characters and objects within the canvas are drawn in full, user interaction of the surface could allow new perspectives to the static two dimensional frame.

As an example, if a comic character is presented close to the edge of the digital screen estate or canvas and half his or her face is covered by the device’s frame border of the screen, the reader could tilt the device and the gyroscope-sensor in the device would record the movement. The perceived 3D depth is then calculated to move the layers to the side (slowly). As a result, the reader could reveal parts of characters visible traits not possible to see in a conventional static comic frame. This is one of many attributes that could be altered through user interaction of layers. It opens up the door to many other modifiable components of a layered narrative composition using user input.

5.5 Interaction and choice

An avid gamer of today should notice an increase of much *gamefication* arising in new digital markets, especially in combination with smartphones and tablets functionality (Zichermann & Cunningham, 2011). There are DJ-remixing games with online fan-made playlists and “running-healthcare-GPS-gauntlet” applications in which to compete against friends over *Facebook*. As most portable devices actually are minimal and powerful computers with built-in multiple sensors, why wouldn't any system feature be more fun if it was a game (Juul, 2005)?

The digital layer interaction being researched, does use retro gaming techniques. One might argue that it could be used for *gamefication of comics* (Zichermann & Cunningham, 2011). However, the technology is limited in its current form, and it would act against the sincerity of the comic medium it is trying to adapt. The user interaction itself can be subtle, enough to give spirit or a sense of movement to an otherwise static comic. It could be enough to inspire creation or modification and connect with a new user base (Nitsche, 2008).
5.6 Sensors

Almost all portable devices used presently for communication, contain multiple advanced sensor types that aid the user in establishing conditions and relevant data. Sensors have become very common in smartphones and tablets mainly due to mass production, allowing decreased prices and smaller sizes of the components. Today, multiple sensors can be bundled, integrated or soldered into a smartphones motherboard, essentially creating a sensor network in the device which standardizes and instigates new areas of user control, further to be explored by developers and researchers.

Sensors have been used since the beginning of graphic computer user interfaces (UI) to control navigation, like in the motion-based steel ball sensors that were found in the early computer mice. The mechanical steel ball sensor in computer mice has since been superseded by an optical sensor, later transforming into the touchpad on laptops, allowing portability. In turn, this evolved and merged into the touchscreen interface we presently have in our tablets and smartphones (Dix, 2004).

As an example of common sensor usage, a smartphone’s GPS (Global Positioning System) sensor can receive satellite data to help navigate or position the user in correlation to their surroundings. A proximity sensor can help an user save battery time by turning off their smartphone’s screen when the device is held against the user’s face. All these sensors can be used in combination to allow new types of functionality in the device, like a compass sensor used together with the GPS. This would give the user exact visual information about on their geographic location on a map, at the same time as indicating their facing direction through an arrow icon aid on the device screen (Kuniavsky, 2010).

In regard to this project, sensors are important for allowing the explored user interaction within the visual representation of a comic, on smartphones and tablets. The combined input of several sensors at once can manipulate space in several dimensions, controlling individual narrative details within the comic’s visual representation on the device screen. Within this context, three specific sensor types have been used for exploration:

5.6.1 Movement

On current smartphones and tablets, there are several sensors that can detect movement of the device. The most commonly used are kinetic accelerometers that detect speed of movement and gyroscopes that detect device rotation in 3 dimensions (X, Y and Z). Other movement sensors might be a compass (360 degrees horizontal rotation), a barometer (height over sea-level) and proximity which senses distance to an user or object (Kuniavsky, 2010). In regard to this project, the movement of the accelerometer and gyroscope are explored as they can record when you start and end a tilting or turning movement of the device. The data is measured in detailed values and in real-time, easily giving data values outmatching the cycled frame-rate of the device screen refresh-rate, which is commonly 60 hertz (equaling once every 1/60th of a second), allowing control of animation on the screen to be fluid if needed.
5.6.2 Touch

The sensor that is the most used on smartphones or tablets, is the touchscreen. It acts as the main controlling function in relation to the visual feedback that is seen on the screen surface. There are several different types of touchscreens, although the most common are *resistive* or *capacitive* (Kuniavsky, 2010). The capacitive touchscreen sensor functions through capacitive coupling, the human body capacitance specifically, which is the sensing of the electricity flowing through our bodies upon touch on a specific position or area of the device screen. The resistive touchscreen works through pressure between two thin layers of electrodes in the screen and works best with non-finger operation, like stylus-pointer pens. The capacitive are the most common today and allow multiple touch positions on the screen surface simultaneously, allowing more advanced real-time control like two- and three-finger sliding movements used on Apple's *iPhone* for changing pages in a document. In regard to this project, a touchscreen will allow user manipulation of individual layers in a digitally represented comic frame, moving them around, uncovering or seeing new pieces of artwork.

5.6.3 Vision

Cameras have been common peripherals in most smartphones and tablets for a long time. Many users disregard, what could possibly be the most powerful sensor in the device, as they use the camera mainly to record memories and events. The hardware in latest devices on the market, contain energy-efficient processors with multiple cores and dedicated graphics accelerators, an example being Nvidia's successful *Tegra3*\(^\text{17}\) platform with 4 processor cores. The improved level of processing power in these devices enable handling several duties at once, including capabilities like continuously analyzing the camera's input in real-time, in order to sustain or support specific user input to the device's operating system (OS). Features like *face-recognition* and *eye-tracking* are therefore dedicated functions within the device OS that developers and designers can access in order to find new ways of usage.

*Face recognition* is a feature that analyzes the camera input for human facial features in order to recognize or position the user’s distance to the camera (Kuniavsky, 2010). Recognition can be used for security in unlocking access to a device or for identity tagging of the user within social network services like *Facebook*. Positioning can be used as non-tangible control input for user interaction. It is used in several advanced simulation games on PC's and game consoles, usually controlling the first-person view angle of a player’s virtual positioning within the game world. When the player moves their head in front of the camera, the viewpoint is repeated in the game accurately. *Eye-tracking* can have similar functionality, although it is mainly used for positioning of an user or for detecting passive gaze movement in the eyes, detailing where and at what our eyes stare (Hammoud, 2008). These techniques were tested during the late design process as proof-of-concept to determine the potential of non-tangible user interaction when controlling digital comic or manga content.

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\(^{17}\) [http://www.nvidia.com/object/tegra-3-processor.html](http://www.nvidia.com/object/tegra-3-processor.html)
6. THE USER PERSPECTIVE

6.1 The User Experience (UX)

One central and important component within this project is the way the technology explored begins, continues and possibly ends, in the eyes of the user. The properties of form, behavior and content should all be streamlined towards supporting user values and rigid structure, not colliding with the needs of a content deliverer. Defining and adapting the user experience will be essential in achieving synergy of the technology explored in this project (Cooper, Reimann & Cronin, 2007). Building up the architecture of the explored technology, which will be referred throughout the thesis as the “Drawn To Life” technology, could be difficult due to the colliding angles of creator and end user. A set of guidelines could be established to help find an in-between path to attain satisfaction from both sides.

6.2 Convergence culture

Considering the nature of how convergence culture or participatory culture seems to infect every other type of media product in existence, it feels inevitable that the technology currently being investigated, would be able to add or to this phenomena (Jenkins, 2006). Once you open up narrative for user interaction, there is a risk it will be adopted by the “collective intelligence” and molded into something else, a new creative entity outside of control and used outside of its intended sphere. This is not necessarily a negative, it could open up a completely new or modified subculture from a intention that was originally completely different in form. It could be an cultural entity that does not concede with other mainstream rules or agendas. If popularity of such narrative direction would prevail, its initial tests and level of activity would decide its future fate.

6.3 Fandom: DevianART and scanlation

The fans of manga and anime are known to take the power of consumption away from the copyright owners, creating their own rules and versions of their favorite media on expressive collaborative forums and community publication platforms, like DevianART. Scanlations are the fan’s own subtitled and translated editions of manga which are spread and shared throughout the internet on forums and irc-channels (Manovich, Douglas & Huber, 2000).

The freedom and anarchy of this subculture could be beneficial to the mediated structure explored within the system. Most likely, if manga fans find any interest in the technology i am investigating, they could quickly absorb it into their workflow. It could conform into experimental scanlation hybrid projects, that could bring new attributes to the manga scene on current portable devices like smartphones and tablets (Lee, 2008).
6.4 Pop-up books and tangible narratives

Fascination has often surrounded the artistic qualities in well done “pop-up” books, read by many of us throughout our childhood. There was always an extra sense of excitement, suspense and awe when turning each page. Consider this project’s investigated layer techniques, a kind of tangible narrative that also emphasizes the user experience of surprise, thrill and surrealism. In the same sense, user interaction of the layered content on screen surfaces of smartphones and tablets, could add a similar tangible quality.


“A process is most easily taught when it is wrapped in an interesting package”

Having the same experience as reading *Alfred Hitchcock: Master of suspense* (Moerbeek, 2006), on a smartphone would be difficult to equal in terms of tangible impact, but there could also be safety in subtle and minimal approaches, Eisner also states these appropriate words that can give food for thought considering this projects researched techniques:

“Powerhouse layouts or excessive rendering technique, which can overwhelm and distract the reader and dominate the story, are counter-productive in this form.” (Eisner, 2008).
7. DESIGN METHODOLOGY

In this section, methods are defined to support research, design decisions and intended use of techniques. It is specified why the service design is the chosen method approach, even though the project never reaches a full holistic service design solution. It also explains why some methods within the service design disciplines are purposely avoided. It details each of the design methods used following the project phases and describes how they affect or support design decisions made in the iterative prototype workflow.

7.1 Using a service design framework

The projects main qualitative methods originated within the field of service design. It was the most appropriate approach, due its variety of methods in user-centered design, co-creation and how it promotes interdisciplinary methods and tools to easier adapt to many design situations (Stickdorn & Schneider, 2010). Service design is a more recently defined and evolving design approach that fits well with a progressive workflow. Using service designs variable qualities, the design could integrate both the creator of delivered content and the end user, equally in the design process, separate stages of development and prototyping.

During the project, specific methods within the service design framework were used and some were purposely avoided. The chosen methods mainly helped exploring, analyzing and finding openings in how to iterate and adapt the design process in the best way possible to support both the creator and user angles within this specific interactive comic context or touchpoint. Within service design, touchpoints represent the most important elements of a service that connect or support high priority features between user-to-user, user-to-machine or machine-to-machine circumstances (Stickdorn and Schneider, 2010). In relation this project, touchpoints helped determine the focus of device interaction between an user’s sensor input and the creator’s allowed narrative interaction of their comic or manga material.

The ambition was to continuously extract and define qualitative properties from creator and user insights, needs, objections, accumulative test results in order to support and merge new iterative design changes of each faction’s front-stage and back-stage (explained in chapter 5) into the continuous prototypes and solutions (Stickdorn and Schneider, 2010). When doing this, only the specific attributes and methods of service design detailed below were targeted for effect, many of the common methods accustomed within service design, like stakeholder maps, storyboards, customer journey maps, user experiences, flowcharts and personas were not used. I was developing one touchpoint using narrative interaction techniques, aiming it to possibly be integrated into future commercial service systems.
There was no need to downplay or ignore one participant over another when shaping the exploration, as they are both of mutual interest to each others' benefit. One might argue that a this exploration would not need insight from two opposite angles of a business, as the comic creator is the deliverer of the artistic creative content, and the reader is the consumer of that content. However, the reader is also the enthusiast of the art form, a powerful financial incentive. They can be inspired enough to branch off into their own artistic endeavors, perhaps using the same content delivery system, modifying it as they see fit.

In the recently released book *Materials Matters in Co-Designing; Formatting & Staging with Participating Materials in Co-design Projects, Events & Situations* (Eriksen, 2012), the author’s opinion is that service design is a relatively new design approach, evolved through several interdisciplinary versions of interaction design. It does not embody specific design objects or tools, instead explaining services to be part of complex structures and networks of services. The definition of service design according to Saffer (2010) defines every element of a service separately, as a part of a chain of events or a given design circumstance. The elements are divided into four categories: environments, objects, processes and people. He avoids describing combinations of criteria or holistic perspectives. In regard to this project, the more recent open approach and theories of Eriksen (2012) and Stickdorn & Schneider (2010) are preferred, due to their flexibility in not determining specifics and objectifying all service traits. One could agree with Saffer (2010) regarding how service design often contributes to “branding”, the building and conforming of a successful service as being the frontrunner franchising part of the corporate identity, but since this project not yet has, and maybe never will have, a full service or a corporate agenda, that worry is currently void.

In the early guidelines of the book *This is Service Design Thinking: Basics - Tools - Cases* (Stickdorn and Schneider, 2010), a collection of many of the service design fields leading researchers and rooters, there are five main principles explained that distinguish and define the attributes of service design thinking. The five principles of service design thinking should be user-centered, co-creative, sequencing, evidencing and holistic. Due to time restraints and target focus circulating around developing a specific narrative interaction touchpoint within a dualistic context, the this project centers on promoting these three principles mainly:

### 7.1.1 User-centered

The focus of the design should be made from of the perspective of the users and their needs. It is important to listen to the user an integrate their opinions as a part of structural shaping of a touchpoint. The variety of characters of users in any context require understanding of habits, opinions, culture and social aspects. The authenticity of the data gathered, help put the participants in their respective perspectives. There needs to be an full understanding of the users context, the design needs speak the same language (Stickdorn and Schneider, 2010). There is not necessarily the need to define that a reader is the only user within this project. By definition, the comic artist can also become the user if a design results in a set of digital rules that they can explore to enhance their narrative.
possibilities. An artist making a comic should be aware of the impact and repercussions of the content delivery they use, whether it is digital or analog. Similarly, a reader should accept that an comic artist chooses to package their narrative in whatever system they feel best supports their style or preference.

7.1.2 Co-creative

Within service design, co-creation is a philosophy that can be applied in situations were multiple stakeholder’s (explained in chapter 4.3) goals are of interest. Relevant and involved stakeholders within the project become participants that affect the design process and outcome. They are constantly involved or considered, when developing all its supporting touchpoints, its’ processes, functions and solutions. There has to be consideration taken to the fact that there are many people involved within a service, so outlining a structure and mapping out the service is essential to grasp its’ core components (Stickdorn & Schneider, 2010).

While undertaking a co-creative method, there could be a need to organize and govern exercises of co-creation, due to the inexperience of many involved participants. Iterative processes help iron out ideas that are weak and the multi-disciplinary collaborative aspects push the strongest attributes forward. There is a democratic aim in order to achieve an equal communicative ground and thoughtfulness of all involved parties. There are many similarities to open-source development fundamentals found in its mechanics (Stickdorn & Schneider, 2010). A comic’s digitally represented surface with added user interaction might not enhance the narrative unless the users have other features of their devices functionality fulfilled, like support for high resolution textures, clear colors, non-flickering strokes in graphics or maximum available contrast in the screen display, while reading comics.

Eriksen (2012) references The Reflective Practitioner (Schön, 1983) when she discusses co-design, which revolves around embodied socio-material situations in design scenarios and practice. She uses Schön’s conclusions that emphasize intentions of focusing on situations, not the involved people or events. The situation itself can be unique, and should be separated as an specific design problem. She argues that Schön’s theory “Reflection-in-action” indicate that professional practitioners have difficulty excerpting tacit knowledge in practice and in effect have more skills than they can exhibit in professional work situations.

Using this theory applied into this project, it could be interpreted that creators of comics may have problems communicating their craft outside of their “safe zone” and known craft, to end users or other artists. Similarly, designers might not be able to properly communicate their design wishes upon them, but could still successfully fulfill their design needs. Their opinions and acceptance regarding digital content could get lost due to in-communication.

In Ben Fullerton’s article Co-creation in interaction design (2009), he speaks of the practice of co-creation as being innovation exercises. Professional corporate firms hold workshops where they mix professionals
from different agencies and disciplines in order to form new teams. Several of these team-members have collaborated before, but not been able to work efficiently together in their current position. When coordinated through analysis of their skills and design strengths, re-organized into new design networks, they could perform exemplary, forming effective new cohesive design functions.

The aspect of co-creation within this project is the dualistic approach to involving creator and user to agree on what rules apply to the mutual interactive and dynamic surface on digital devices. Both are stakeholders, and both have creative dynamic needs to explore through interaction.

### 7.1.3 Sequencing

Much like a movie, a service contains rhythm, excitement and tempo. If some part of a service does not work or fatigues the user, it will slow down its working state and as a result, the service will lose users. A service is dependent on supporting a *flow* of moments that detail what happens through a service’s many phases. These are divided into what happens visibly or noticeably to the user (frontstage) and the part of the service that is invisible or hidden to the user (backstage). Like many good movies, it is important to keep the expectations of users high and build a constant momentum and suspense. Using key touchpoints in the service as flow markers and identifying when and where weaknesses appear, momentum, expectation and excitement can be sustained (Stickdorn and Schneider, 2010).

Although this thesis does not fulfill or complete a full service design prospect, *sequencing* is relevant within the touchpoint being explored. This is important in regard to its’ aesthetic qualities and presentation, if seen as a part of future potential service. When looking at the separate touchpoint as a service element that needs to sustain rhythm and tempo, it is vital to also sustain this when using dynamic visual effects and parallax scrolling layers on the devices screen. If comics and manga are to be represented accurately through digital interaction, content flow and narrative pace must be achieved in consecutive content presentation or between story elements. A constant stable frame-rate (+60FPS) will help the reader perceive the interaction and animation as smooth, integrated to the point of rendering the effect invisible (Csikszentmihályi, 2008). If it would be slow, stuttering or flickering, the narrative experience could be damaged permanently to the point that the user loses interest, which would shadow other potential connecting touchpoints, should it ever be merged into a full service or system. As a foresight, there should be heavy emphasis on optimizing code and presentation as much as possible within the project timeframe, before user tests begin, to keep the rhythm of the subjective experience, to immerse the user and keep them occupied while using the technology.
7.2 Interviews

This method was used in order to get useful data that supported concurrent design decisions throughout the project. Several phases of re-occurring ethnographic interviews were performed using Alan Cooper’s model in *About Face 3: The Essentials of Interaction Design* (Cooper, Reimann & Cronin, 2007) with an aim to gather relevant opinions and data from both artist and reader of comics. They were divided into 3 stages: *early interviews, middle interviews* and *later interviews*. The middle interviews stage was purposely left out, as this was a project phase where essential prototyping work was prioritized.

7.2.1 Early interviews

This stage was mainly used to get a broad, open-ended source of knowledge going into the start of the project (Cooper, Reimann & Cronin, 2007). It begun with exploring the characteristics and getting an introduction into the topic of the comics scene. Asking several involved parties like the creators, users and certain authority sources of academic stature on the subject. People like professors and professionals, their opinions, the climate of creativity, rules and borders, do’s and do not’s, the independent comic production scene.

7.2.2 Later interviews

This interview technique was used when following up user tests at a later stage of prototyping or proof-of-concept evaluations. This phase revolved mainly about confirming and clarifying data, during and after tests. Specifics were defined, adjustments to records made. This is where evaluation of several design aspects were performed with hindsight. Here there were options to loop back and evaluate previous misconceptions, It was also used as followup data, leading into end stage of production (Cooper, Reimann & Cronin, 2007).

7.2.3 Contextual interviews

Stickdorn & Schneider (2010) define interviews as contextual in focus. In this regard, it was important to interview my participants in their natural habitat, where they worked or in their homes, wherever they felt acclimatized. It was in the projects best interest to make participants feel comfortable and calm, to offer them a suitable personal space and comfortability, it improved conditions for extracting honest natural feedback. It was also important to consider the hidden data of an interview, the attributes of character that came out in their non-behavior and silence.
7.3 Observations

This is a research method that accumulated a lot of data through simple means. It was best done using a low profile, good manners and becoming incognito, blending into the environment or user group that needed to be surveyed. Saffer (2010) defines observations into 4 segments or styles, that can support various contexts and conditions: shadowing, fly on the wall, undercover agent and contextual inquiry. Contextual inquiry was the most suitable form of observation for this project.

7.3.1 Contextual inquiry

This is a variant of the observation technique Shadowing. It is more open and aware to the immersion of the surveyed participant. The interviewee can interrupt the participant, ask him or her questions at any time to explain circumstances and events (Saffer, 2010). Since there were documentations and project presence during several of the artists work routines, this was an appropriate approach, since it aided the understanding and clarifying of their artistic techniques.

7.4 Brainstorming

This is the act of a design process when thoughts, ideas and solutions fly rampant through the designers mind in an order to arrange, ponder and concretize the future direction of the design. In order to get maximum throughput, it helps to perform shorter brainstorming sessions with shifting areas of focus, not limiting oneself to ideas that connect only to the project or design area, rather one should try to stray away from it.

During a short period of time I tried to concoct as many ideas and solutions as possible with a wide range of reference, even themes not connected to the actual project. The design ideas were not self-censored and no time was spent expanding them further during this process (Saffer, 2010). In reference to the project, brainstorming was a part of the early design phase, after initial research was done, in order to widen the future possibilities of the design reaching outside the area of tangible devices and services.

7.5 Prototyping

This was a critical part of the project. An iterative prototyping process that started from pre-defined ideas. These were based on early research and brainstorming sessions, they were transformed through stages, ultimately resulting in a function, service or proof-of-concept technology.

As this project was as much an exploration of possibilities, as a concrete design effort, it transpired over to proof-of-concepts at at later stage of prototyping, due to time restraints. Selected method approaches in This Is Service Design Thinking (Stickdorn & Schneider, 2010) was used, as they formed an adaptable approach, suitable for this projects dualistic creator vs. user angle. This iterative process is regarded as modular and non-linear in its characteristics. It was suitably used, as the target group was divided, lucid and somewhat undetermined in the initial prototyping stages.
7.5.1 Exploration

At this stage, the culture and goals of both the artist and reader was identified. The main problems and strengths of the topic were examined with a means of understanding who the design was for. Initial findings were then organized and categorized in as much detail as possible (Stickdorn & Schneider, 2010).

7.5.2 Creation

In this second stage, focus was on creating as many branches of code and features as possible. This was the most important stage in regard to the design heuristics, realization and tests (Stickdorn & Schneider, 2010).

7.5.3 Reflection

This is where tests were put into realistic settings and fieldwork. Emotional contexts were considered and staging approaches were used to test weak areas, narrative features and technology (Stickdorn & Schneider, 2010).

7.5.4 Implementation

The final stage of putting the results from exploration, creation and reflection into a final prototype. Concentration was also on evaluating proof-of-concepts due to time constraints, to support in what other contexts the prototype might realistically be applied and in what form (Stickdorn & Schneider, 2010).

7.6 Proof-of-concept

This is where conceptualization and tests of various technologies supported potential design decisions and future service solutions. It was a form of exploring to identify the possibilities of certain design angles that would be unnecessary if proven too time consuming to fully develop. This enabled use of several variants of tests and experimental code libraries, that could support techniques like eye-tracking or perspective-changing projection walls for promotional events.

Preece, Rogers & Sharp (2002), define proof-of-concept as a part of a low fidelity prototype (“lo-fi”). It allows the designer to evaluate various design concepts quickly, lower costs of development. Some flaws are its limited usefulness in specific scenarios, non fulfilling certain requirement and that it might have navigational disadvantages because of its simplicity and limitations. There are no ways to determine error redundancies in realistic usage scenarios.

Use of proof-of-concept was concluded at a later stage of development specifically because of interests in replacing physical sensors like gyroscopes and accelerometers to control interactivity on the device with alternative intangible technology. It was done in order to assess if our eyes could easily control interactivity of digital content without physically handling a smartphone or tablet, like altering the content when our eyes gaze on specific surface points.
There were many options to explore, considering the abundance of sensors tablets and smart phones have at their disposal. The camera facing the user is a powerful sensor when combined with algorithms analyzing the recorded image, like movement of the user, their distance from the device or emotional state through analyzing facial features.

7.7 User tests

User testing is a systematic evaluation in order to improve usability design (Preece, Rogers & Sharp, 2002). As the design process proceeds, as many user tests as possible should be performed within the given timeframe of the project. In an iterative design process, user testing should reoccur in each important iteration of the craft. It is easier to evaluate simple or low fidelity (“lo-fi”) prototypes, due to the inability to critique their weaknesses over their qualities (Goodwin, 2009).

Qualitative user testing needs proper conditions to be give accurate data and should be documented through recording devices like video or audio to support and prove later decisions. Statistical data is to be collected from sensor-based equipment when tracking user input and screen focus, to easier apply certain tweaks of layer-movement and depth control.

The tests were done within the context of readers interacting with the prototype content on the device. Different content was tested to evaluate movement of patterns, colors, line and border definition. The empirical qualitative data collected during these user tests supported the final prototype changes and design conclusions.
8. DESIGN PROCESS

This section details the research, design decisions, prototype work and proof-of-concepts. In each segment, there are connections made to earlier design theories, methods and technologies presented. After detailing each process, the content will show implementation of the methods and theories in the prototypes and proof-of-concept. Finally, there is a discussion of what was learnt from each phase in a design process analysis.

8.1 Initial research

During the initial phase of the project, it was important to firstly strengthen the direction of where it was heading and define its momentum, isolating the subject and determining focus. The project was initially closely aimed towards the UNIME collaborative theme, although there was still uncertainty as to where the context of comics / manga would finally land. The collaborative essence was ultimately conformed, manifesting itself through a shift towards the user interaction of the presented surface in the comic and its delivery format, the smartphone or tablet. Distant, virtual collaboration between artists had therefore become intimate interaction between the artist and the reader, the consumer of the narrative.

Several mentoring sessions with academics and professionals connected to the courses and programs in visual communication, interaction design, media and art at Malmö University, were conducted to help shape the direction of the project. Tony Olsson, Jakob Dittmar, Simon Niedenthal and Gunnar Krantz were questioned about how to approach development and progression of the project, to help define a specific angle.

Jakob Dittmar’s article Digital Comics (2012) and Julie Taylor’s article on Interactive Comics (2004) give insight into the current and past conditions of the digitally represented comic, although Taylor’s article mainly focus on online website material and games that use comic-style effects. The articles give insight into distribution channels that non-distributed work use online, and the possible future directions of comics / manga narratives. Dittmar discusses the limitations of portable screen estate, like resolution and the size of screen becoming an issue when reading, but confirms that much like McCloud’s (2000) infinite canvas, the printed conventions of the comic / manga narrative no longer apply, as the screen space can be moved around, manipulated and defined by the digital format offered in the device.

Will Eisner’s Comics And Sequential Art (2008) and Scott McCloud’s Reinventing Comics (2000), both detail and discuss the future of comic distribution and presentation of digital portable devices, although they are still written some time ago, leaving a gap in regard to the technological advances of the last years in tablets, smartphones, processor power and screen fidelity. These advances show much promise in regard to optimizing a digital comic experience.
8.1.1 Interview and discussion: Gunnar Krantz

As a leading local authority on knowledge of the comic creation scene, a successful comic artist himself and professor at Malmö University, Gunnar K. is an accomplished source to aid insight into the topic of comics, its evolution and future. Gunnar K. agreed to discuss his opinion about current and future development the comic / manga narrative and distribution formats. Initially, a longer interview and discussion was held, using Stickdorn & Schneider’s (2010) method of early interviews, centered on the collaborative aspect being investigated early in the project. The discussion then shifted more towards the technical aspect as the topic of collaborative platforms became more peripheral and distant, focus was shifting towards the comic surface and its manipulation.

There were discussions about comic makers’ preferences of workflow and techniques, how the analog approach of paper, ink and brush, still seems to hold an unparalleled reverence within the profession of comic / manga creation. The printed format is still regarded as the ultimate distribution technique by most comic creators. However, the discussion confirmed suspicions that social online creative forums like DevianART and affordable digital tools like the Wacom drawing tablets, are changing the “game” of illustrative content online. Younger generations of content creators are approaching alternative techniques through learning open source tools, via youtube-live-drawing-guides and increasingly cheaper creation software.

Discussions continued about the state of convergence culture (Jenkins, 2008) and the phenomena of how subculture within comics quickly can turn to mainstream, through the aid of a digital frontier online. Through social media and instant free online availability, an online comic like Anders loves Maria19 (Engström, 2010) can become an instant success within weeks, inspiring many new offspring projects and initiating creative needs in readers. During the interview and discussion, I was made aware of the biggest swedish manga community Mangaka20 and current successful independent swedish manga and comic creation studios / artists, like Åsa Ekström, Kolik Förlag, Jesper Nordkvist, Nosebleed Studios and Yokai.

8.1.2 Interviews and observations: Serietecknarskolan

This free-to-join field day gave much needed insight into the practices and conditions of an upcoming young generation of artists within the manga and comic scene. Using Saffer’s (2010) contextual inquiry and Stickdorn & Schneider’s (2010) and Cooper’s (2007) contextual and early interviews as guidelines, several students were interviewed and observed about their preferences in techniques and routines when creating comics / manga.

There was a clear precedence towards the practices using analog tools and print throughout the interviewees and observed participants. Serietecknarskolan teach several disciplines, using both analog and digital tools, only a few participants preferred the digital approach in the creation of their work. The ages of most students were around 16-25 years old, many showing

19 Still life = a work of art depicting mostly inanimate subject matter, typically common objects like food or flowers etc.
20 http://anderslovesmaria.reneengstrom.com/
early adoption of digital devices, actively using modern smartphones and computers in their workspace. When asked about their preferences of comics and manga, there was divided interest between printed manga, non-manga comics and independent online web-comics, with a slight majority towards interest in printed non-manga.

8.1.3 Brainstorming 1: Screen awareness

Using Saffer’s (2010) guidelines, sessions of brainstorming gave some ideas towards prototype development or direction. Focus was mainly on finding manipulation and fields of use for the represented digital surface (screen) on mobile devices, smartphones and tablets.

The first concept revolved around manipulating color and contrast on a smartphone screen in real-time, depending on the angle of the device towards the sun (using the camera sensor). Increasing contrast of individual background layers within comic frame, vision could improve when using device in harsh sunlight, hence the device becoming “aware” of the position of a user. This is similar to a technique found in today’s smartphones and tablets. They use built in sensors to control adaptable brightness settings in surrounding conditions of light, in order to save battery time and improve vision perception while in dark conditions. This concept differs due to the improving characteristics of each individual layer of the content. It could similarly be used as a narrative effect, to light certain layers within a narrative when using the device in dark surroundings, like a character within the comic lighting a cigarette on one layer, while a layer in the background dims down, creating narrative focus on specific action within the frame, in effect creating an real-time depth-of-field effect on the layers, much like the characteristic of a photographic telescopic lens.

8.1.4 Brainstorming 2: Layer individuality

This regards to specific graphic edge control in each layer of a comic frame, that could be adjusted in separately or in combination with other layers in real-time. The motive being shifting color or patterns towards helping readers with vision disabilities, like color blindness. The raster effect of manga in printed form will give moire resolution flicker and image problems when seen on a smartphones lower resolution display. This could be improved through layers changing colors or patterns in each layer, thereby optimizing the displayed picture depending on the content material.

8.1.5 Brainstorming 3: Canvas focusing

This concept was singled out due to its focus on non-tangibility, in effect meaning control of the device without hand or finger interaction. Zoom-in / -out of the 3D layered comic frame’s infinite canvas, due to eye-tracking or face-tracking focus data captured through the device’s camera. The parts of the comic canvas the reader wants to see are automatically shifted into focus, blurring out peripheral layered content. In effect, automated dynamic comic narrative, controlled by vision alone through the positioning of eyes or face in front of the smartphone or tablet.
8.1.6 Research analysis

The students at Serietecknarskolan who use a preferred digital toolset, brought interesting possibilities to this project's ideas revolving a new digital format. An interesting aspect in regard to this project, is the layered approach of those students who use layers when creating their work. One user test participant stated that some of her creations use between fifty to a hundred layers for each composition, all using transparency. Within a prototype optimized for user interaction, this could be used for stunning effect when put into kinetic movement, if each separate layer could be manipulated independently of each other. Imagine a comic character's hair or facial detail drawn in hundreds of transparent layers presented over one another, with individual color features and outlines for each branch of hair per layer. If these layers are automatically animated through user interaction independently of each other, incredible depth and dimensionality could be extracted for the composition, similar to that of a motion comic, animated motion picture or anime.

The multitude of competing distribution software and applications on today's smartphones and tablets, confuse the user as well as the creator seeking distribution. ComiXology is a leading digital distribution application with novel narrative techniques, but the opposition and competition of the market is currently vast and expanding. A lot of fans assemble their own "scanlation"s of comics and manga (Lee, 2009; Manovich, Douglass & Huber, 2000), distributing it freely through file-sharing networks and open-source formats. This might refrain many creators from adapting a digital format, due to overwhelming variety of distribution possibilities offered and initiative of self control or independence. The tangible qualities and sensations of the printed paper might also be much too alluring and nostalgic for creators or fans of the medium due to its successful long running history and user base, it is still the default distribution format. A digital portable counterpart of the medium might need additional features and techniques found in other narratives (games, film, web-comics), to alter narrative qualities, to offer new choices of consumption.

8.2 Prototype 1: Javascript, HTML5 & WebGL

The first prototype concept was initiated after making the decision to skip analog "lo-fi" testing with paper and cardboard, which was initially planned. The reason being that "digital paper" would be more flexible and effective in early testing, it would be able to change content easily. Using inspiration from McCloud’s (2000) infinite canvas and the techniques of Disney’s multi-plane camera (Thomas & Johnston, 1995), a simple prototype was constructed in javascript and HTML5 using Hii’s article zLayer: simulating depth with extended parallax scrolling (1997) as inspiration. The intention was to make a digital comic frame come alive through user interaction, using the mouse or mousepad in a web browser window, by moving the layers around from a central axis point. It was important to include browser support, as to allow artists to easily embed their digital comics within their own webpage, a common form of distribution for independent comic creators.
As an analog metaphor of how the prototype would work, if each layer or subject of an hand-drawn illustration were drawn on separate pieces of transparent film paper, the prototype would represent a wire connecting each paper on a depth axis with some distance in between. When the front paper would be moved separately from the bottom paper, each paper in between would move in a perfect line, shifting the perspective and depth of the composition.

To initiate the prototype in digital form, a simple layered artwork was created in *Photoshop CS* (Adobe, 2013), using eleven layers of transparent monochrome content and numbering them in concurrently in the order of layer structure, from front to back. Subjects in the distance that would not need much movement, would be positioned as back layers (low numbers), and closer objects would become top layers (higher numbers). At this point, the digital limitations or optimizations for texture memory size or bit depth, were not considered enough. An image resolution of 1280x720\(^2\) pixels would suffice for the first tests.

A detailed breakdown of the simple monochrome content layers created, can be seen on the cover page of this thesis, which show every individual layer created to test the effect, along with them all layered together as a final composite. Much like early animation, not much attention was made to objects that would move outside of the screen area or borders (Lutz, 1926: Thomas & Johnston, 1995). The intention was to enable use of comic artist's pre-made or earlier layered artwork without alteration, so there should not be any consideration taken to specific objects or subjects within layers that would move in and out of the visible screen at this point of development.

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\(^{21}\) [http://www.mangakai.se/](http://www.mangakai.se/)
The natural tangibility and depth that physical pop-up books give while turning page to page and unfolding new art (Moerbeek, 2006), was constantly an inspiration, as to how the prototype animation and motion would act. It was important to get a gradual increase in motion as the user manipulated the content through the mouse or mouse-pad. There could be no stutter or choppiness of the movement on-screen, as this would counter-act the immersive qualities and depth perceived. The use of WebGL within HTML5 code uses the acceleration found in the computer’s graphic hardware components. This aids the presentation frame-rate and smoothness, keeping it at a common steady screen refresh rate of 60 hertz, meaning one frame of animation is presented once every 1/60th of a second. This a lot smoother that the standardized frame-rate of motion pictures and anime, that move at 24 FPS (frames per second) in cinemas, 25 or 30 FPS on television or online streaming. In consideration to the human eye’s abilities, the rather slow 24 frames per second adds a lot of darkness in between frames which adds to the perceptual lucid qualities found in cinema motion. At the prototypes proposed 60 frames per second, motion might seem more hidden or subtle, which would add to an immersive experience.

8.2.1 User tests of prototype 1

Nosebleed Studios were the first stakeholders to thoroughly test the first prototype. They initially expected more of a designer tool, with options of control and presentation for digital illustrations. At this point in the process, the crude simpleness and monochrome style of the content did not make a good representation of the technology, although they understood it was a simple prototype with material to suit the occasion. Looking past the first impressions, they were positive of the sense of immersion and depth added to a single image or illustration. During the following discussion, they were worried about such an effect taking over a narrative and felt it might suit a younger audience, who would want to play around with the content.

Another worry, was how the content would be protected online to prevent unauthorized use or copyright infringement, if comic content was to be presented in the prototype as simple downloadable JPEG, GIF or PNG formats. Opinions were raised regarding the resolution of the device and technology was important, to be able to keep the detail, color and fidelity of their material intact when presented on a device. When they publish manga novels, most of the work is monochrome. When printed for publishing raster textures are used instead of colors. Rasters are patterns of dots and lines. When displayed on screens, these usually produce moire flickering and instability, as screens can’t properly show the fine raster detail due to limitations in dot resolution. In order to prevent this on screens, the content or images have to be processed, through blurring or enhancement filters.

Nosebleed Studios agreed to deliver some of their material for additional prototypes and tests. They specifically thought the technology might work when the content would be adapted to motion, thematically. We also discussed the possibilities of alternative presentation of the technology adapted for other settings or functions. Specifically within the promotional events like exhibitions or fan events, where projections or displays in public
relation booths (PR22) could use similar layer effects to promote new releases, using projections and sensors recording people’s movement around the promotional area, altering the narrative content based on where they were positioned, the number of onlookers in proximity or movement around the booth.

When Simon Lundmark tested the prototype, there was a long running discussion about the prototype’s area of use and future possibilities. Topics brought up were the present-day variations of narratives within digital images, games, and gameification of comic material (Zichermann & Cunningham, 2011). Simon raised concern about how a previously static piece of artwork, might draw attention to weaker elements of design, when layered parts would be presented independently of each other. His opinion was that a comic artist would have to be aware about the independent motion of each layer while creating the art, much like the practices of animators working with anime or motion pictures, which could be problematic, drawing focus away from the comic’s narrative. He continued commenting on the potential over-use of effects, possibly distracting readers, proposing the initiative that “less is more” in most regards. Referencing cutscenes from games, that use similar animation techniques, he could see a use for this technology enhancing immersive connections of comic content within game narratives.

During a Sketch Jam gathering of the social activity group Creative Carnivale, the user tests were approached mainly from a reader perspective, as many participants were also avid comic fans. They were all proponents of sketching and analog art, so they would act as a proper control group to give insights on the prototype usage from a reader perspective, having much knowledge of comics. Participants commented on the technology being a natural evolution of many other hybrid narrative forms in the past. They could cite several online comic works that explored similar ideas in their presentation of content.

There was an acceptance of possible new ways of presenting comics and some users were aware of digital comic distribution like ComiXology and Marvel’s distribution applications on Apple’s AppStore. There was a strong respect towards printed graphic novels and manga, many referencing animated film and anime as inspirations. Their input towards the prototype and the discussion was positive, pointing out that it could prove an indicator of further unknown possibilities for the comic format in the future, if given time to properly explore and evolve its functions. There was a worry of how it would affect...
content already released for print or confined to the regular format. Most agreed there would have to be controlled conditions, and material made with the prototype in mind, not necessarily content adapted for it.

8.2.2 Analysis of prototype 1

There have been prior research projects investigating user interaction in comics. Hiroaki Tobita & Kaoru Shimasaki’s article *EnforManga: interactive comic creation using drag-and-drop and deformation* (2009) and Hiroaki Tobita’s article *Comic computing: creation and communication with comic* (2011) look at how comics can be constructed and manipulated digitally through separating content, moving around subjects, adding effects and altering order of structure in real-time. Similarly, this prototype shows promise in allowing attributes and user interaction normally found in animation or games.

The most important aspect of the prototype, is how it affects the comic narrative by adding the *illusion of life* (Thomas & Johnston, 1995) into the canvas or frame. In effect, when the layers move independently through user interaction, focus is brought to the layers in the front as they move more, their features are distinguished and focused upon by the reader. The artist would need to arrange layers accordingly, much like how a cinematographer or film director frames a scene, placing actors center or peripherally or using certain optics for depth-of-field, isolating subjects within the frame. A negative effect of the *illusion of life*, is when motion in the frame stops or is interrupted, which brings special attention to all content that does not move, it could hinder the sense of *flow* and narrative progression (Csíkszentmihályi, 2008). The prototype needed controlled and fluid motion patterns through enhanced or higher frame-rate, to not steal attention away from the integrity of the frame.

The issue of copyright infringement and its prevention through DRM (digital rights management) is a realistic and current dilemma for many artists. HTML5 and javascript have inherited weaknesses regarding protecting content online. Specific coded routines, like how the WebGL buffers its graphics memory or disallowing browser canvas options, would need to be considered in future development in order to sustain artists possibilities of controlling their digital distribution. It is common knowledge today, that most digital content can be hacked or copied in some manner, as long as the hacker is persistent enough. Distribution can never be completely controlled through DRM, but artists still have the inclination of making it difficult. One way of sustaining control, could be to package the content towards mobile devices like Apple’s iOS (2013) or Google’s Android OS (2013), which allow much creator control when released as an application. A downside to DRM is the inhibitions the reader experiences, making it more difficult for them to use their purchased content across multiple devices or computers, possibly adding a negative property to the experience.
8.3 Prototype 2: Processing and OpenGL

Focus of this middle stage of prototyping was on streamlining and adapting a framework from one platform to another, in this case from javascript and HTML5 in a web-browser, to the open source code environment and Java prototyping platform, Processing. This would allow porting to mobile devices at a later phase of development.

Work continued on evolving the technology and code towards mobile devices, specifically Google’s Android OS (2013). Converting the javascript code to the open source platform Processing allowed direct access to optimized web-browser performance, due to the code pipeline in Processing’s web export and conversion engine. Processing has the ability to use 3D graphics acceleration, converting 3D calculations using OpenGL commands, thereby optimizing performance to a higher level, that could not be achieved through HTML5 in this case. This means that user interaction on the prototype would result in smooth high frame-rate performance, with no lagging or stutter in the independent layer movement.

A simple form of digital rights management could be added through Processing’s ability of exporting javascript, embedding the comic content within a separate javascript window inside the browser, effectively making it unavailable for user options normally allowed on web pages, like downloading or saving images. A reader could theoretically still copy the content, but would have to do separate screen-dumps of each visible frame, making it an undertaking of sizable proportion.

This phase allowed assembling the first test using Nosebleed Studios promotional material, specifically adapted for this project. Using around twenty layers of high resolution content in 24-bit color with a “tropic pirates vs mermaids” manga theme, it showed the fidelity possible in the prototype when professional comic artists deliver high quality content. As Nosebleed Studios were informed of the early ideas, they delivered a layered
illustration where water was a component. This allowed the user interaction in the prototype to control the thematic swaying of water, floating boats, movement of sea-life and position of characters in the waves.

8.3.1 Analysis of prototype 2

Using Stickdorn & Schneider’s (2010) guidelines of sequencing and Csíkszentmihályi’s theory of flow (2008) applied to the material delivered from Nosebleed Studios, helped the prototype achieve another level of much needed fidelity. Adapting the prototype to follow stakeholder feedback, resulted in transforming features away from the web browser presentation. Frame-rate, smoothness and resolution increased, giving a more appealing visual presence. At this point it was hard seeing the holistic nature of a service where the technology could act on its own solely in a web browser. Most likely it would need to be packaged together with additional features, like a proper user interface, user instructions and a way to navigate between content pages. It would seem that minimalist features would be better suited to a mobile device, smartphone or tablet, due to the confined space, the similarity to the printed comic format and the novelty of sensor input controlling content through user interaction.

An advantage over the previous prototype, is the integration of a simple form of DRM. As the content is now packaged and accelerated through the Processing pipeline into javascript, users can no longer get the option to download the images inside a web browser. The images are kept in a specific folder on the web-server, which can be accessed only if hacked or if knowledge of the filenames is gathered in advance. Even if hacked, the user would only see each of the layered files separately, so they would have to assemble a complete picture from all of the files to see it complete. Given that it becomes an unique experience for every user, as every user input affects the content differently, the individual layers hold less value separated. The individual layers need to be assembled and experienced through the prototype code together, in order to keep its narrative value. A negative effect of this kind of DRM approach, might be if somehow the users could get access to the individual layer files and begin to use them outside of their intended use, making fan-art or modifying the content. This could result in interesting hybrid narratives or offspring products (Manovich, Douglass & Huber, 2000). However, many artists might feel their work would be compromised, lose integrity and abandon the format (Lee, 2008).

8.4 Prototype 3: Mobile devices with sensors

The final phase of prototyping is preparing and conforming the prototype towards the stakeholders interests using the iterative process (Saffer, 2010), looking at mobility, DRM and improved user interaction. Continuing integration of stakeholder feedback and user tests, aligning to the service design framework of co-creation (Stickdorn & Schneider, 2010). Since the early beginning of the project, there has been continuous focus on investigating the possibilities of the mobile platform, smartphones and tablets. Drawing advice and inspiration from the prior user tests and discussions, work continued on a prototype for the Android OS platform.
Using the Eclipse development software together with the Keta²³ open source sensor library, a migration of code was done in order to optimize the technology for different mobile devices. The test device used was the recently released 7-inch tablet by Google, the Nexus 7, containing a 1280x800 pixels resolution screen. Since most modern smartphones and tablets contain multiple sensors, examples being touchscreen, camera (for light and gestures), infra-red, accelerometer, gyroscope and proximity, input controls and user interaction can be much more dynamic. Since all tablets are controlled mainly by touchscreen, this replaced the control layered motion previously controlled through mouse or mousepad in a web browser.

Since the code was now tweaked for sensor input, additional parameters were added to control additional layer and canvas features of the comic content. Previously, only the mouse or mousepad controlled the layers in an X and Y position, allowing limited user interaction. The mouse and mousepad controls translated quickly over to touchscreen input allowing instant tangible qualities through touch interaction, moving the layers, subjects and canvas around on the screen. The built in accelerometer of the tablet could also report X, Y and Z input parameters, allowing real-time user control of content, depending on angle, rotation and tilt. This could be combined with many other sensors, allowing deep control of the content. The X and Y coordinates reported by the accelerometer in the tablet were added as additional values on top of the input from the touchscreen.

Since there was now an abundance of control options for user interaction, a 3rd movement control of layered comic content was added to the Z-axis of the accelerometer. This allowed a breakthrough ability not discovered in earlier tests, as the user now could control the content depth-wise, traveling into the comic through tilt-movements of the device, essentially pushing away layers past the readers point of view. As the device tilts, depending in user interaction, the user can move into the canvas in 3D, revealing focus of background subjects and allowing to move content away towards the sides of the canvas, effectively mimicking a dolly-shot²⁴ or the multi-plane camera (Thomas & Johnston, 1995).

8.4.1 User tests of prototype 3

Using contextual and late interviews (Stickdorn & Schneider, 2010 : Cooper, Reimann & Cronin, 2007) as methods, user test were performed following the completion of the final prototype presented on Android tablet, Nexus 7. After submitting adapted material in an earlier phase of the project, Nosebleed Studios found mostly positive attributes in the final prototype presented. They saw added value in the DRM that the Android application brought when being exported to a software package for the device. Natalia Batista of Nosebleed Studios stated that she would invest in an application that would export comics as applications for distribution, given that they as creators were allowed more options to control the content.

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²³ PR = public relations, promotional areas where artists promote their work, usually found at yearly exhibitions or events.
²⁴ https://code.google.com/p/ketai/
Considering the constant movement of the comic content by user interaction when holding the device, there was a worry of it overwhelming the narrative. The inability of an user holding the device steady, caused layers to shake too much in the current test settings. Nosebleed Studios would be more inclined to attaching the user interaction on specific content, like the cover, inlay or other material that match the interaction, as in the case with their adapted water-theme illustration for prototype 2 and 3, where the water would move about due to user interaction. They could see much value in people using the interactive comic surface for real-time animated backgrounds in their smartphones, stating that many similar applications were already successful with other themes, tied to franchising and fan content. Personalized comic backgrounds from original comic creators, might be very popular with fans of a specific character or franchise, especially in the comic genre.

Gunnar Krantz saw the prototype as a new way to experiment with old animation techniques, quoting early Walt Disney’s “hold” technique (Thomas & Johnston, 1995) as similar, a technique that involves bringing life to a character even though it is not involved in narrative movement. The technique is defined through animating each frame, even though the subject is static and in between action. If Mickey Mouse is sitting down on a chair, we would interrupt the sensation of flow, if the frame would just freeze, we would immediately assume him to be lifeless. Slightly moving his hair or pose, will keep the illusion of life in the scene. Gunnar felt that separating layer content and manipulating it reminded him of onion-skinning animation techniques found in the vaguely abandoned multimedia software titles, Flash (Adobe, 2013) and Director (Adobe, 2013), since they adopted classic animation techniques early in development. These days, Flash and Director are being phased out of support from the smartphone and tablet giants Apple and Google, instead adopting HTML5 as their standard for web content.

User tests at Serietecknarskolan revealed promising results, with students wanting to partake in future prototypes using their material, seeing marketing value in its presentation qualities. During tests at Sketch Jam several testers could see future of the technique in cutscenes, as many game developers for smartphones and tablets already feature similar styles for their games. Max Weiland stated that he would gladly accept the technology as a consumer format, but would be careful about allowing such user interaction in regard to his own art. As an anecdote, Max Weiland had pursued a similar project in the analog realm, as an art installation.
several cutout slides of matching illustrated/painted art, he suspended them aligned with a slight distance in between each slate. This allowed a visitor to view the art from any angle and see new perspectives, but you could only view the intended perspective from the front, much similar to the technique investigated in this project.

8.4.2 Analysis of prototype 3

Much like attributes found in first-person controllable games (Wardrip-Fruin & Harrigan, 2003), the qualities of the third added axis -Z affecting the content on the smartphone, added new experiences to the testers. It could be compared to the act of gamification (Zichermann & Cunningham, 2011), in that you are allowed to interact and travel within the narrative canvas or frame. Adding specific action events to certain layers or positions in the layer, would further add to the tactile gamification attributes. The motion of the viewpoint affecting the layers, controlled by user interaction, would have to be further adjusted to suit a more subtle effects. After the test results, it can be concluded that “less is more” is a proper suitable quote and would also act as a good indicator, as to how the sensibilities of further prototype development might continue in the future.

Adding user interaction to certain chosen content, like adapting content to motion in the narrative when a character is driving a car or running, would seem natural, as it might heighten the specific action within the narrative at that moment. Since this prototype is constantly feeding data from user interaction, manipulating the comic canvas and content, it sustains the sense of life in the screen. This could be positive and negative, depending on how much movement a comic creator would want in their narrative. It would have to become an user setting that could be activated when needed.

Nosebleed Studio’s opinion regarding packaging the prototype as an application for designers would make sense. Scripting it so that it becomes a droplet or a plugin for Photoshop CS (Adobe, 2013), could tempt comic creators to distribute their work exclusively as a smartphone application, with the user interaction and depth perspective optional to certain content. Not only would such a comic application be exclusive, it would protect their distribution rights and content. On Android it is possible to lock applications purchased to the device ID, therefore limiting copyright infringement.
Without spoiling too much of Moebius and Alexandro Jodorowsky’s graphic novel masterpiece *The Incal* (2009), its narrative structure follows a certain repeating pattern which could possibly be adapted for a novel narrative structure, using techniques developed in this prototype. The reader could be allowed to read it as a frame within a frame instead of a frame after the other, as in conventional comics. Essentially moving through the canvas, unveiling the next event by traveling into the comic, beyond the frame borders. An expanded and improved version of the final prototype application could offer a test version of this kind of novel narrative function.

### 8.5 Proof-of-concept: Eye-tracking and face-recognition

In order to explore further input in combination with the built in cameras on many devices, eye-tracking and face-recognition felt important to explore. Using the *OpenCV* library, an open source code library for analyzing and tracking camera-based data, several tests were performed privately to evaluate if the data could be used towards the narrative control functions of earlier prototypes. Eye-tracking and face-recognition software are today quite common and featured together with most operating systems on mobile devices, smartphones and tablets, like *iOS* (Apple, 2013) and *Android OS* (Google, 2013). Tests showed that face-tracking currently available in libraries for *Android OS* act a bit slow when using the current codebase, with less that stellar update of data input. It would need a proper programmer to optimize properly for this project’s prototype use.

The red box that indicates face detection areas moves around erratically on the screen, indicating that it need optimization in order to function properly in an user interaction context for the smartphone comic prototype.

![Fig. 18: Screenshot of face-tracking test, using OpenCV library and Processing.](image)

25 Film production term for a camera setup on wheel-tracks that glides towards subjects through push.
8.5.1 Analysis of proof-of-concept

Complete non-tangible control is possible through analyzing positioning of a user in front of a smartphone or tablet using the device’s camera. It would allow for additional alternative input using the software libraries offered by the smartphone or tablet maker and operating system supplier. The features should be optimized and coded for fast response, or with spline-curves controlling intermediate movement between coordinates with acceleration / deceleration.

Combined with other sensors, it might add interesting possibilities of intangible manipulation, such as narrative subjects only appearing if a user is close enough to the screen. A proximity sensor would allow similar function in this regard. In *Passive eye monitoring* (2008), R.I. Hammoud discusses *gaze-based interaction* and natural eye movement, as it can be used by people with disabilities, that cannot interact with a device through touch. In regard to this, *gaze-based interaction* might be able to replace some touch-only based interaction that exists in the project prototype presently. It might also add novel sensor functions, like tilting content inside the device without actually tilting the device, using your head-position as controller.
9. DISCUSSION

In this final part of the thesis the results will be discussed from the experiences and results of the research design process. Positive and negative attributes will be compared, promoted or discarded, depending on relevance. The thesis research questions address how creators of comics can allow or control user interaction and distribution of their work, when it is presented on smartphones and tablets. During the project's exploration of these questions, a solution has been designed that gives artists the possibility to convert their work into a copy-protected application that allows multi-dimensional user interaction through a smartphone’s or tablet’s sensors. The final discussion of the project's findings will be addressed through the divided dual perspectives from earlier theory chapters, first from a creator perspective and then an user perspective. Each major outcome has several separate sub-sections in order to highlight the most relevant discoveries.

In this project, two potential end users share the same burning interest on two opposite sides of the delivered format and that has resulted in different angles of interest in the final design. Is the design a tool for artists or a delivery format for readers? From both a reader and an artist perspective, conclusions can be made from user tests, that printed analog products using paper and ink, still rule as the default and most revered delivery format for comics. It could be summarized as a type of creative conservatism, it still has a strong hold of artists, practices and consumers (McCloud, 2000). The final core design decisions, results and needed features, surfaced through the iterative process, it reveals what the artists and users value in this explored touchpoint and what became the “Drawn To Life” technology.

9.1 From a creator perspective

The artists who participated in this project as stakeholders showed an ongoing deep dedication and incentive to develop their skills, try new tools and nurture their creative potential. This was apparent through the various phases of the project and during user tests. Even after evaluating the first prototype, they were seeing possibilities and needs reaching far past what would be possible to solve or deliver within the projects time-frame and scope. A lot of effort was put into considering every creator’s opinion and input, listening to their ideas, finding appropriate solutions and merging control options into every iteration and aspect of the technology. The following three sub-sections will discuss the most essential outcomes and conclusions from a creator perspective.
9.1.1 Interactivity vs artistic integrity

What was ultimately needed to make an artist’s work become “drawn to life”? The basic characteristics of the “Drawn To Life” technology explored, was to retain the artistic qualities of an artist’s work, while at the same time bringing out hidden qualities and new perspectives of that same material by digital means. Whether the artists would work on an analog canvas, drawing their work with charcoal or compositing digital high resolution pixel-art with hundred layers, all their accumulated work is still reduced to a single sheet of artwork viewed consequently, one at a time.

Most of the artists involved in evaluating the technology were afraid the presentation technology would overshadow the narrative content displayed on the portable device screen. They would prefer limited interaction refrained to sparse moments with certain specific or adapted material, like front, back or centerfold pages of a graphic novel. However, they never considered theory and possible functionality of using an infinite canvas (McCloud, 2004). It would allow all content (all pages) to be inserted into a single frame, letting the user traverse through the narrative and content without changing a page. It would require novel ways of thinking how to structure the narrative of the comic during the creation process.

Similarly to powerful compositing software’s creative possibilities, technology can overwhelm and intimidate artists as well as readers, if they do not know how to properly exploit the strengths and capabilities. One could argue that three dimensional space has no place in art that is purely two dimensional when initially created. However, if creators knew about the qualities of the sensor technology and layer motion / separation, they might be more inclined to modify their content in order to work with great narrative effect. In order to adapt, artists different needs must be considered.

In order for artists to convert their work into interactive form, they need easy manageable export tools, guidelines and total control of how to allow or limit user interaction.

The unified criteria that would have to be fulfilled, was how the creator’s artwork would have to be available in a digitally layered form in order to be brought to the illusion of life through animation techniques and separate layers (Thomas & Johnston, 1995). Much like the Disney multi-plane camera needs separate sheets of glass aligned in order to to animate depth and add dimensionality in cartoons, the elements contained in the “Drawn To Life” technology must also be separated in order to function as an interaction. Although, it must be a controlled composition with separated components with a singular unified motive of limited interaction.

According to user tests, specific creator control that restricts certain sensor interaction must be exercised. Manipulating content in a X- and Y- pattern will give subtle effects to content, while moving in the Z-axis will add new 3-dimensional qualities that could inspire new forms of storytelling in comics. With several sensor inputs working together, they could all control a unique narrative feature within the represented comic, essentially representing a sensor network, much like adding artificial intelligence or programmed behavior patterns to computer games (Zichermann & Cunningham, 2011).
In its current form the “Drawn To Life” technology explored is straightforward in how the sensor-data controls narrative and form. Flow, minimalism, pauses and continuity must be considered in order to control the narrative without invading the senses or sabotaging the experience for a reader (Csikszentmihályi, 2008). If an artist adds automatic motion to their digital work by sensor input, it might only be successfully conveyed to the reader, if motion exists within the comic narrative itself (Thomas & Johnston, 1995). As an example, the Nosebleed Studios material used in the prototype had a tropical pirate theme set under water. In this case, the user input from sensors affected how the water moves, giving an floating sensation to the narrative setting.

9.1.2 Digital Rights Management (DRM)

It was discovered early into the development stages that creators wanted total control how their work was used, displayed and distributed online. Putting their work on the net instantly meant they lost all control over that material, but it would become a necessity for promotion and to maximize profits. They felt they gave up certain ownership attributes when they released artwork on their websites, as a result they were suspicious about how digital interaction on smartphones and tablets could limit these possibilities.

Protection of an artist’s intellectual property is critical in order for them to adopt digital distribution.

This aspect was taken into account during prototype development and can be found in the technology developed. Since narrative material is enclosed in an application for Android OS, it can be locked to the unique device number found on that device. To break the protection you would have to reverse engineer or hack the device. Even if the presentation technology is used in a web-browser online, using embedded javascript code, the individual image seen cannot be saved to the hard-drive like common pictures found on the web. A reader would have to make a screen dump of the desktop screen, in order to capture the narrative on screen. Even so, the captured image would only be one instance, one frame of the narrative, since it is moving dynamically in 3 dimensions due to user interaction.

9.1.3 Analog print vs digital screen

The printed format of comics and manga has been a standard and revered way of distribution for many decades. In order for more readers to converge from analog print to a newer digital format, new incentives and features offered by artists can help increase acceptance (McCloud, 2004). The “Drawn To Life” technology can offer such an incentive. User tests indicated that the artist would be the stakeholder with most to gain from the “Drawn To Life” technology, mainly due to their interest in DRM management and distribution. The added interaction, narrative functions and control also bring creative motivation, which support the artist more than the reader. The design process indicated artists having a certain reverence and nostalgia for the analog printed format, which meant skepticism towards newer formats and solutions.
Printed media is still the preferred format of distribution for comic artists and the standard of how to measure success, sincerity and quality.

There are several ways analog print might converge into an enhanced interactive digital version of an intellectual property. Atmosphere and mood are narrative qualities that could be enhanced through user interaction and sensor input, as it could be subtle or intense depending on how the artist has set the input sensitivity to adapt to the content. Through the separation of layers, there is the possibility of re-arranging a linear narrative into non-linear. Switching narrative focus through subtle movements, changing the order of events in real-time. The most revered possibility and enhancement, would be its power to physically connect a reader to the narrative content on a device. The transfer of kinetic energy from the user translated into the narrative on screen, allowing the reader to see his’ or her’s life energy represented and shaped into events and motion inside the comic canvas. Bringing real life into the illusion of life (Thomas & Johnston, 1995).

9.2 From an user perspective

One of the early difficulties in the project was identifying what role the reader would play in regard to the creator and where emphasis at the beginning of development would be weighted. Optimally, the readers’ status would be identified simultaneously with the artist in the design process, defining clear profiles and agendas. The service design co-creation method would help focus divide between the stakeholders and shape the reader input evenly with the artists agendas (Stickdorn & Schneider, 2010). As interviews, observations and user tests were done through out the design process, the reader priorities gradually formed. The following two subsections discuss the main stakeholder interests from a reader perspective.

9.2.1 Reader immersion

In an interactive narrative, a reader has a desire to act, to change and to manipulate. This might symbolize that comic artists would conform to interactive narratives only when first proven that the reader has an active need to manipulate their content. With that in mind, there are specific features that might instigate readers adopting digital comics or manga that use the “Drawn To Life” technology.

The reader is given ability to view and manipulate the narrative frames and layers from different perspectives, moving them around, uncovering previously hidden parts of the content, like characters, objects and locations.

The ability to “move” a elements within the comic or manga canvas, bringing it in or out of focus on the device screen, allows the reader to uncover or hide specific parts of the artwork. It is one feature that would make “Drawn To Life” technology rare in its’ offered feature-set within the specific comic or manga context. To allow the reader to see what is behind objects or characters, also brings the possibility of unveiling purposely hidden information by the artist, like text or additional artwork, which could alter the narratives structure, meaning or outcome.
The reader has the ability to read multilingual narrative content that adapts according to user settings in smartphone or tablet.

By using digital layers and modifying specific content within them, artists could offer the reader their work’s written dialogue in several different languages. These parameters could then be automatically changed by the smartphone or tablet, as the “Drawn To Life” technology could check if a reader would have pre-set language per default in their device operating system. This feature is currently not fully developed in the “Drawn To Life” technology, although it could easily be added. The technology already separates the artwork’s composition into layers with individual properties, hence it would be a simple process of tagging a specific “language” or text layer, which the “Drawn To Life” technology then automatically adapts to, if a reader prefers their native language displayed.

Readers are aware that comics and manga carry strong narratives, involving many different qualities and styles. Strong narratives naturally inherit narrative traits from the past, which might explain why strong narrative techniques of imagery, motion and sound adapt and conform into new technologies, games and mobile devices. As legacy formats die out, new standards are born that readers gradually adopt. Therefore by effect, there is a future for interactive comic surfaces. There is an inevitability of change in all technology, but art and narratives are timeless (Cooper, 2007).

9.2.2 Consumer habits

Comics have a long running user base of fans and dedicated consumers that are used to the smell, texture, feel and fidelity of printed comics, manga and graphic novels. At the same time readers are more open towards variables regarding consumer delivery formats and changes in narrative structure and storytelling (Jenkins, 2006).

The reader adapts easier to new technologies and delivery formats than an artist adapting to distribution and narrative tools.

When Apple’s iPhone was released in 2007, users quickly adopted the device, as it simplified processes, streamlined functions and was impressively presented. The “Drawn To Life” technology could very well incline more users to adopt its’ format, since it invites simple interaction and motion to a previously static medium. Readers of comics and manga refrain from taking initiative in how a delivered format should be, many accept the artists final representation of the narrative, as results from user tests supported. In this regard, it might be up to the artist to initiate a new kind of presentation, in order to attract new readers and consumers.
9.3 The future

Considering the commonality of the smartphone in the world today, its growth the last 5 years since the grandeur of Nokia, it is hard to imagine where we will be in another 5 years. Within a couple of months, the next iteration of the Google Nexus 7 with retina display is rumored to be released\(^26\), offering yet another tablet on the market with very high dot resolution. This could lead the way to yet another step up in proficiency regarding how comics could be presented in a more accurate manner on smartphones and tablets. There are also advances being made in screen types and technology regarding texture, thickness and shapeshifting screens\(^27\). There are already prototypes of screens with the density of paper that can be folded and display extreme contrast, much like printed paper. With screen technology like this, “drawn to life” could find increased leverage of interest, in regard to tangibility and fidelity approaching the level of the printed analog distribution formats.

9.3.1 Performance issues

Regarding the state of the prototype there are several issues that need to be addressed in order to achieve higher fidelity. A proper coder needs to optimize the memory bandwidth and buffering of the OpenGL graphics acceleration, so that high resolution artwork would buffer correctly without performance degradation in frame-rate. The code of movement must also be corrected in order to allow additional individual layer manipulation, spline-curve movement, blur- or line-sharpening effects.

9.3.2 Distribution system

If the project’s final design prototype and service is analyzed from a possible open source perspective, the reader’s creative influence of use might differ. Making a software user guide for independent comic readers who want to modify existing content, could bring interesting prospects of alternative use, and this could expand once it is used for other material than comics, like enthusiast photography. There are some issues that would need to be addressed if photography should adopt the “Drawn To Life” technology. Most digital photography hardware and cameras in smartphones today, use very high resolution sensors, like 8-16 megapixels (up to 4000x3000 pixels in size). At the moment, the “Drawn To Life” technology only handles resolutions up to 1280x800 pixels, which means it would need additional coding optimization in order to be introduced to photography enthusiast or commercial market.

9.3.3 Digital sweatbox

For artists, this design solution could also act as a digital version of a sweatbox (Thomas & Johnston, 1995), an analog animation tool used at Disney Studios in the 1940s to help indicate possible changes, paths and planning of animation in a film. Artists could use this design to prepare and plan for possible animation techniques, if planning to adopt other forms of

\(^{26}\) http://opencv.org/
\(^{27}\) http://gigaom.com/2013/05/10/take-that-ipad-mini-retina-display-nexus-7-at-google-io-says-analyst/
narratives or artistry. Even though there are several features similar to a “digital sweatbox” in modern compositing tools like *Photoshop CS* (Adobe, 2013) and *Manga Studio* (Smith Micro Software Inc., 2013), there are few available within the portable device market.

### 9.3.4 Compositing software plugin

In the coming months there will be further exploration into the construction of a plugin, script or droplet, so that artist would be able to export an application directly from within their compositing software of choice, like *Photoshop CS* (Adobe, 2013). There will also be investigations into how the technology could be adapted for promotion events through projection and flat-screens using large area sensors, as well as how it would work as a user controlled customizable dynamic background on *Android OS* devices.

### 9.3.5 Integration into other systems or services

Since the prototype technology is coded in a linear structure using javascript, it would easy to migrate into a other software integrating it inside a package of other software features, building a custom presentation application. As an example, it has the possibility to be outsourced code that could be licensed within other comic distribution solutions like *ComiXology* or *Marvel*. It could act as a visualization in between loading-screens of other software, or as a preview function within a comic online shopping network or application. Even though the developing platform is *Android OS*, it should not require much effort to adapt the codebase for other portable operating system environments, like *iOS* or *Windows 8 Portable*. It would need sufficient expertise, proper coding experience and additional financial resources supporting its development.

### 9.3.6 Developing a full service around explored touchpoint

Using a fully holistic and complete service design process, this technology could find its way into becoming one vital touchpoint amongst several others supporting service elements within an graphic distribution context. Considering it has the built in Digital Rights Management (DRM) functionality, it could stand on its own in any service context of visual content delivery. If a complete service was to be built around this technology, it could serve as presentation solution for various collections of real-world installations (artwork, photography etc) that need dynamic specific tailored and copy-protected container services for their distribution. In that case it could have several side-services that connect to make the experience more pleasant. It could be thematic shopping applications of digital comics allowing content previews using “Drawn To Life” technology. There might be connecting system functions allowing similar side-products and merchandise from the same distribution network, like desktop backgrounds, games, toys and films. It depends solely on how the service design can adapt the “Drawn To Life” technology and code for certain other system components.
This project has explored possibilities of allowed user interaction when presenting comics, manga and graphic novels on smartphones and tablets. It was done using mainly a service design approach to cater two opposite perspectives, the artist and the reader.

In collaboration with Nosebleed Studios, Serietecknarskolan and several other relevant stakeholders, I developed a “Drawn To Life” technology that allows copy-protected distribution of intellectual property. Through the technology, I have demonstrated the possibility of converting digitally layered artwork to become dynamically interactive in four dimensions, on devices using the Android OS.

Through the design process and user tests, I can argue that artists of comics and manga are positive towards allowing limited user interaction to their work, as long as they can control distribution through Digital Rights Management (DRM).
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Figure 3: Two promotional posters for the UNIME collaboration project (2013)

Figure 4: Screenshot of compositing software Easy Paint Tool SAI and the use of layers to create composition. (Smith Micro Software Inc., 2013) Available: http://1.bp.blogspot.com/_jWcV-X08gqk/TIrSRSljHMI/AAAAAAAAARA/1ThXYlO0ll8/s1600/Well_PaintTool_SAI_by_Tasted.jpg [4/10/2013]

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Figure 7: Screenshot of the arcade game Defender (Williams, 1982) Available: http://www.virginmedia.com/images/defender.jpg [4/10/2013]


Figure 11: Parallax layers displayed separated in 3D space, showing perception, depth and distance calculation layer-to-layer. Available: http://upload.wikimedia.org/wikipedia/commons/8/82/TWW_parallax_scrolling_sample_1.jpg [4/10/2013]

Figure 12: Screenshot of the first simple HTML5, javascript and WebGL prototype. [3/20/2013]

Figure 13: Photo of Creative Carnivale / Sketch Jam user test. [3/27/2013]

Figure 14: Screenshot of the 2nd prototype using Processing with embedded code and 3D acceleration. [4/15/2013]

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Figure 16: Photo of Nosebleed Studios evaluating their material used in a final prototype user test. [5/12/2013]

Figure 17: Photo of Nosebleed Studios evaluating their material used in a final prototype user test. [5/12/2013]

Figure 18: Screenshot proof-of-concept test using face-tracking, OpenCV library and Processing. [4/20/2013]