SEGMENTATION OF PANELS IN D-COMICS

XINWEI WANG

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XINWEI WANG
王欣慰

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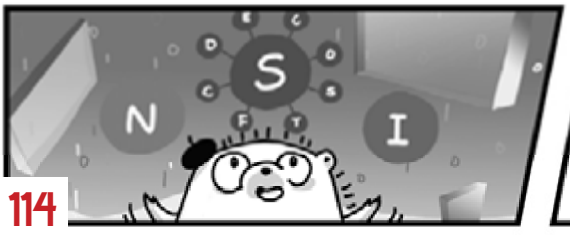

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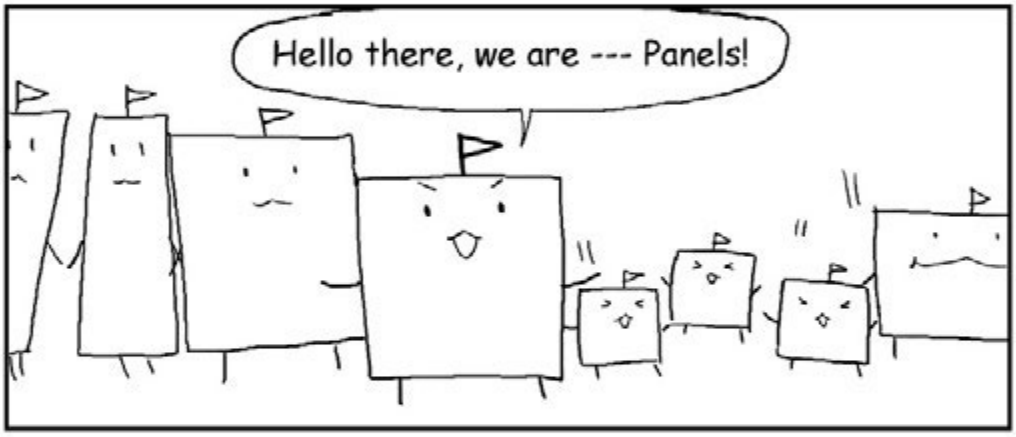
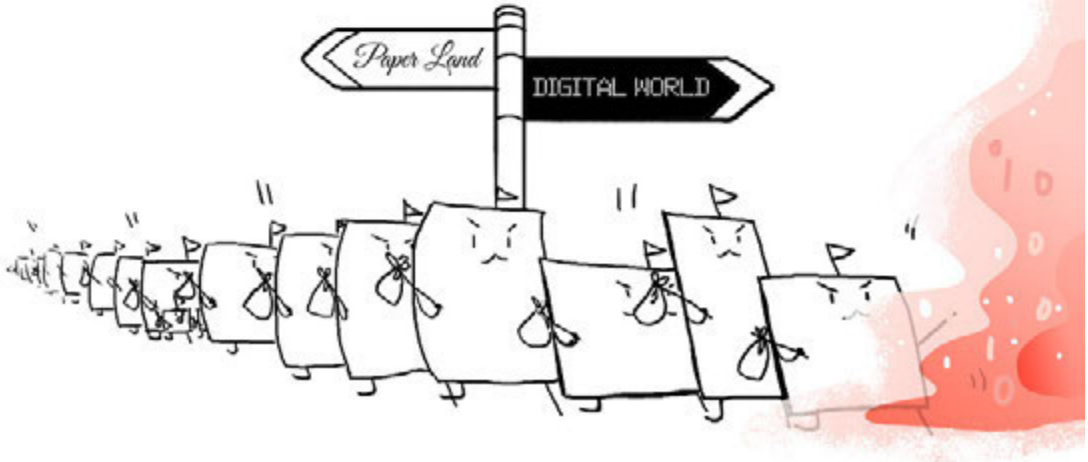


And this is a story of us panels migrating from the paper land to the digital world.



PREFACE

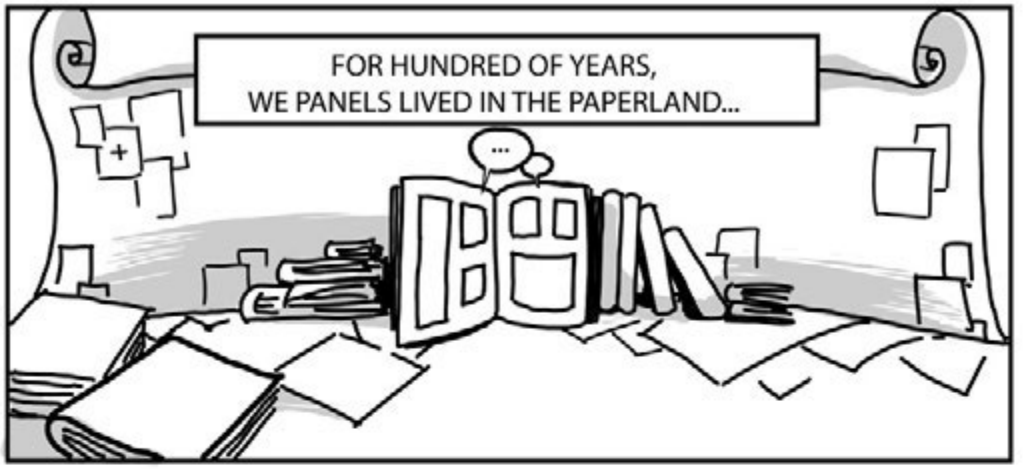
A Story of Panels

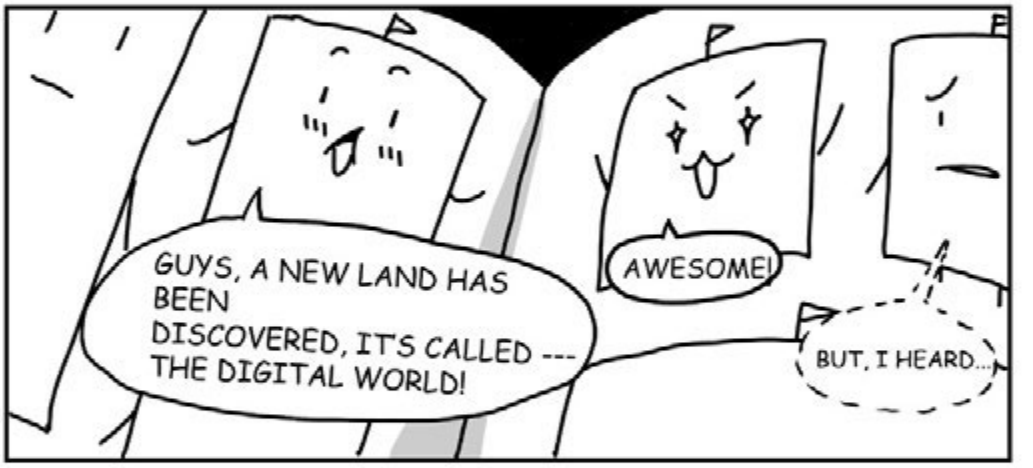
Every story needs a protagonist. The protagonist of this dissertation is not the abstract concept of comics, but the *panels* (a discernible visual area that contains a piece of the author's storytelling interpretation in comics, see Section 2.2) that construct comics. Each panel is comparable to an individual human being: the shape can be short, tall, slim or fat; the appearance can contain different drawings and colours; the content that each panel conveys can be comparable to various personalities such as peaceful, encouraging, sad or romantic. Where do the panels come from? What are the panels made of? What's the purpose of their existence? These are some questions we may be curious about when meeting the panels, just like meeting a group of people.

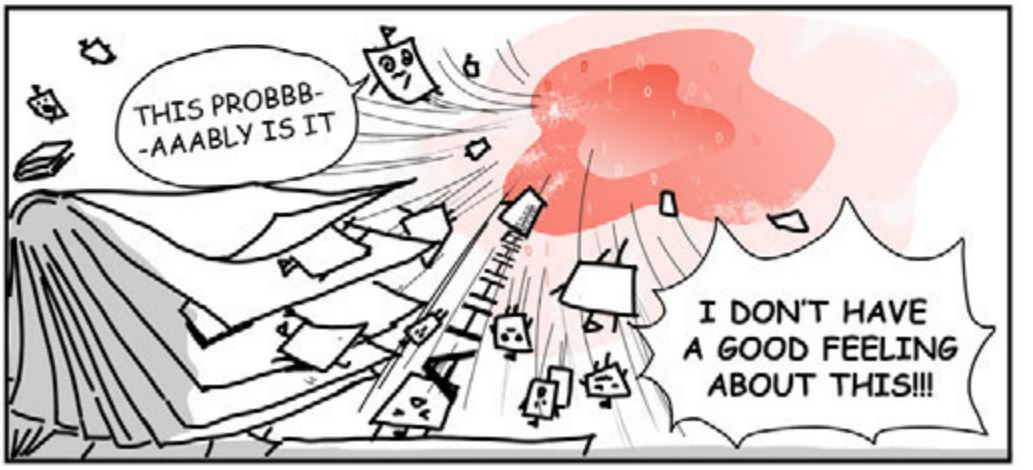
The living condition of panels has been undergoing rapid change since 1985, along with the development of the World Wide Web (Garrity, 2011). Panels have been living on printed papers for over hundred years. But since electronic technologies and the Internet became widely available, a new world opened up for panels: a digital environment enabled by electronic devices. What does this new world look like for panels? What will happen to the panels? Can panels survive in it? Will the relation of the panels change?

This is the story which this dissertation aims to tell. In fast-changing times, the panels are on their journey to explore boundaries and discover possibilities.

Welcome to witnessing this adventure!


FOR HUNDRED OF YEARS,
WE PANELS LIVED IN THE PAPERLAND...
...


GUYS, A NEW LAND HAS BEEN DISCOVERED, IT'S CALLED --- THE DIGITAL WORLD!
AWESOME!
BUT, I HEARD...


THIS PROBBB--AAABLY IS IT
AHHHH
I DON'T HAVE A GOOD FEELING ABOUT THIS!!!

CHAPTER 1

Introduction

Story is not only our most prolific art form, but also rivals all activities — work, play, eating, exercise — for our waking hours. We tell and take in stories as much as we sleep — and even then we dream. Why? Why is so much of our life time spent inside stories? Because as critic Kenneth Burke tells us, stories are equipment for living (McKee, 1997).

Storytelling, as one of the earliest human activities for communicating thoughts, can be conducted through different communication channels. According to McLuhan, the medium is the message (McLuhan, 1994). The ***message*** from the author can be communicated in various media such as novels, comics, animations, movies, and games. Comics, as a storytelling medium, is[1] described by Cohn (2005) as "the industry that produces comics, the community that embraces them, the content which they represent, and the avenues in which they appear".

Based on a long interest in comics (Section 1.1), we have observed that within the comics industry there is an increase in the consumption and production of digital comics (Section 1.2). Although there exist several exploratory practices and research studies (Section 1.3), there is no existing theory about digital comics, nor large industrial production.

1.1 Personal motivation

I was born in the mid-eighties. Personal computers and the internet started to be popular when I was around ten. Then the smart mobile devices became common in my twenties. I grew up with great enthusiasm for reading comic books. I still read comics, but mainly with smartphones and tablets.

My passion for comics is partly because of the story and characters. There exist so many comics, and therefore so many story worlds and different characters. For an individual living in this reality, I gained knowledge and experience by reading comics.

The display method with mostly images and some text is also what I prefer. I can sense richer information and emotion through images than plain text. It is a pleasure to enjoy the artwork as well: the drawings, the compositions, the layouts, etc.

1 This dissertation considers comics as one type of the storytelling medium, and therefore addresses comics normally with a singular form.

Since comics are constructed by static images, it is up to me to decide the reading order, the duration to stay on a particular image, the time to think and digest. What can happen between this panel and the next panel? What's there on the next page? I'm always full of curiosity and expectation once I start reading comics.

Moreover, comics have become one expression method for me. I grow up with gaining more experience and understanding. But I have no intention to describe the experience and understanding with complicated words. I want to transfer those into simple, maybe entertaining comic stories.

The development of technology in the last thirty years has brought many changes to the comics industry. For example, many comic authors are now making comics with electronic tools. Many printed comics have been scanned into the digital environment so that more readers can gain access through the internet instead of obtaining physical books. On the one hand, I believe that the digital environment and electronic devices should contain new space for creating comics; on the other hand, I feel the reading experience of many existing comics displayed on the screen is still limited compared to printed comics. With the hope of continuously having high-quality new comics to read, this research has been initiated.

1.2 Industry background

> *People sometimes say that physical books have qualities that do not transfer well to digital. We want to show that digital has narrative qualities that cannot transfer to print. … For instance, books which are written for the web can be: data-led, locative, generative, algorithmic, sensor-based, fluid, non-linear, expandable, cookie-ish, personalised, proximal, augmented, real-time, time-sensitive, adaptive, collaborative, and share-y (Visual Editions; Google's Creative Lab in Sydney; Universal Everything, 2016).*

Generally speaking, the comics medium is widely spread in the world both location-wise and culture-wise. The bigger comics markets include North America, Japan and Europe. Taking the Japanese market, for example, according to a recent report from the All Japan Magazine and Book Publishers and Editors Association (AJPEA) published in 2017 (All

Japan Magazine and Book Publishers and Editors Association, 2017), the estimated sales of the comics (manga in Japanese) industry in Japan amounted to 445.4 billion yen (about 4 billion US dollars), in 2016. It reached a 0.4% growth compared to the previous year's 443.8 billion yen. The total sales can be divided into two parts: comics printed on paper (including print comic books and magazines), and comics displayed on electronic devices (including digital books and magazines). The sales of printed comic books were 194.7 billion yen (dropped 7.4% compared to 2015); the sales of printed comic magazines were 101.6 billion yen (dropped 12.9%); the sales of digital comic books were 146 billion yen (increased 27.1%); and the sales of digital comic magazines were 3.1 billion yen (increased 55.0%).

The comics industry involves a wide number of participants, such as authors, editors, publishers and readers. It also contains a diverse range of story types, such as adventure, biography, romance, mystery, folk tales, horror, fiction, superhero, etc. (McCloud, 1993), which have all been explored in a vast number of productions.

As exemplified by the previous report about the Japanese comics industry, the sales of printed comics are dropping, while the sales of digital comics are increasing. In 2011 one of the biggest book retailers in the world — Amazon.com — claimed that e-books are outselling printed books (Amazon.com Inc, 2011). The rise of digital comics can be traced back to the moment when the personal computer and the Internet started to become popular: examples of pioneers in digital comics can be found from 1980 onwards (Garrity, 2011). The transition from printed comics to digital comics contains varieties that can be categorised as (1) digitalised versions of existing printed comics, and (2) exploratory digital comics made for the digital environment and electronic devices.

Firstly, when digitalising existing printed comics the paper-based comics are scanned and saved in the digital environment, and a display strategy for the electronic device is created. There exist many online comics websites that scan the printed books and show the image page by page. The main problem with this strategy is that there is a size difference between the original carrier[2] (paper) and the new carrier (electronic device with a screen). Consider displaying the same page on a smart phone screen of 4 inches and the display of a personal computer of 27 inches. If the screen is bigger than the page, there will be space left on the screen if the original resolution and the length-

2 The term the carrier of comics used in this dissertation refers to the physical vehicles (such as papers and screens of electronic devices) that can carry the drawings of comics and present comics to readers. Duncan et al. (2009) addressed it as the medium of comics. However, since the word medium can also be considered as the singular form of media, the word carrier was selected to emphasise the concrete physical existence, to distinguish it from the abstract concept media.

width ratio are maintained. If zooming the original page to fit the screen, the image will be stretched and may lose readability. If the screen is smaller than the page, then the image has to be compressed to fit the screen, or cannot be displayed fully. One solution for this way of digitalising comics is the guided view. As explained by the company who developed it: "comiXology's patent-pending Guided View™ technology allows readers to view a comic on a panel-by-panel basis suitable for mobile devices in a way that mimics the natural motion of the user's eye through the comic (ComiXology, 2014)". The guided view provides a panel delivery method on electronic devices for reading comics based on the printed comics. Reading comics (including comics, graphic novels, and manga) on electronic devices (such as iPhone, iPad, Android tablet, and Kindle Fire) is possible with the support of the comiXology application.

Secondly, there is the option to explore how digital comics can be specifically created for the digital environment on electronic devices. There are many examples of explorations of new tools for creating and making digital comics. Web-based comics (webcomics) (such as PHD Comics (Cham, 1997) and Zen Pencils (Than, 2012b)), and many Korean webtoons (webcomics) (Cho, 2016) are positioned on a horizontal or a vertical canvas. This canvas could never fit on one physical paper but can fit in the web page. For example, in the *Bongcheon-Dong Ghost* (Horang, 2011) a vertical linear panel layout was developed, where the reader needs to scroll/pan the canvas on the screen to follow the story. Another example is *The Boat* (Huynh, 2014), which not only applies animation and sound effects, but also splits the background images and foreground panels. When scrolling, the background and foreground appear with relative moving speed, which creates a unique reading experience. Goodbrey's work such as *PoCom-UK-001* (Goodbrey, 2003) and *A Duck Has An Adventure* (Goodbrey, 2012) are typical examples where the next panels are shown after clicking on the current panel. McCloud's project *The Right Number* creates the possibility to dive and zoom into the narrative experience by placing the next panels in the middle of the current panel(s) (McCloud, 2003). Arhanta Comics published several "responsive comics" online (Nascimento, 2017), the comics can have different layouts based on different screen sizes. The term responsive comics is adopted from responsive web design to arrange content for different devices and screen sizes.

Other explorations are designed for specific electronic devices, especially touch-screen tablets. The story *Meanwhile* (Shiga, 2014) provides the reader with a reading experience by selecting the narrative branches. *Niko and the Sword of Light* (Imaginism Studios / StudioNX, 2013) contains not only the possibility to trigger static panels, but also some animated panels. *Modern Polaxis* is a combination of a print comic book and an aug-

mented reality app. Sutu (2014) uses the printed book as a reference, and hides the narrative itself in augmented reality. Moreover, an online video shows an ongoing project of creating a comic reading mechanism in virtual reality (VR Forum, 2015).

To summarise, the transformation from printed comics to digital comics is a continuous trend. There already exist many examples in the comics industry. The understanding of designing digital comics should be further studied.

1.3 Academic background

The existing research of comics is based mainly on comics in the form of printed books. Several seminal introduction books can be found, such as *Comics and Sequential Art* (Eisner, 1985), *Understanding Comics* (McCloud, 1993), *Why is Manga Interesting* (Natsume, 1997), *The System of Comics* (Groensteen, 2009) and *The Power of Comics* (Duncan, Smith, & Levitz, 2015). Other studies apply a more scientific approach to examine the construction of comics, such as The Visual Language of Comics (Cohn, 2013b). Together with other academic articles, this body of knowledge can provide fundamental insights into understanding comics, and can function as a starting point to compare the difference between printed comics and digital comics.

Besides the major role of storytelling, comics are applied in other areas such as: comics as product/procedure instructions (Mallia, 2007); comics as storyboard for the design process (Dykes et al., 2016b; Van der Lelie, 2006); comics as overview of movies (Tobita, 2010) or games (Chan et al., 2009); comics for education (Cimermanová, 2015; Green & Myers, 2010; Jacobs, 2007; Moraveji, Li, Ding, O'Kelley, & Woolf, 2007; Tatalovic, 2009); comics as online communication tool (Kurlander, Skelly, & Salesin, 1996); and comics as a medium to communicate research and design (Dykes et al., 2016a, 2016b). These studies can provide insights into the boundaries of comics, and a comparison with other storytelling media.

The term ***digital comics*** (***d-Comics***) used in this dissertation refers to the comics that are specifically created for the digital environment and are displayed on electronic devices. This term has been previously addressed by McCloud (McCloud, 2000) and Goodbrey (Goodbrey, 2013). Existing research about d-Comics is very sparse. McCloud wrote a printed comic book called Reinventing Comics (McCloud, 2000) to discuss the future of comics. Many of his predictions have now been realised: some of these are introduced in Section 1.2 and Chapter 2 of this dissertation. Goodbrey studied d-Comics while being a practitioner and a creator of digital comics. He pointed out that the key to understand-

ing d-Comics is about the change of space (Goodbrey, 2013), which refers to the display space that paper printed comics and digital comics ("medium" in Goodbrey's words) can offer. With this understanding, Goodbrey discussed three major topics under this change: pages versus windows, page turns versus panel delivery, and space versus time. These references will be further discussed when considering the design space of d-Comics in Chapter 2.

Several scholars have concerns about d-Comics. Groensteen claimed that the "spatio-topical system" of printed comics is hard to be captured in d-Comics (Groensteen, 2009). McCloud and Goodbrey — although positive — also mentioned many limitations of the existing explorations of d-Comics. For example, the distractions of music and animation (McCloud, 2000), or the limited control possibilities for the user when using the guided view panel delivery (Goodbrey, 2013).

However, it is a fact that the digital environment and electronic devices have an advantage for comics. For example, a reader can gain access to a vast amount of d-Comics content with a small electronic device through the Internet while remaining mobile. Furthermore, the images in comics can be searched with keywords, although this is currently limited to text or image instead of bridging the two formats. However, if the metadata such as keywords and descriptions are created, the reader could find the relevant d-Comics content by searching. In printed comics, the reader would probably have to flip through many pages to find the intended content.

Although the research of digitalising comics is limited, there are many studies conducted in related fields. For example, research about electronic devices, research about digital interface design (Mayhew, 1992; Rauterberg & Szabó, 1995), and research about interaction design (Lim, Stolterman, Jung, & Donaldson, 2007; Preece, Sharp, & Rogers, 2015). These can all be considered as references when discussing the research of digital comics.

1.4 Outline of the dissertation

This dissertation began from the carrier transition (from print to digital) point of view (**Chapter 1**), and investigated the design space of displaying d-Comics with a mixed research approach.

Although the digital environment and electronic devices can bring benefits to the comics industry, there are many difficulties of creation and migration. After establishing the state of the art of this research (**Chapter 2**), we took the approach of investigating the difference caused by different carriers. In order to find out how to design d-Comics for the screen-based electronic carriers, the main research questions have been defined as: ***Is there a segmentation unit existing in d-Comics similar to the page in printed comics? What method can be used with the new carrier to express this unit?*** The research questions were further broken down into two sub-questions: (Section 2.5).

Q1: How is a panel sequence segmented in d-Comics?

Q2: What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?

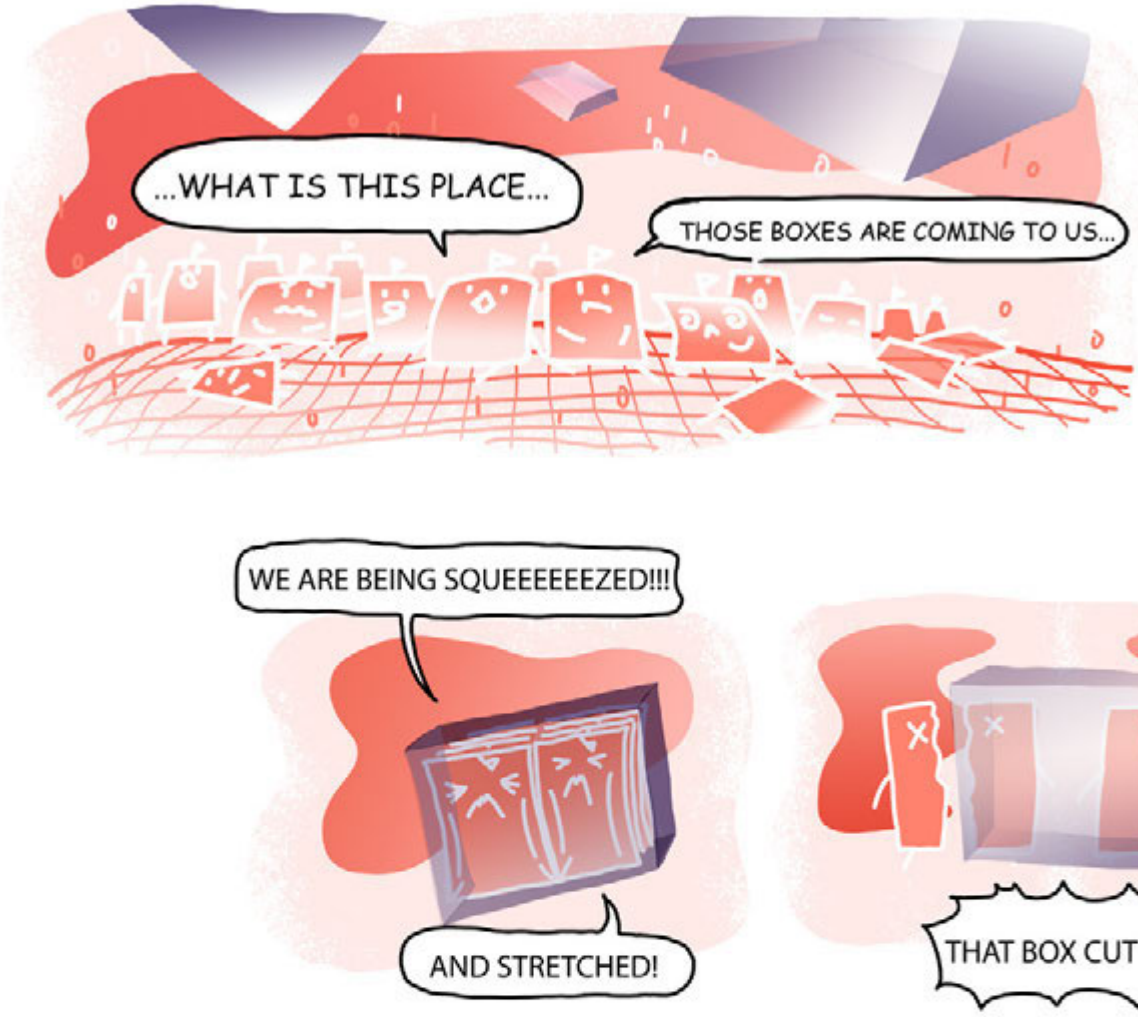
Chapter 3 investigates the first research question by conducting an online experiment to ask readers of d-Comics to segment the panel sequences (Section 3.2). The result of this experiment answers the first research question (Section 3.3, Section 3.4). A new vocabulary is created to address the different status of the segmented panel groups in d-Comics: phasel, fadel and phasel gap (Section 3.5).

Chapter 4 further justifies the strategies of segmenting the panel sequence in d-Comics. Section 4.1 reviews the existing research about segmentation in comics. A second experiment is conducted to evaluate the segmentation strategies (Section 4.2). The result (Section 4.3, Section 4.4) establishes two strategies for creating segmentation in d-Comics: narrative structure and spatial arrangement. Interaction as a potential strategy is addressed but not investigated (Section 4.4.3).

Chapter 5 applies the vocabulary and the two strategies to investigate interaction as a third strategy with the third experiment (Section 5.2). The result (Section 5.3, Section 5.4) verifies interaction as being a strategy for panel sequence segmentation in d-Comics, and therefore the answer of the second research question is updated.

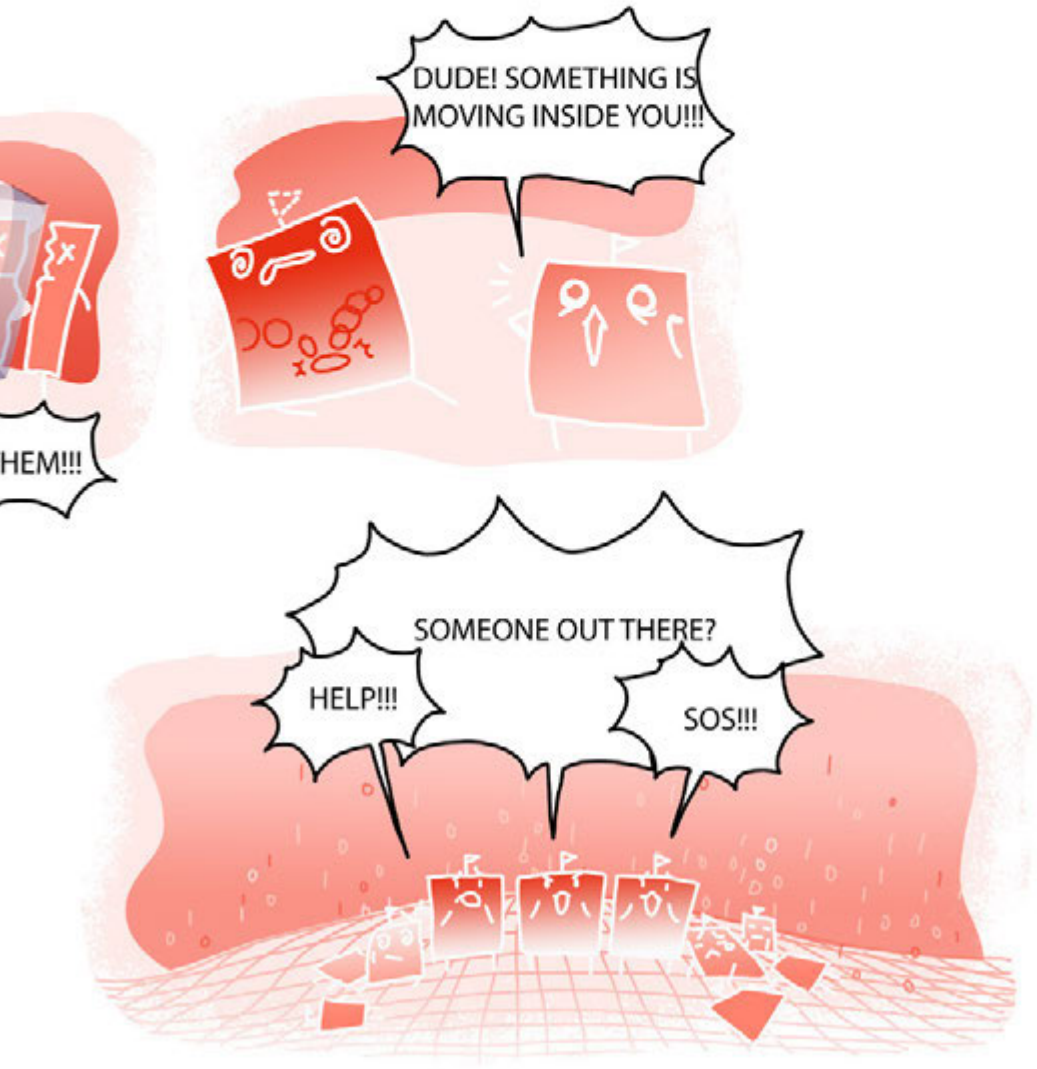
Chapter 6 concludes the findings from the empirical studies. Section 6.1 includes the answers to the two research questions. Section 6.2 distinguishes the findings from d-Comics with printed comics.

Chapter 7 includes the limitations of the research (Section 7.1), further discussion of the understanding of d-Comics, and the related territories based on the study of segmentation (Section 7.2), and future work (Section 7.3).


...WHAT IS THIS PLACE...
THOSE BOXES ARE COMING TO US...
WE ARE BEING SQUEEEEEEZED!!!
AND STRETCHED!
THAT BOX CUT T

CHAPTER 2

State of the Art



This chapter aims to frame the research question by bringing forward research and practice about digital comics. Section 2.1 gives an overview of comics as a storytelling medium. As part of this overview, the following topics will be discussed: what a "story" ("narrative") is, the definition of comics including related attributes, the genres, the historical developments of comics, the creation process of comics, the difference between "narrative" and "author's interpretation". This overview leads to a focus on two important aspects of comics: panels as the crucial unit of comics, and, two major carriers of panels (i.e. printed paper books and electronic devices). Section 2.2 establishes a point of view that panels are the building blocks of comics. This section introduces the role of panels in comics, discusses the definition of panel and summarises the visual elements that can be included in a panel. Section 2.3 introduces the differences between placing panels in printed paper books and the digital environment in electronic devices. In printed paper books there are natural segmentations[1] of the panel sequences, due to the existence of pages. This causes the panels to form spatial groups which are dependent on the specific pages. However, in the digital environment, there is the opportunity to design layouts which don't make use of the page-based layout. Therefore, in Section 2.4 the implications caused by the carrier difference are further described. These are the segmentation of a panel sequence and the required interaction of the reader to move through segmentations. This chapter concludes in Section 2.5 with detailing the main research intent of this dissertation: to discuss how to design for d-Comics by investigating the relation among panels in the digital environment. Three research questions are raised in the end.

2.1 Storytelling & comics

The increasing number of studies in comics during the past thirty years (Section 1.2) reflects the significant strides of understanding the mechanisms underlying comics. Because American comics, European comics, and Japanese manga have been very influential, most of the existing studies are written in English, French and Japanese (Cohn, 2013b; Duncan et al., 2015; McCloud, 1993). Due to the time and language limitations of the author, this dissertation mainly focuses on introducing comics studies written in/translated into English.

1 The word "segmentation" means "Division into separate parts or sections" (Oxford English Dictionary, 2017b). In this dissertation, it refers specifically to how a panel sequence is divided into multiple panel groups. The choice of the term is to be coherent with the terms discussed in Section 4.1.

2.1.1 Comics as a storytelling media

A narrative is a "spoken or written account of connected events; a story" (Oxford English Dictionary, 2017a). Storytelling, as one of the earliest human activities for communicating thoughts, can be conducted through different communication channels. McLuhan described media as "extensions of man" and listed comics as one of the media, together with many such as photography, games, movies, radio and television (McLuhan, 1994). Comics pioneer Will Eisner has illustrated the different storytelling media through history (Eisner, 1985). A narrative can have different media formats. For example, A Song of Ice and Fire[2] can be written in novels as text, created as print comic books, filmed as a TV series, generated as video games, etc. These communication channels share the same core conceptual narrative, but, due to their differences, have their unique forms and carriers. For example, the novel (one volume) is written in English text: the form is British English which has its grammar and vocabulary, and the carrier is a page-based physical book which has its size, weight and other physical properties.

What characterises "comics" as a medium? Eisner (1985) described it as a sequential art — "the arrangement of pictures or images and words to narrate a story or dramatize an idea". McCloud (1993) defined comics as "juxtaposed pictorial and other images in deliberate sequence, intended to convey information and/or to produce an aesthetic response in the viewer". In an online review of Groensteen's *The System of Comics*, Neil Cohn (2008) remarks, "he identifies 'comics as a language,' a 'system' that arises out of the 'combination of a … collection of codes,' most strongly motivated by 'iconic solidarity'". In spite of the ongoing debate on the definition of comics, the core feature — the "sequentiality of images" — is discussed in all the publications referred in this paragraph.

The word "***comics***" is, in common knowledge, mainly referring to printed comics. With the development of print technology from the 19th century, sequential panels started to be printed in newspapers, magazines and books (McCloud, 1993; Duncan, 2015). From 1980 onwards, when the personal computer and the Internet started to become popular, examples of pioneers in digital comics can be found (Garrity, 2011). It is still debated whether the ancient cave paintings, Egyptian hieroglyphs, Trajan's Column, Greek paintings and Japanese scrolls can all be considered as comics (McCloud, 1993). But it is clear that the history of comics is strongly connected to the development of the technologies that support their creation, presentation, and distribution.

2 A Song of Ice and Fire is a series of fantasy novels by the American novelist and screenwriter George R. R. Martin, the first of which is A Game of Thrones.

2.1.2 Creation of comics: Narrative vs author's interpretation

For a reader, comics might be a printed book or a file that occupies a few megabytes of storage on an electronic device with a screen. However, to the authors, comics are the result of a creation process that takes a tremendous effort.

To communicate a narrative, the author has to carefully consider how to convey it. The same narrative is not equal to the presented panels. In other words, it depends on individual authors how a narrative is interpreted into comics. This interpretation is a personal process from the conceptual ideas in the author's mind into visible concrete comics. One example that illustrates this was an online event of creating comics hosted by a comics author, Hotta, called the Hajiman Challenge (Hotta, 2013). The rule was that Hotta provides a piece of narrative written in text, then participants can create short comics accordingly. The collected comics vary among all the different participants. Although all the created comics were based on the same initial narrative, different participants created different numbers of panels, different combinations of panels, and different images to show within the panels.

This dissertation will address this process as the author's interpretation. The author's interpretation is an overall arrangement of the message the author wants to convey with comics. The interpretation is richer than the narrative only. It contains the author's personal choice of how to convey the narrative, such as the choice of the moments in the narrative, the order of the moments, the drawing style, the camera angle, even the personal preferences for certain characters or actions.

Several authors and researchers developed theories about creating comics (Eisner, 1985; Groensteen, 2009; McCloud, 1993; Natsume, 1997; Tezuka, 1996). These theories are mainly about storytelling methods and drawing techniques. McCloud introduced The Six Steps and The Five Choices which can cover the different stages in the comic creation process. The Six Steps include: idea/purpose, form, idiom, structure, craft, and surface (McCloud, 1993). For example, the author can start with an idea of telling a story to praise courage (idea/purpose). The author chooses the form of telling the idea with a sequence of panels (form). Then an adventure type of story is decided (idiom). The narrative structure can be considered as three stages: the hero was living a normal life; danger forced the hero to go to the adventure; the hero concurred the danger and gained a happy life (structure). The author chooses to craft the story with a realistic drawing style, black and white with limited screen tone, and arrange the layout of panels (craft). And the surface is about the production values and appearance. McCloud claimed that the

process doesn't have to follow a linear order, or include all the steps. The Five Choices refer to: choices of moment, frame, image, word, and flow (McCloud, 2006). The "choice of moment" is related to the narrative structure. The "choice of frame" is about choosing the right distance and angle to view the moments. The "choice of image" is about rendering the characters, objects, and environments in those frames clearly. The "choice of word" is about picking words that add valuable information and work well with the images around them. The "choice of flow" is about guiding readers through and between panels on a page or screen. McCloud further elaborated that creation doesn't have to follow a predetermined order. The comics can also begin with an interesting sentence or a single image. Most comics artists juggle all five choices as needed.

The author's interpretation exists in every step and choice, but not all of the steps and choices can be directly seen by the reader when reading comics. The creation of comics contains two parts: the author's interpretation that can be visualised through comics, and the author's interpretation behind the visualised comics (such as a deliberately blank moment in the narrative between two panels). Therefore, panels in comics can represent narrative, but the visualisation of panels on certain carriers also contains additional information from the author's interpretation (such as the author's choice of flow). The following two sections will further introduce two keywords — "panels" and "carrier".

2.2 Panels in comics

This section will continue investigating the format of comics as a medium, most of all, the panels as the building blocks of comics (Section 2.2.1), and the visual elements of panels (Section 2.2.2).

2.2.1 Panels as the building blocks of comics

Duncan et al. (2015) defined panel in comics as "a discernible area that contains a moment of story". This definition touches another controversial topic in comic studies: time. Most scholars, such as Eisner, McCloud and Natsume, indicated that a panel should represent a specific moment of the story (Eisner, 1985; McCloud, 1993; Natsume, 1997). Cohn challenged this point of view by bringing up many exceptions. For example, there are situations where the narrative is not strongly driven by time or where the starting point, duration, and ending point cannot be clearly contained inside one panel (Cohn, 2010). Therefore, whether a panel should always represent time in a story remains a question.

As to the role of panels in comics, and the relation among panels, there exist the following opinions:

» McCloud describes six types of panel-to-panel transitions (moment-to-moment, action-to-action, subject-to-subject, scene-to-scene, aspect-to-aspect, and non sequitur) (McCloud, 1993).

» Natsume (Natsume, 1997) summarises three core functions of panels: separating time to provide the reading order, creating a psychological feeling of compression, and using the spatial expression to support the meaning of the drawings by providing boundaries. Beyond these three main functions, Natsume also introduces many unique spatial arrangements of panels. For example, in Shojo manga, panels sometimes are deliberately arranged in an unclear reading order to express uncertainty such as during a dream or a memory. Another example is that panels can overlap to indicate a certain connection in the narrative.

» Groensteen introduces "six important functions of the frame, which I call the function of closure, the separative function, the rhythmic function, the structural function, the expressive function, and the readerly function" (Groensteen, 2009). Groensteen uses the word "frame" to distinguish from the "contents of the panel" (Groensteen, 2009). Moreover, Groensteen introduces a study entitled Les aventures de la page (translates as "The adventures of the page") from Benoît Peeters, which doesn't have an English translated version. "In this text, Peeters distinguished four conceptions of the page, respectively, designated as conventional (where the panels are 'of a strictly constant format'), decorative (where 'the aesthetic organisation prizes every other consideration'), rhetorical (where 'the dimensions of the panel submit to the action that is described') and, finally, productive (where 'it is the organisation of the page that appears to dictate the story')" (Groensteen, 2009).

» Cohn (2013b) made a connection between panels and the narrative structure by claiming that individual panels can be classified based on the roles they have in the arc of narrative (such as peaks, initials, releases, establishers, prolongations, and orienteers). Furthermore, Cohn addressed the spatial relation of panels as the external compositional structure of panels (ECS), which includes: grid, blockage, separation, overlap, and staggering (Figure 2.1). Cohn and his colleagues have done multiple studies to investigate the external compositional structure (panel composition within one page) based on Western comics and concluded that the "navigation of comic pages follows strategies that extend beyond the Z-path used to read the written text and common Gestalt group-

ings like proximity. 'Assemblage' constraints and preference rules comprise a system for navigating an ECS, that work toward the building of hierarchic constituent structures".

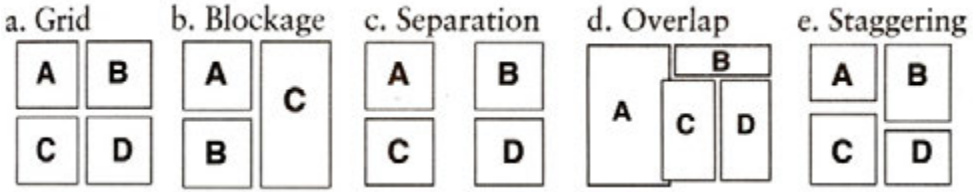


Figure 2.1: ECS of panels from Cohn (2013b).

As discussed in Section 2.1.2, this dissertation distinguishes between the narrative and the author's interpretation. The panels contain more information from the author's interpretation than from the narrative and the author's storytelling interpretation will transfer into panels. Based on these considerations, in this dissertation, the term panel will refer to a discernible area that contains a piece of the author's storytelling interpretation.

This dissertation mainly adopts Cohn's understanding of panels, that panels have roles in the narrative structure of comics, while the spatial layout of the panels contains also the author's interpretation for storytelling. Panels are the building blocks of comics; every single panel carries a piece of the author's interpretation of the story to tell[3]. If the author's interpretation can be expressed with a single panel, then it's not comics, it's a comic drawing. The reason that this term is in the plural form is because there should be more than one panel, since one panel is normally not enough for conveying a whole story. This leads to the following questions: What content should be put in one panel? What should be put in another panel? What is the relation among panels?

2.2.2 Visual elements of panels

The previous section defined the term panel as a discernible area that contains a piece of the author's storytelling interpretation. Each panel occupies a visual space, and within one panel many visual elements can be applied by the author.

There is an extensive number of studies that investigate which visual elements can be included in a panel (Cohn, 2013b; Duncan et al., 2015; Eisner, 1985; Groensteen, 2009; McCloud, 1993, 2006; Natsume, 1997; Tezuka, 1996). Based on these studies, eight categories of visual elements can be put into a panel were summarised.

3 In addition, the gap between two panels represents the author's interpretation of "not tell". This is the "invisible art of comics" as McCloud (1993) described. The topic of panels and gaps will be further discussed in the following chapters

1. Environment (such as a room, a forest, sea, etc.)
2. Character (such as a human, a dog, a talking robot, etc.).
3. Object (such as an apple, a clock, a sword, etc.).
4. Symbol (such as impact stars, motion lines, thinking bubbles, etc.).
5. Text (such as the character's dialogue, narration, sound effect, etc.).
6. Frame (such as different size, shape, and border style of the panel).
7. Camera angle (such as looking down, looking up, zooming in, zooming out, etc.).
8. Drawing style (such as black and white, certain colour combination, abstract or concrete, etc.)

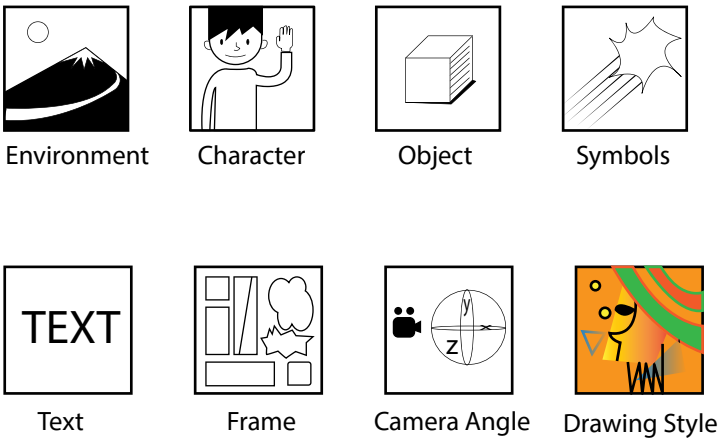


Figure 2.2: The eight elements that construct a panel.

Understanding better how panels are made could clarify the underlying principles of making comics. Besides that, this understanding could help to distinguish in more detail the differences between comics and other storytelling media. It is worthwhile to notice that a panel is an arrangement of the above elements. This means, in printed comics, once the panel is printed on paper, the arrangement cannot be changed anymore. However, within one panel the relation of the elements doesn't need to be fixed. In a digital environment, the relation between the elements could be more flexible and change dynamically. Since panels exist on a two-dimensional plane, they can have all geometric shapes: rectangles, triangles, circular shapes, or other irregular shapes. Besides the panels themselves, the spatial relation among panels is based on several parameters. This will be further discussed in the following sections.

2.3 Placing panels within carriers

The previous sections introduced comics as a storytelling medium which is constructed by panels as its main building blocks. The next logical question to ask is: Where to place these panels? We normally see the panels as a part of a page in a printed book, since this is traditionally the physical carrier of the panels. But this preconceived idea was formed based on the tools that were available when the authors created the page-based panels: pen, ink, and paper. With the introduction of d-Comics, tools and carriers are changing. Tools such as a stylus, touch-screens and advanced software enable new ways to place the panels.

Wilde (2015) raised the question whether comics that appear on different carriers (printed comics and digital comics) should still be considered as the same medium, since the features of the carriers are distinctive. This dissertation, as discussed in the previous sections, holds the point of view of comics as an abstract medium that can be placed on different carriers. In other words, panels are not naturally printed on paper or displayed on a screen; there is a state of the panels before they are placed onto the carriers. Once the panels can be separated from their carriers, it can be investigated how different carriers with different features will influence the presentation of the panel.

As introduced in Section 2.1.1, the history of comics is strongly connected with the development of the technology. Therefore the history can be considered as a history of panels immigrating from carrier to carrier. As discussed in the background section, the current panel immigration happens between the printed paper book and the digital environment (illustrated in Figure 2.3).

As shown in the figure, when an author is arranging the same number of panels, the result can be different depending on the qualities of the specific carrier. The different material and technological properties will be discussed, respectively, in Section 2.3.1 and Section 2.3.2.

2.3.1 Printed paper books

According to McCloud's (2000) explanation, printed comics also evolved over many stages of development. In early printed comics, the length of a page was limited. Therefore, a problem emerged: the full panel sequence couldn't fit on one page, and therefore the sequence had to be broken to fit the page. Then a second problem emerged: how to navigate between the different panels?

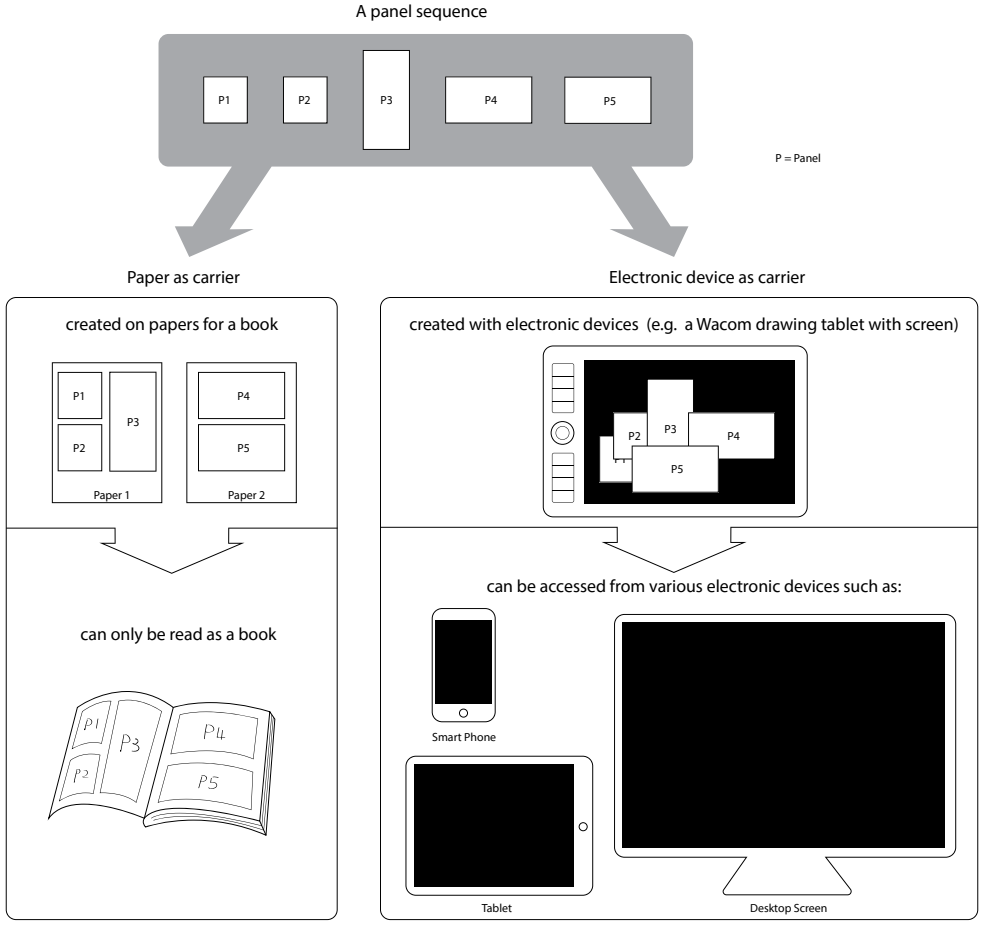


Figure 2.3: Separating panels from the carriers.

When the panel sequence was positioned over a linear line, it was clear for the reader to follow a direction. Once the starting panel is defined, the reader can simply continue with the panel next to the starting panel which hasn't been read yet. When following this logic, a reading direction can be defined. However, if this linear line is broken, it could result in confusion for the reader. From one panel which has been read, there could be more than one panel to be the next one to read. In conclusion, the reader cannot figure out the reading order solely based on the spatial relation. One solution could be to add numbers to the panels to indicate the reading order. Later in the development of printed comics — as the popularity of comics creation and comics reading increased — authors gradually learned how to better guide the reader's attention. Finally, a common understanding of how to read page-based printed comics has been established: from top

left to bottom right in comics, and from top right to bottom left while in manga (Cohn, 2013a). Figure 2.4 illustrates one example of placing a panel sequence of comics on multiple pages and indicates the reading route for the reader.

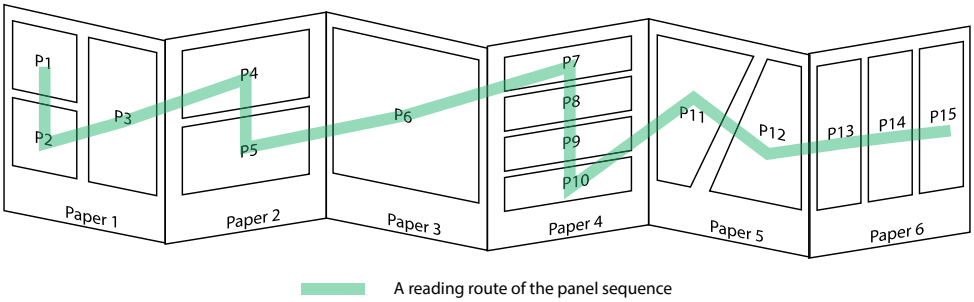


Figure 2.4: Example of placing a panel sequence on multiple pages with a reading route.

Comics authors normally use paper to make comics. For example, using professional paper which has good properties to make high-quality scans to reproduce the comics. But it is also common that the author uses notebooks for designing the layout and transcribes it into detailed drawings on ordinary printing paper. A comics author who creates for a paper-based carrier has already settled which panels are on which page and the layout of the panels on each page before printing. This workflow is different from a novel author. A novel author considers the chapters, paragraphs, sentences, and pauses, but normally doesn't have to consider to fix a certain amount of text on one page, unless there are typographic designs such as a riddle. A novel written with text can be printed on a thin book with large pages, but can also be printed on a thick pocketbook with small pages. However, changing the size of the paper for printing is a disaster for the presentation of comics and the reading experience of the reader — because the page and layout are part of the author's interpretation which cannot be separated flexibly. Meanwhile, simply squeezing a large comics page into a small page, or expanding a small comics page onto a large page, will change the clarity of the image and can cause difficulties in reading.

2.3.2 Digital environment in electronic devices

Once a panel is printed on a particular area of a page, the location will last until the paper of the printed comics is gone. Throughout its whole lifetime, the panel can no longer change position, nor have a different appearance. On electrical devices there are no pages: all the panels in the digital environment have to share one single screen space.

Panels are stored in the digital memory or storage, waiting for the processor to compute the pixels to be illuminated on the screen. Once new panels have to be displayed, the previous panels occupying the screen space will be cleared. Although the panels are not always displayed on the screen, they are always stored. All the parameters to define the relations among panels, which used to be fixed in printed comic books, become flexible in the digital environment. Since the panels are not limited to the physical paper anymore, they can be invoked anytime, the shape and order can change, and different feedback can be provided to the reader.

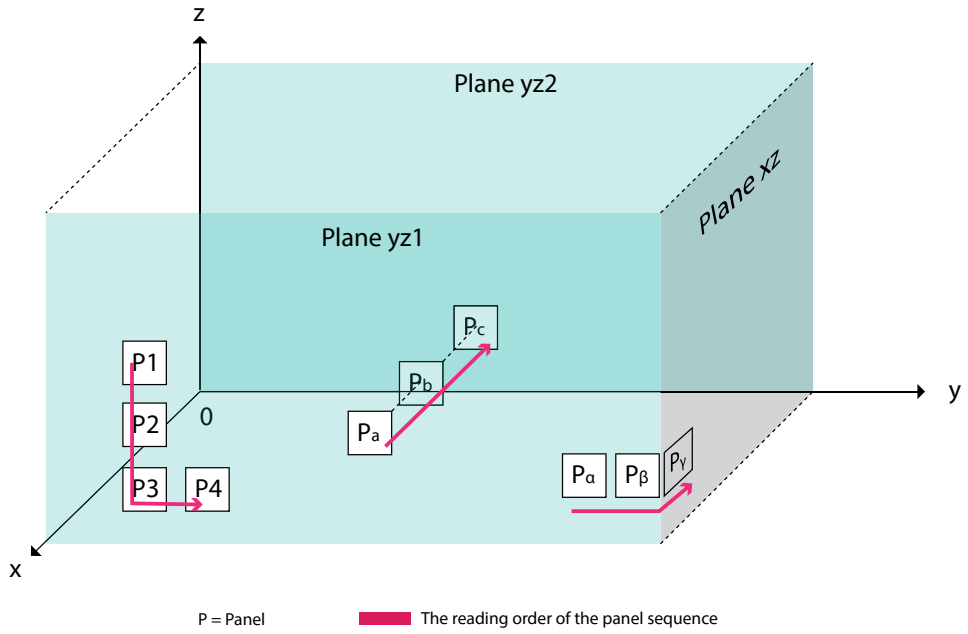


Figure 2.5: Placing panels in a digital environment.

In the digital environment panels don't have to be placed on physical paper, and therefore the laws of physics don't necessarily have to apply to them. Compared to the two-dimensional plane that paper can offer, the digital environment can display panels with any angle in a virtual three-dimensional space.[4] For example, the illustration below (Figure 2.5) demonstrates a scenario that can happen with d-Comics. The location of panels can be three-dimensional. The reader can find these panels with the electronic device by following a navigation designed in the d-Comics.

4 According to the review from Welchman (2016), human vision is three-dimensional. Although we can imagine and calculate higher dimensions, we can only see three dimensions. Therefore, the visualisation of the digital environment where the panels can be displayed is 3D.

Moreover, the location of the panels in the digital environment doesn't have to be fixed because the panels can dynamically move. Instead of our eyes moving between the panels, the panels will deliver themselves based on our command. Goodbrey called this concept panel delivery, and the application of this can be found in many explorations of d-Comics such as PoCom-UK-001 (Goodbrey, 2003), A Duck Has An Adventure (Goodbrey, 2012), and Meanwhile (Shiga, 2014). In these three applications, the command that a reader has to conduct to trigger the panel delivery is all designed as "clicking the next panel". To be more specific, the reader can use the mouse (or a finger if it's a tablet application) to click a panel that is on the side of the screen, then leading by that panel, the following panels will move to the centre of the screen, while the previous panels will move out to the other side of the screen. This type of input-output mechanism on the screen of electronic devices is considered in the discipline of interaction design. Beside "click", there are many other input methods such as "drag to scroll" and "pinch" that can be applied in designing the interaction of panel delivery. Figure 2.6 illustrates several input gestures for a touch-screen electronic device based on the descriptions of Cooper et al. (2014). The input of a reader for this carrier can include ***tap, drag, swipe, pinch, etc.*** Inputs such as swipe can have different finger movement directions. The same input with different moving directions can be mapped with different visual displays. For example, in a digital map application, pinch in means zoom in, while pinch out means zoom out.

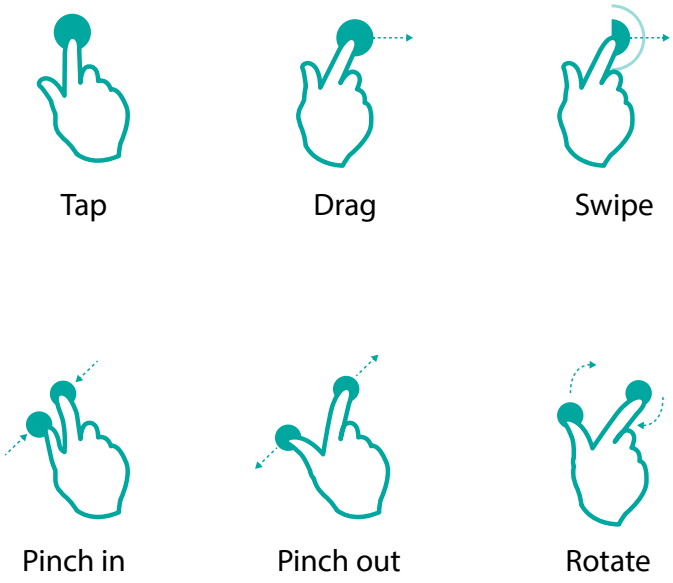


Figure 2.6: Multi-touch gestures for touch-screen devices.

As shown in Figure 2.3, there are different electronic devices that can access and display the panel sequence stored in the digital environment. These electronic devices have different screen sizes and different form factors, which means that it depends on the specific electronic devices how many panels can be displayed at a time. And when finished reading the panels, the reader (user) has to interact with the electronic device to move through the panel sequence. The interaction can also vary based on the capabilities of each specific electronic device.

In general, the digital environment can provide several opportunities for placing and displaying panels: a visualised three-dimensional virtual space, a not fixed display location, and different interactivity for panel delivery.

2.4 Segmentation of panels caused by carrier

Digitalising a novel (a text sequence) is easier compared to digitalising a printed comic book. Written languages — such as English — unfold through time and can, therefore, be considered as linear. Thus, although there are many different screen sizes on which the number of characters that can be displayed on one line differs, this doesn't cause problems to understand the text. Possibilities such as adjustable fonts, different font sizes, and horizontal or vertical display are advantages of e-books compared to printed paper books. However, when it comes to comics, things become quite challenging.

The previous section introduced the two different carriers for placing a panel sequence. Printed comics are created on paper. The page size, and the size and location of a panel on that page are all fixed. The segmentation of a panel sequence is based on page. To be able to continue reading the panels, a reader has to flip pages. However, the physical pages don't exist on electronic devices. The panels are stored digitally and displayed on the screen of an electronic device. Different electronic devices have different screen sizes, and therefore the displayed size of a panel and the location of a panel on the screen can change. The interaction required for the reader to continue reading can vary from different electronic devices, and is based on specific interaction design.

This section further explores the following questions. Based on what can a panel sequence be segmented in printed comics? Which levels of segmentation are there in printed comics because of the page? What is the essence of page-based panel sequence segmentation? How to design segmentations in d-Comics?

2.4.1 The "page-turner" in print comics

According to the existing printed comic books, different scales to discuss the relation among panels were observed. Different scales will cause different panel grouping and segmentation. Therefore, a figure is created as an example to clarify the different scales (Figure 2.7).

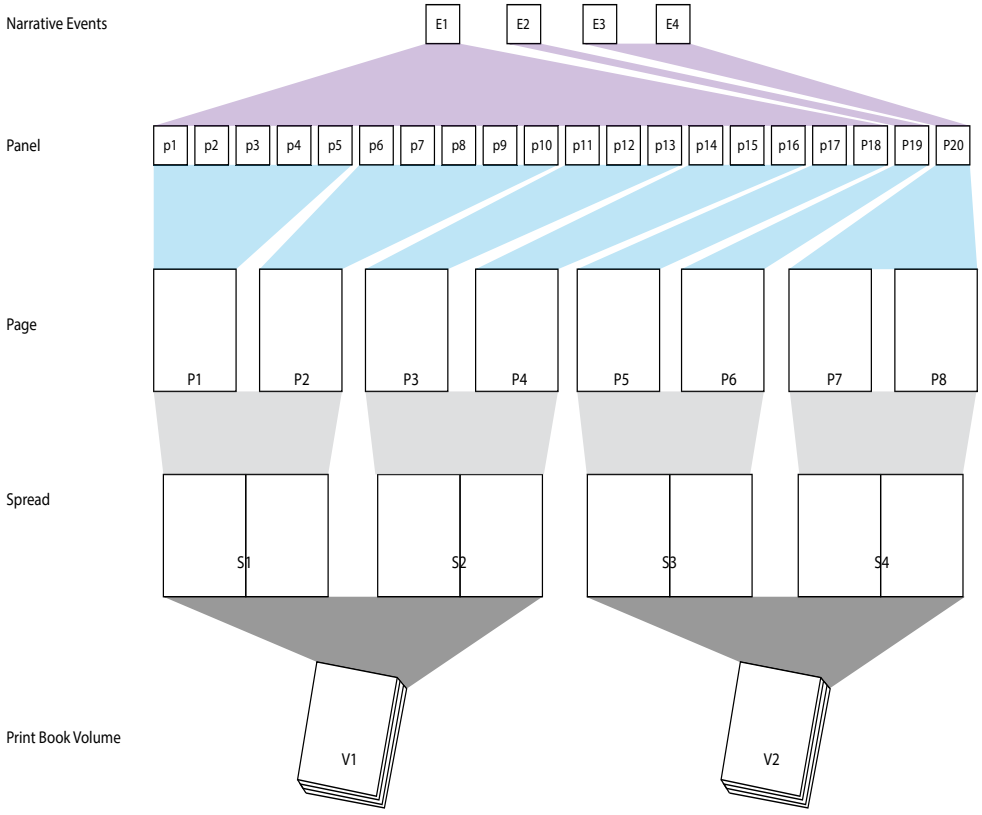


Figure 2.7: Segmentation levels in printed paper books.

Figure 2.7 demonstrates the relation between narrative events, panel, page, spread and book volume in printed comics. An event can be visualised with multiple panels (E1 and p1-p18), or a single panel (E2 and p19). Multiple events can be captured with one panel (E3, E4, and p20). Similarly, the number of panels that a page can contain is not a fixed number. Two pages next to each other when the volume is opened constitute a spread. Panels in the same spread can be seen, while panels on other spreads are covered and therefore cannot be seen at the same time. Finally, a printed book volume is created with

multiple spreads. Thus, in the example in Figure 2.8, a comic story can be divided into four events, twenty panels, eight pages, four spreads, and two volumes. In print comic books, the most frequent panel sequence segmentation happens due to the existence of the page. A spread is the second segmentation unit. Then the last segmentation unit is the volume.

When a panel sequence has been segmented and arranged into different pages, the relation among panels is no longer only a linear relation. Because of the existence of the printed comic book, the segmentations of panels can be considered on the following levels:

1. The segmentation within one page (one side of a physical page).
   This is known as the "panel layout", or the external compositional structure of panels (ECS) in Cohn's (2013b) words. As Groensteen (2009) and Natsume (1997) suggested, the spatial arrangement added rich complexity to the panel relation. This level of segmentation is about how panels that belong to one page divide the space of that page. According to Pederson and Cohn (2016), the design of the layout within the page evolves through time.

2. The segmentation within a double-page spread.
   A spread is the maximum area one panel can have. Also, the segmentation of two pages in one spread can be connected by a panel. This type of panel is the largest panel of the whole book. Compared to other panels, this type of panel normally requires a longer duration to read. It is usually made to show a large-scale scene, an important moment, or both.

3. The segmentation of the physical pages in a volume.
   In printed comic books, one physical page has two sides, and each side is considered as one page. When one side is visible, the other side on its reverse is invisible. The previous two segmentations happen in a two-dimensional plane, while this segmentation occurs in the third dimension. The thickness of the printed book defines the length of the panel sequence. This segmentation is about letting the reader feel aware of the location of panels by visual and tangible cues, such as the page numbers, the thickness of the already read and unread pages, and the weight of the pages.

4. The segmentation of volumes.
   There are panel sequences that cannot be finished in one book but need multiple volumes. A book is a collection of physical pages. Multiple volumes mean that several physical page groups are created, and thus also a segmentation of these groups are created. This segmentation requires the reader to spend more effort than just flipping pages. The reader has to put down one book then find and open another one.

The word "page-turner" is used to describe attractive stories in books that can make the reader continuously flip to the next page to follow the story. It is a common technique (also known as "cliffhanger") to segment a panel sequence on different pages for story-telling purposes to enhance curiosity, suspense, surprise, emphasis, storytelling pace, etc. For example, imagine the protagonist of the comic is facing big trouble at the end of one spread, and the tension is relieved in the next spread. In this example, the reader will generate curiosity and is eager to flip to the next page. Another example: if the current spread is very sad or horrible, the reader probably would want to flip through as quickly as possible so as not to face that spread.

2.4.2 The challenges of placing panels in d-Comics

The existence of pages, as a carrier, is crucial for comics. However, the panel display mechanism with the digital environment in electronic devices is different from the printed book — there exists no physical page, and therefore no page-turning interaction. For a panel sequence that requires a printed book to carry, it normally cannot be displayed with a readable size on the screen of an electronic device at one-time — the segmentation of the panel sequence can still happen. Three challenges are summarised for placing and displaying d-Comics:

Challenge 1: Segmentation of panels caused by different screens

There are different screen sizes on which panels can be displayed. If a printed comic book needs to be digitalised, how should it be displayed on different electronic devices? The panels on a printed comic book are fixed. When a page of that printed comic book is transferred to a digital environment, there could be two scenarios: the screen is the same size as the page, or the screen has a different size to the page. When the screen is bigger than the page, what to display? If it displays only one page at a time, then what about the rest of the space on the screen? If it can display multiple pages at a time, then what should be the spatial location of these pages? Can this arrangement break the suspense and surprise that the author meant to create by using the page-flipping interaction?

Another situation could occur when the screen is smaller than the page. Many pioneers have tried to overcome this challenge by selecting individual panels from printed comic books to display on small-screen devices. In the academic arena, researchers have studied how to use computer algorithms to distinguish different panels on a page as individual units (Li, Wang, Tang, & Gao, 2014; Tanaka, Shoji, Toyama, & Miyamichi, 2007; Yamada, Budiarto, Mamoru, & Miyazaki, 2004). In the industry, companies like Amazon (Amazon.com Inc, 2011) are working on digitalising printed comic books with both full-page structure and individual panels. The Guided View (Steinberger & Najmabadi, 2018) technology "allows readers to view a comic on a panel-by-panel basis suitable for mobile devices in a way that mimics the natural motion of the user's eye through the comic" (comiXology, 2014). Several scholars expressed their concerns regarding breaking the page layout and display comics panel by panel. Groensteen (2007) claimed that the spatial relation provided by the page is a system, and any change of spatial arrangement may jeopardise the narrative and could limit the author's expression. Goodbrey (2013) argued that the guided view is "limiting the reader's control" during reading. A recent study shows that, although the paper book was similar to its digital equivalent, the digital disrupted view (display one panel at a time) is less good in terms of reading comprehension, feelings of fatigue, and psychological immersion (Hou, Rashid, & Lee, 2017).

To sum up, this challenge is caused by the display method of the digital environment in electronic devices. To overcome this challenge, it is necessary to examine the relation among the panels in the digital environment: Where in a panel sequence should it be segmented? How to display the panel groups on a screen after being segmented?

Challenge 2: Segmentation of panels caused by reader

When McCloud was envisioning digital comics, he introduced a concept called the "infinite canvas" (McCloud, 2000). In this concept, the monitor (screen) — which often acts as a page — may also act as a window. Therefore, through this window, the reader can access the digital environment as an infinite canvas. As addressed in Section 2.3.2, the digital environment can provide a three-dimensional virtual space visually, and the display location of a panel does not have to be fixed. A panel sequence displayed on the "infinite canvas" doesn't need to be broken, as in physical paper. Therefore, a panel sequence also doesn't need to be segmented into groups to fit on the different pages. Instead, the panel sequence could be displayed at any location on the screen. There are many examples (especially Korean webtoons) which use a panel stream to allow readers to read comics on small-screen devices.

When a panel sequence is displayed on an infinite canvas, the reader can stay at a location on the canvas freely. However, the visible area of the screen is limited. Therefore, the screen will create a segmentation of the canvas caused by reading.

Figure 2.8 illustrates one example of the segmentation during reading a panel sequence placed on the infinite canvas. The screen area can display two full panels at a time. Ideally, the segmentation should be like situation A and B. However, if the reader has the freedom to scroll through the canvas, situation C and D could happen.

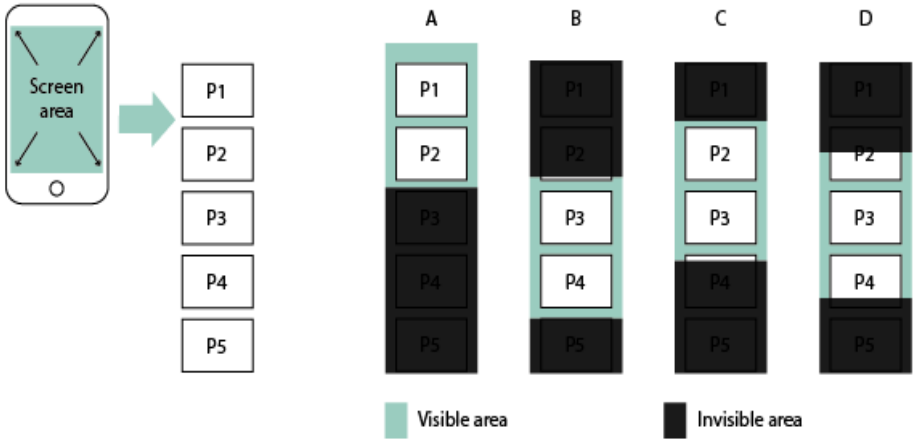


Figure 2.8: One example of reader segmentation.

Would this segmentation generated by the reader during reading jeopardise the author's storytelling intention? Can the reader still be able to recognise segmentations under this circumstance? Should there be any design to enhance the intended segmentations?

Challenge 3: Moving through segmentation

As discussed previously, the existence of pages requires the reader to flip to the next page to continue reading. In other words, it is the one and only input that the reader has to provide to move through segmented panels. This is defined by the physical qualities of the pages. The locations of the panels are bonded to the pages.

However, the locations of panels are no longer constrained by pages in d-Comics. The visible space that a screen can provide is three-dimensional. Figure 2.9 illustrates three situations that can happen when placing a panel sequence in a three-dimensional virtual space.

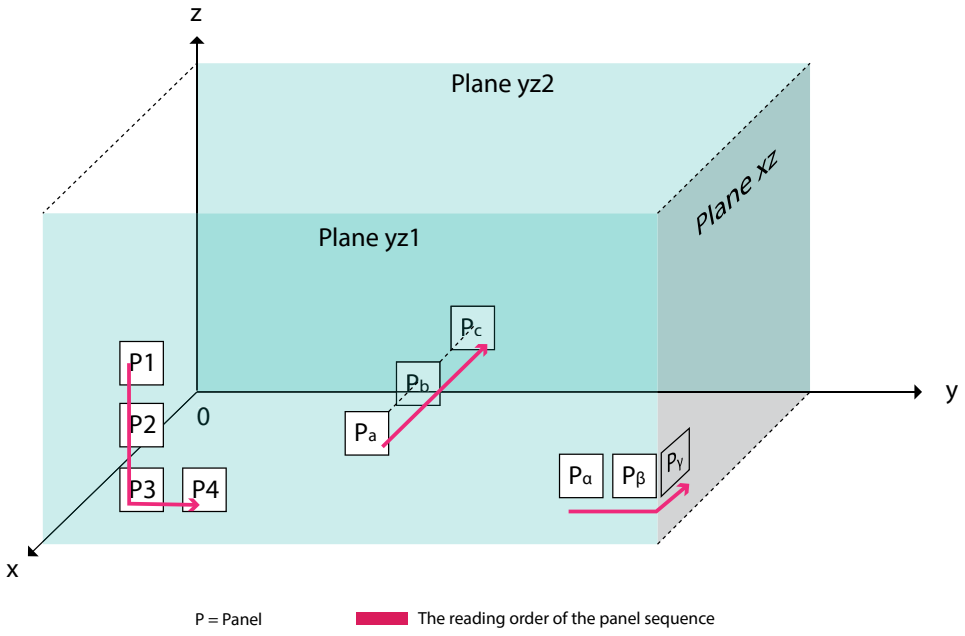


Figure 2.9: Three examples of placing panels in a 3D virtual space.

The panel sequence with Panels 1 to 4 is placed on "Plane yz1". This is a regular usage of a screen for displaying panels. However, in the example with Panels a to c, the panels are placed across "Plane yz1" to "Plane yz2". When the reader is reading Panel a, the other two panels, Panel b and Panel c, are not necessarily invisible. It depends on the angle of the screen with this spatial arrangement. In the example with Panels α to γ, the panels are placed on Plane yz1 and Plane xz which are perpendicular to each other.

Panels are two-dimensional images that can be placed on a two-dimensional plane. Every spread of a printed book is a plane. One plane may cover the other planes physically. Moving through segmented panels on different spreads in printed comics simply means flipping the pages. But how to move through panels that are placed in a three-dimensional virtual space? Depending on how the panels are located, there can be different movements and navigations. In the Panels a to c example, the reader can hold the electronic device to move a distance in real physical space to find the panels. In the Panels α to γ example, the virtual space can rotate itself to bring the panels onto a different plane.

There exist many interaction options for readers with d-Comics on many different displays. How to design the interaction that allows readers to move through panel segmentations? How can the interaction design support the storytelling purpose? How to let the readers know how and where the panels are located (to design the navigation among panels)?

2.5 Research questions

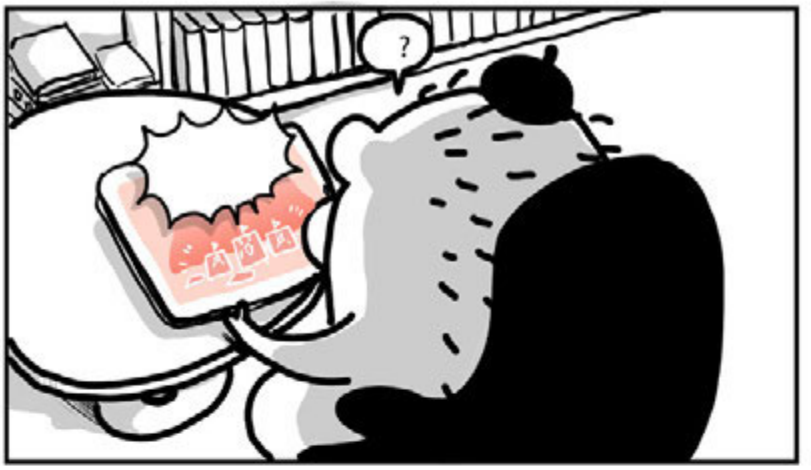
The challenges that emerge when designing the segmentation of panel sequences in d-Comics revealed the influence of the carrier on the panels. This leads to the necessity to examine the relations among panels in the digital environment: ***Is there a unit in d-Comics similar to the page? What method can be used with the new carrier to express this unit?*** The previous review of how a panel sequence is segmented in printed paper books leads to an assumption that a panel sequence can be segmented in d-Comics as well. From this hypothesis, two research questions are formed:

Question 1: How is a panel sequence segmented in d-Comics?

The virtual space in the digital environment is unlimited. If a panel sequence in d-Comics can be displayed on an infinite virtual space, how can it be segmented? Is there a general pattern recognised by the readers for segmenting a panel sequence?

Question 2: What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?

Based on the results collected from the first question, the cause of the decision of segmentation can be further explored. Is there any essential reason for panel segmentation that can be shared both by printed comics and d-Comics? Are there unique strategies that can only be applied to d-Comics? How can the strategies provide input for designing d-Comics?


?


GREAT! YOU CAN SEE US! HELP!
PLZ DO SOME RESEARCH!
HELLO, PANELS, HOW CAN I HELP?


TIC TAC
TIC TAC
PANELS! I MAY HAVE FOUND A WAY!
THANK FOR COMICS-GOD!
PLZ TELL US!
QUICK!
YEYY!

CHAPTER 3

Segmentation of Panels in d-Comics

The previous chapters have established the research purpose and questions. This chapter aims to answer the first research question: How is a panel sequence segmented in d-Comics? As discussed in Section 2.1.1, the most important attribute of the panels is the sequentiality. The spatial relation generated by the carrier (i.e. printed paper books or digital environment in electronic devices) comes afterward. Thus, to investigate the relations among panels in d-Comics, the influence of the page should be removed — or at least limited — so that the basic sequentiality can be investigated.

The segmentation of a panel sequence has another aspect: the panels between two segmentation lines (the location where a panel sequence is segmented). This dissertation will address these panels as a panel group. In other words, the research question can be rephrased as "How can panels in a panel sequence be grouped in d-Comics?"

An empirical study has been conducted (Experiment 1). The material used for the experiment is derived from webcomics, instead of page-based printed comic books. In general, webcomics are based on vertical panel sequences. Moreover, there is no segmentation caused by physical page change because it is made for a digital carrier. For this experiment, the panels of one comic story were placed in a horizontal linear sequence on one web canvas. Participants can scroll the web canvas to read the comic story. Between every two panels, there is a button designed to indicated a segmentation. Participants were asked to segment the panel sequence based on their understanding of the comics.

3.1 Introduction

There are two parties involved when discussing the segmentation of a panel sequence: the author and the reader. Which party to choose for the research on the segmentation of panels?

In printed comic books, as explained in Section 2.3.1, the segmentation of panels is embodied in the physical pages. In other words, when reading a printed book, the reader is reading a panel sequence which has already been segmented. As described in the Hajiman Challenge (Hotta, 2013) (Section 2.1.2), it is the author's freedom to create a different number of panels based on a narrative. If multiple comics authors are conducting research about panel sequence segmentation, they may generate a different number of panels. In this case, the research focus is about the creation of panels.

The segmentation of a panel sequence should be discussed based on a specific and stable panel sequence. This means that the action of identifying segmentation should happen after the panel sequence is made. At this stage, it is about collecting the understanding of the readers about segmentation. There are three benefits of this approach: 1, the result can describe a general pattern about understanding panel sequence segmentations; 2, the result can be further investigated to deeply understand the influence factors that play a role for the understanding of the panel sequence segmentation; and 3, the result can help the author to design segmentations which fit the understanding of the majority of the readers.

3.1.1 Materials

For the experiment, four comic stories were chosen from the webcomics *Zen Pencils* (Than, 2012a, 2013a, 2013b, 2014a), shown in Figure 3.1. The comics were altered for the purpose of the experiment — with the kind permission of the author — to explore how a panel sequence could be segmented. The segmented panels and gaps of the four stories for this experiment can be found in Appendix I. There are three reasons for choosing specifically these comic stories as the study material.

Figure 3.1: Four short comics from Zen Pencils.

Firstly, because both the creation and the display are screen-based, this limits the influence of the physical pages. Zen Pencils is an online comic website regularly posting short comic stories. According to an interview (Than, 2012b), the author creates the panels mainly using digital tools, such as a Wacom tablet and Adobe Photoshop editing software. The comics he creates normally occupy a long vertical space, much longer than a single physical page. The reader has to scroll down on the screen to read: see, for example, Figure 3.2. There is no page to divide the panel sequence. As we have discussed in Chapter 2, this use of the digital environment is meant for on-screen reading.

Figure 3.2: The original panel layout of The Lucky Ones (Than, 2012a).

The second reason for choosing these comic stories is the variety they can contain. All the panel creation elements as discussed in Section 2.2.2 (such as character, text, environment, colour) can be found in these comic stories. Additionally, the narratives contain different types of plot twists. By exploring comic stories with different narratives and panel creation elements, more insights could be gained from the experiment.

The Lucky Ones (Than, 2012a) contains a narrative about a profound life reflection, where the moments captured in the panels move backward in time: from the old gentleman visiting his wife's grave to the moment they met. *In Spite of Everything* (Than, 2013a) starts with a grown-up man who found his childhood drawing tools. Then a flashback

shows his painful childhood experience of being discouraged from drawing. Finally, the narrative is going back to the moment when the man is holding the drawing tools and starts drawing. *Because It's There* (Than, 2014a) tells a story of a mountaineer who conquers many difficulties and finally achieves his goal of being on top of the mountain. The story uses a parallel storyline about a rich couple and the mountaineer, to emphasise the narrator's opinion: to appreciate the mountaineer's spirit and to despise the lifestyle of the rich couple. *Ithaka* (Than, 2013b) is a rather long story of a man who receives a map from his father and starts his journey towards Ithaka. He defeats a monster, experiences different cultures, meets the love of his life and finally arrives at Ithaka. When he is reaching the end of his life, he passes to his daughter a new map indicating the original place he came from, and the new adventure of the daughter seems to start, just like her father.

The Lucky Ones has an unclear segmentation, especially related to the story time and the text, since these are the memoirs from the character. The reading direction is moving forward, and the images unfold together with the reading direction. However, the depicted story is moving backward. *In Spite of Everything* has a story time flashback in the narrative, which is supported by the graphical expressions. The flashback parts have less colour compared to the present parts, and the appearance of the protagonist changes from an adult to a child in the flashback parts. A minimum segmentation between the present and past in the story is expected to be observed. The narrative can show the perspectives of multiple characters. *Because It's There* uses two groups of characters (the mountaineer and the wealthy couple) to enhance the narration contrast by using similar actions such as eating meat with a fork and climbing the mountain by using a pickaxe on the rocks. This graphical similarity of panel transition can be considered as the usage of meanwhile in the English language, however, without any explicit time indication (place texts that indicate the exact time in a narrative) within each panel, the comparison on story time cannot be considered as a precise time. *Ithaka* starts and ends with the similar scenarios of the older generation who pass the map to the younger generation. The same usage can be found in many stories such as The NeverEnding Story (Ende & Doyle, 1983), One Hundred Years of Solitude (Márquez, 2014) and The Circular Ruins (Borges, 1984). In all these stories the starting narrative pattern is repeated in the end — almost like a loop in time. However, it is just that the patterns are similar. Therefore, to observe how similar narrative and images appear at the beginning and end of a comic strip are perceived, this story is selected.

The third reason for choosing these comic stories is that the length of the comic stories is suitable for an online experiment. *The Lucky Ones* contains nine panels. *In Spite of Everything* contains eighteen panels, *Because It's There* contains thirty-five panels, and *Ithaka* contains fifty-nine panels. These stories don't take a long time to read, but are very complete. The total reading time is estimated to be 10 minutes.

3.1.2 Procedure

Before the experiment was conducted a pilot study was executed with five participants, with the goal to improve the phrasing of the questions and the flow of the experiment. After the improvements were implemented, an advertisement to recruit participants was posted in groups related to comics on various social network platforms, including Facebook, LinkedIn and Reddit. The author of the original webcomics also retweeted the post. The post contained general information including the purpose, the requirements, risks and estimated duration of the experiment. After a potential participant read the information and agreed to participate voluntarily, the link for the experiment could be accessed on the device of the participant.

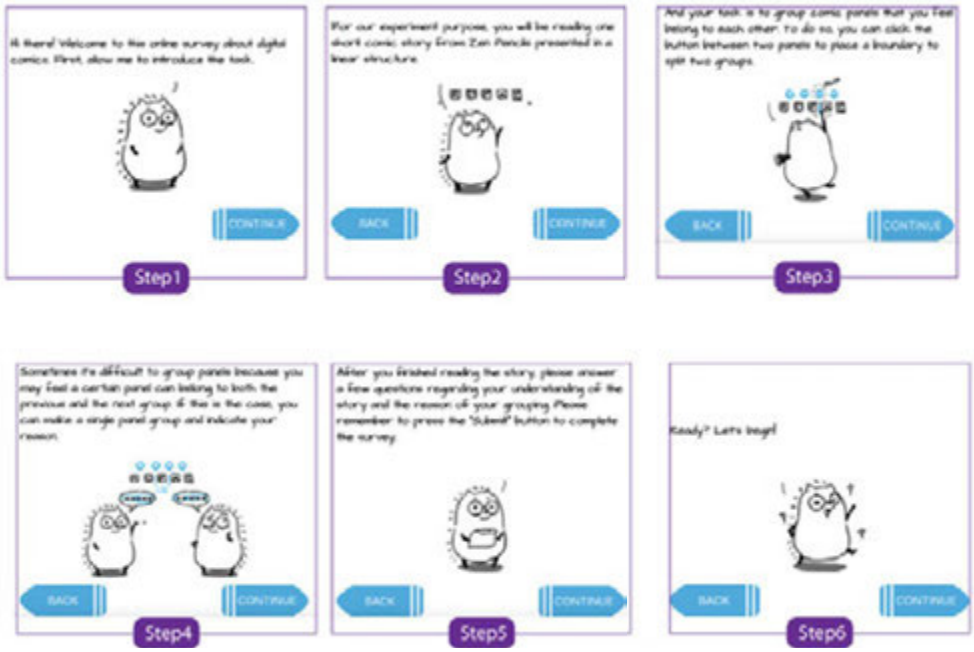


Figure 3.3: The introduction interfaces of the online experiment.

A visual introduction appeared after the participant clicked the link (Figure 3.3). The introduction explained the goal and interaction of the experiment. After the introduction, one of the four comic stories was presented to the participant. The selection of which comics to show was randomised automatically. The stories were given integer numbers. The system calculated the balance of the total number that each story number was completed by a participant. Then it provided the least submitted story to the next participant. Following this method, each comic story was completed by twenty participants.

3.2 Experiment design

3.2.1 Separating panels from the original layout

Originally, the panel layouts of the four comics were arranged in a vertical sequence, with some variations. For example, in Figure 3.4, the third panel is not below the second panel, but juxtaposed on the right side of the second panel. This means that the original comics require the reader to follow a zigzag reading path from panel to panel. However, if this layout remains in the experiment, it won't be clear for the participant where to indicate the potential segmentations. For example, in Figure 3.2, if the segmentation line is drawn under panel one, it might not be clear to understand where this segmentation refers to since the next area is two juxtaposed panels (Panels 2 and 3). A common understanding could be that this is a segmentation between Panels 1 and 2. However, it could also indicate a segmentation between Panels 1 and 3. To avoid unclear situations as mentioned above, the spatial layout of panels has first to be simplified. The panels in this experiment should be arranged linearly, to limit the influence of page structure and to enable the participants to provide a clear indication of the segmentations.

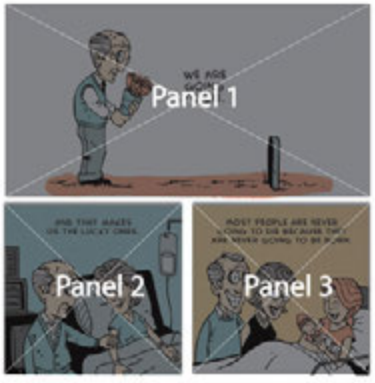


Figure 3.4: The first three panels of The Lucky Ones.

A horizontal layout for the panel sequence is chosen for two main reasons. Firstly, it is because of the shape of panels. To examine the segmentation of the panel sequence, other influence factors such as the size of the panels should be limited. Therefore, the panel size should be as consistent as possible. Most of the panels in the comic stories are shaped as rectangles, with a longer width than height. Therefore the panels will retain their original quality when all the heights are resized to have an equal height (while the width also changes proportionally). Then, the panels with equal heights and different widths can be aligned horizontally. The second reason for choosing a horizontal layout is to keep the participants' reading flow as linear as possible. To achieve this it is important to limit the influence of other factors on the segmentation of the panel sequence. For example, the texts in the comic stories are in English, which should be read from left to right. Placing panels horizontally meets this general reading flow.

3.2.2 A panel group with one panel

Once a linear panel sequence has been segmented, panel groups will automatically appear between two segmentations. A panel group is a unit. In a printed comic book, a page will cause a segmentation in the panel sequence, which results in a group of the panels placed on one page. A double-page spread or a volume can all be considered as a panel group, with smaller panel groups inside. Then what would be the smallest unit of a panel group? The extreme situation could be a single panel that is isolated because it is placed between two segmentation lines. This situation might already exist – for example, in printed comic books where sometimes a page or even a spread only contains one panel.

As discussed in Section 2.2.1, the relation among panels could be more complicated than just a linear transition. There could be a panel (or a panel group) that contains a combination of some information related to the previous panel group, and some information already to build up to the following panel group. Therefore, we suspect that there is a structure that a reader can understand from a linear panel sequence. The main goal of this experiment is to find out whether a panel sequence can be segmented in d-Comics. A secondary goal is to discover whether overlapping relations between panels occur.

3.2.3 Panel display and interaction

The panels have been resized to have equal height (320 pixels on the digital device), while the height-width proportion was kept the same in the experiment. The visual distance between each two panels was equally distributed. One panel was added in the beginning to introduce the test procedure, and one panel was added at the end to finalise the test procedure. Between each two panels, there was a crop icon (represented by the symbol of a pair of scissors), that participants could click or tap to indicate a segmentation. When the icon was clicked or tapped once, a blue line would appear to indicate the segmentation chosen by the participant. When the icon was clicked or tapped again, the placed segmentation would disappear. If the participant created segmentation lines on both sides of a single panel, two selection items would appear, for the participant to indicate the reason for identifying a single group panel. There were two reasons that could be selected: either the panel belonged to both the previous and next panel groups, or the panel could be considered as an independent group. The layout of the panels mentioned above can be found in Figure 3.5.

The experiment was developed as a web-based application based on HTML, CSS, and JavaScript technologies. The participant could scroll the canvas horizontally, either with mouse clicks on a computer or with finger touches on a touch-screen.

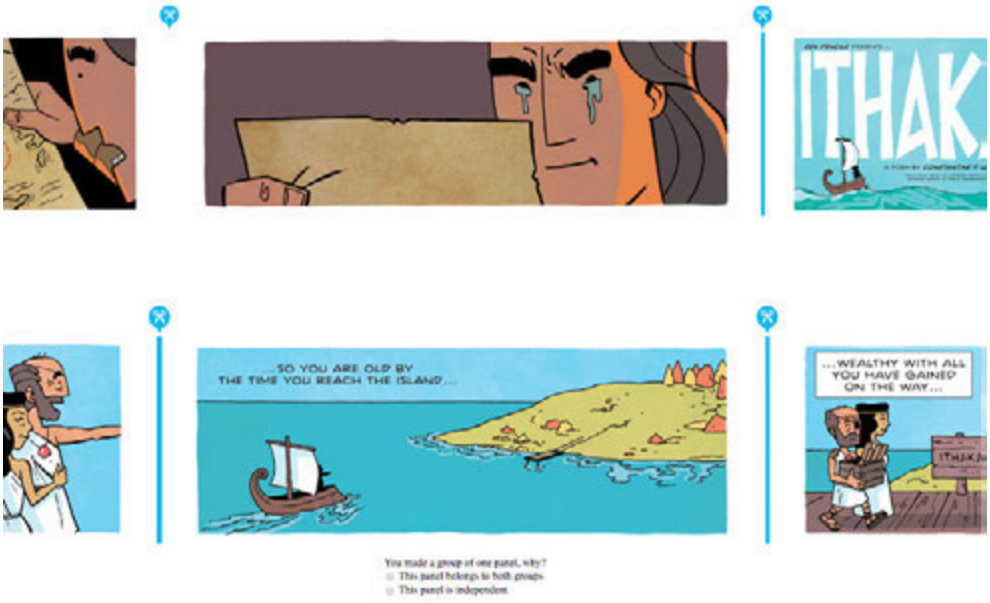


Figure 3.5: : The layout and interface of the online experiment.

An introduction consisting of six steps was designed to help the participants understand the experiment (shown in Figure 3.3). In the introduction, a comics character explained the participants' tasks, such as: how to indicate panel sequence segmentation, how to identify if there is a panel group with one panel, and how to complete the experiment. This introduction was designed as a visual instruction because it could help understand the task. The six steps in the introduction were designed to show one at a time. When the participant clicks the continue button, the next one will be shown. The location of the introduction text and buttons are programmed to adapt to the screen size dynamically, in order to make sure that the text is readable even on small-screen devices.

3.3 Results

The experiment was published online in November 2015 for two weeks. The result is reported below.

3.3.1 General Information

Participants: Participants were recruited in online groups related to comics on social networks. The website of the experiment received more than one thousand visits. The experiment received 87 completed responses (finished reading the instruction, the comic story and submitted the questionnaire). Seven responses were excluded from the dataset due to: incomplete answers (n=4), system error from the device of the participant (n=1), and two responses were emitted (randomly) to balance the number of responses for each story (n=2). The remaining dataset in total had 80 participants, including 45 men and 35 women, the average age of which was 29.6 years. The experiment was conducted in English, and all participants were able to read the comics and answer the questions in English: 25% of the participants were native English-speakers, 55% were native speakers of European languages, and 20% had other native languages. Among the participants, 79% were non-religious, while 21% held a belief such as Catholic, Christian, Muslim, Islam or Buddhist. Out of 80 participants, 75 participants had an education level of a Bachelor degree or higher. Since the participants were mainly recruited from comics-related interest groups, 88% of the participants maintained a limited comics-reading habit. With regard to the experience with comics, 25% of the participants were heavy comics readers, 35% read comics regularly, 27.5% read limited comics from social networks and news, 8.75% read comics only in their childhood, and 3.75% claimed they didn't read comics at all. For accessing the experiment, 72.5% of the participants used a computer, while 27.5% used a tablet device or cell phone. The range of the screen size was from 980×551 pixels to 2160×1307 pixels.

Task time: The average time that a participant needed to read all the panels and finish the segmentation tasks was 3.36 minutes (n=80, σ=2.34). The average time of The Lucky Ones was 2.84 minutes (n=20, σ=2.75), In Spite of Everything was 2.39 minutes (n=20, σ=1.53), The Lucky Ones was 4.04 minutes (n=20, σ=2.10), and Ithaka was 4.14 minutes (n=20, σ=2.46). In general, the more panels the story contained, the longer duration was required for reading. However, the average time for reading and segmentation tasks of In Spite of Everything (20 panels) was less than The Lucky Ones (11 panels). When participants were asked to estimate their reading time, 60% of the participants chose the option "less than 5 minutes", 21.25% chose "5 to 10 minutes", 11.25% chose "in a flash", 2.5% chose "10 to 20 minutes", 2.5% of the participants chose "more than 20 minutes", and 2.5% chose "not sure". In Spite of Everything had the most varied range of estimation, while Ithaka had the most coherent reading time estimation.

Enjoyment of reading: In the questionnaire, the participants were asked about their reading experience with questions about the enjoyment of reading regarding traditional print medium, the experiment story, and the interaction that was designed for this experiment. The enjoyment of the story focuses on the narrative and panels. The enjoyment of the interaction is about reading panels with a linear layout from the web page on electronic devices. The participants could use a five-point Likert scale to rate their response, from Not enjoyable at all (score=1) to Very enjoyable (score=5). The result is shown in Table 3.1. In general, the enjoyment of reading d-Comics was less than reading printed comics. The enjoyment of the story was relatively higher than the enjoyment of the interaction.

Table 3.1: Enjoyment of reading.

	The Lucky Ones (n=20)	**In Spite of Everything (n=20)**	**Because It's There (n=20)**	**Ithaka (n=20)**
Enjoyment-Print	3.95 (σ=1.22)	4.25 (σ=0.85)	3.75 (σ=1.33)	4.1 (σ=1.07)
Enjoyment-Content	3.45 (σ=1.15)	3.95 (σ=0.83)	3.85 (σ=0.75)	4 (σ=1.03)
Enjoyment-Interaction	2.9 (σ=1.41)	3.7 (σ=1.30)	3.75 (σ=1.02)	3.5 (σ=1.19)

3.3.2 The segmentation of panel sequence

Overview of panel sequence segmentation: In general, the more panels a story contained, the more panel groups could be perceived (Figure 3.6 a & 3.6 b). Figure 3.6a uses a bar chart to visualise the number of panels in each story. Figure 3.6b uses a box plot to describe the number of segmented panel groups in each story. The more panels a story contains, the more segmentations were identified. The average group number of The Lucky Ones is 2.95. The average group number of In Spite of Everything is 4.3. The average group number of Because It's There is 7.85. The average group number of Ithaka is 10.85. The decision of panel segmentation deviates more when more panels are involved.

Individual comic story panel sequence segmentation: The following figures (Figure 3.7, Figure 3.8, Figure 3.9, Figure 3.10) reflect how the participants placed segmentation lines between the panels for each story. The panels and gaps mentioned can be found in Appendix I.

The word "***gap***" is commonly used in comic studies to describe the space between two panels. The gaps in the linear panel sequence will be indicated by following the order as Gap 1, Gap 2, Gap 3 and so on. Any gap has the potential for placing the segmentation. To determine whether a gap is considered as a segmentation in the panel sequence by the majority of the participants, 50% or more of the participants should have placed a segmentation line in the same gap. As explained in the Experiment Design section (Section 3.2.3), the first and last panels in each story were the introduction and final explanation of the experiment. Therefore, although the gaps are listed in the results, they cannot be considered equally as important as the gaps between the panels which contain the story.

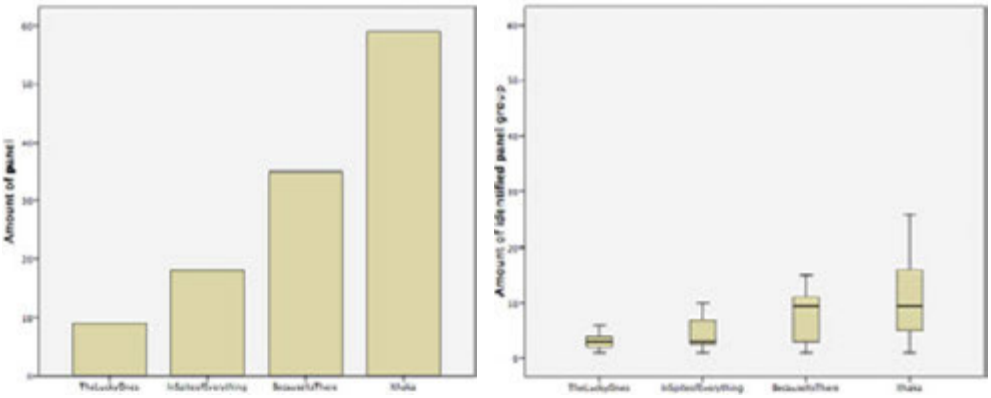


Figure 3.6: (a) The number of panels of each comic story, (b) The mean and deviation of identified panel groups of each comic story

The Lucky Ones: In Figure 3.7, the vertical blue line represents the threshold of 50% of the participants (10 out of 20). Gap 10 is the only gap that showed an overall agreement of participants above this threshold. Twelve (60%) placed a segmentation line to indicate different panel groups. However, Gap 10 is a gap between the end of a narration panel and an experiment introduction panel.

There is no panel Gap with an agreement above 50% among the segmentations between the panels (Gap 2 to Gap 9). Gaps 3, 5 and 7 have higher numbers of segmentation line placement compared to Gaps 2, 4, 6, 8 and 9.

In Spite of Everything: Two clear segmentations can be observed in this story: Gap 8 (75%) and Gap 17 (70%). Gap 8 is the gap that contains the narrative transition when the story is going backward in time (the adult character starts to recall his childhood memory). Gap 17 bridges the jump from the past to the present (the memory ends and the story returns to the adult character). In both Gap 8 and Gap 17 (Panels 8 & 9, Panels 17 & 18), clear changes in the panels where the segmentation took place can be observed; for example, in the character (appearance between adult and child) and also the changes in drawing style (from normal colour to mostly black and white). The panel sequence segmentations in this story have created three panel groups.

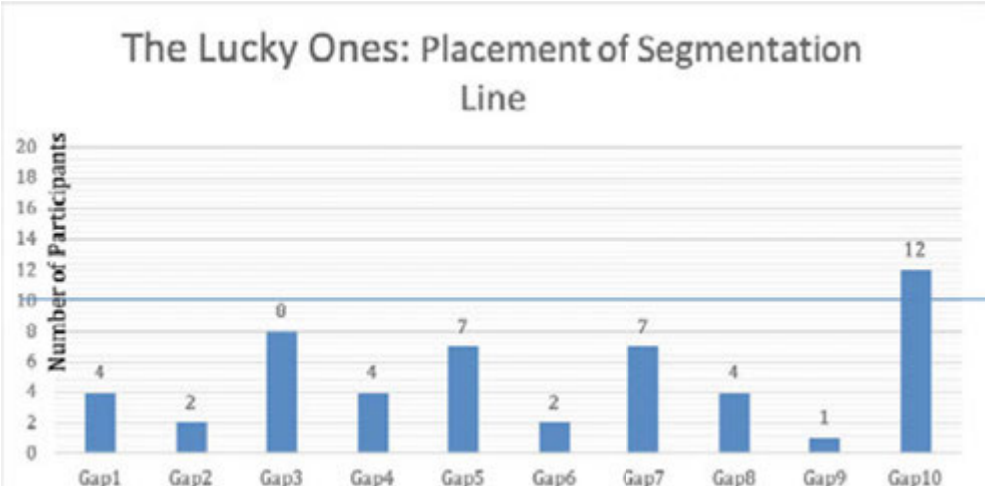


Figure 3.7: Placement of segmentations in The Lucky Ones.

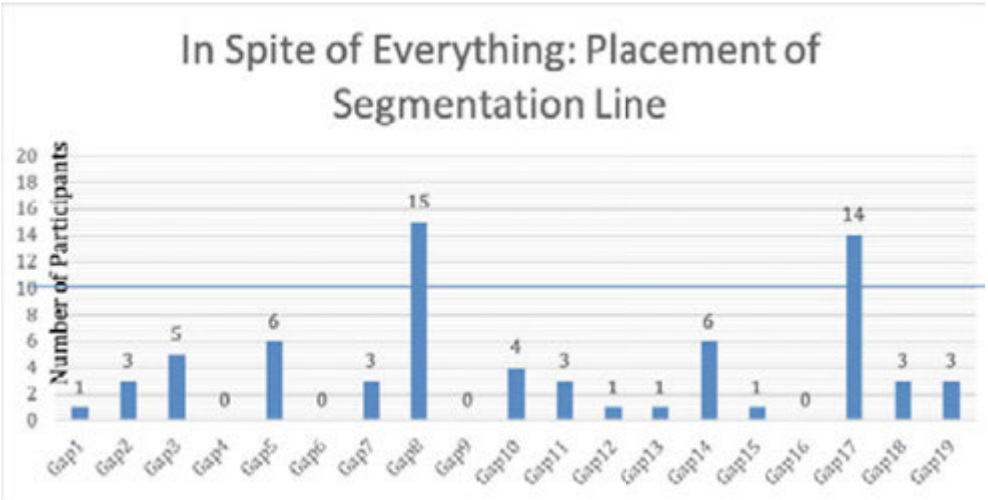


Figure 3.8: Placement of segmentation lines in In Spite of Everything

Because It's There: In this story, 9 gaps received 50% or more agreement of the participants about the segmentations: Gap 3 (n=17), Gap 7 (n=14), Gap 12 (n=11), Gap 14 (n=14), Gap 19 (n=12), Gap 21 (n=13), Gap 24 (n=13), Gap 25 (n=12), and Gap 36 (n=10).

» Gap 3 represents a narrative transition of the main character moving out from his lab to go public. Visually, it includes changes of environment (lab to public stage), character (number of characters), object (lab equipment then an airplane), text (from no text to some narration text), frame (from a shorter panel to a longer panel), and camera angle (from zoom in to zoom out).

» Gap 7 represents the main character finishing his speech then departing with the airplane. Visually, it includes changes of object (from no airplane to focus on the airplane), text (from speech text to no text), camera angle (from a peak of the speech stage to focus on the airplane).

» Gap 12 represents a transition between the story of the main character in a newspaper and a rich couple walking in a jewelry store, while the clerk is reading the newspaper. Visually, it includes changes of character (from the main character to the couple), camera angle (from zoom in to out), and frame (from shorter to longer).

» Gap 14 represents a transition in narrative from the couple to the main character. This includes changes of environment (from the jewelry store to a snowy landing place of the airplane), character (from the couple to the main character), text (the narration text), and frame (from longer to shorter).

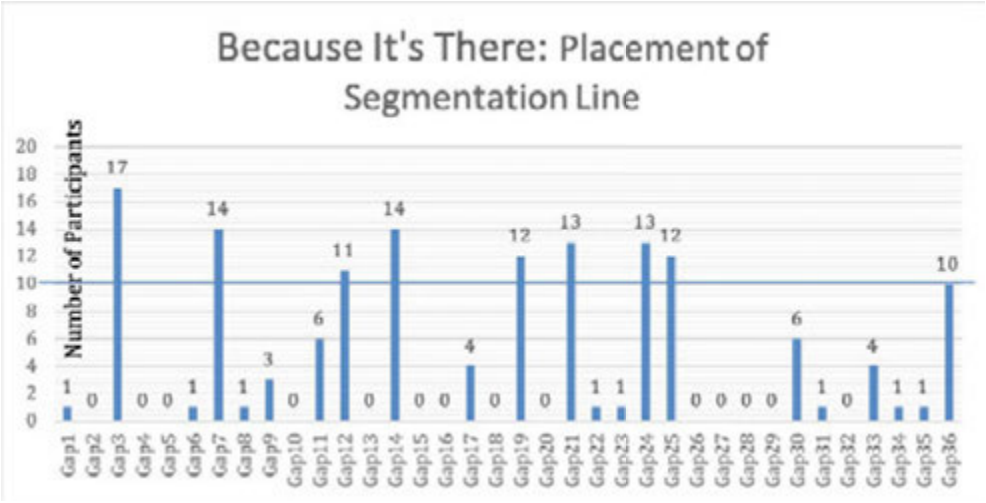


Figure 3.9: Placement of segmentation lines in Because It's There

» Gap 19 represents a transition in narrative to compare the similar actions of the main character with the couple. From the main character digging on top of the snow mountain, to the couple using a fork to eat the meat. It includes changes of environment (from the snowy mountain to a dining table), object (from mountain climbing equipment and the mountain to a dining fork and the dish), character (from the main character to the couple), symbol (from no symbol to motion lines to represent the movement of the fork), text (from narration text to no text), frame (from longer to shorter), and camera angle (from zoom out to zoom in).

» Gap 21 represents a transition from the rich couple eating a luxurious meal to the main character climbing the mountain. It includes changes of character (from the couple to the main character), environment (from the dinner to the mountain), object (forks to mountain climbing equipment), text (different narration text), symbol (from no symbol to motion lines to exaggerate the main character's motion), and camera angle change (from zoom out to zoom in).

» Gap 24 represents a transition from the main character who found some skeletons on the mountain to the leftover bones on the couple's dining table. It includes changes of character (from the main character to the couple), environment (from the mountain to the dinner), object (from skeletons to bones), text (different narration text), and frame (from shorter to longer).

» Gap 25 represents a transition from the couple back to the main character. It includes changes of character, environment, object (leftovers on the table to some unknown equipment from the main character), text (from with narration text to without), and frame (from longer to shorter).

» Gap 36 is the gap between the end panel of the story and the instruction image for completing the experiment.

There are nine segmentations in this story which are most clearly indicated by the change of characters. This division created two panel groups with only two panels (Panels 13 & 14, Panels 20 & 21), and two single panel groups (Panels 12, Panel 25).

Ithaka: There are some gaps where the agreement among participants about the segmentation lines is 50% or more: Gap 6 (n=17), Gap 30 (n=16), Gap 37 (n=11), and Gap 49 (n=11).

» Gap 6 represents the main character making up his mind and then starting his journey. It includes changes of environment (from inside the house to the ocean), text (from no text to the tile of the story), object (from a map to a boat), frame (from longer to shorter), camera angle (from zoom in to zoom out), and drawing style (the colour tone from brown to blue).

» Gap 30 represents a transition from a red stone dropping on the water (after the main character defeats the monster) to the main character getting older with grey hairs, one wounded eye, and the red stone as a necklace. It includes changes of character (from a younger main character to the main character becoming older), object (the red stone becomes the main character's necklace, and the wounded eye from the previous battle got an eye cover), text (from no text to narration text), and drawing style (the colour tone from blue to yellow).

» Gap 37 represents a transition of the main character in a harbour area to an Egyptian city. It includes changes of character (from the main character with a big crowd watching a dance, to tiny human figures near the huge city gate), environment (from the harbour area to the big city), object (from no object to the city gate with statues), text (difference in narration), frame (from longer to shorter), camera angle (from horizontal to high angle), and drawing style (the colour tone from purple to light yellow).

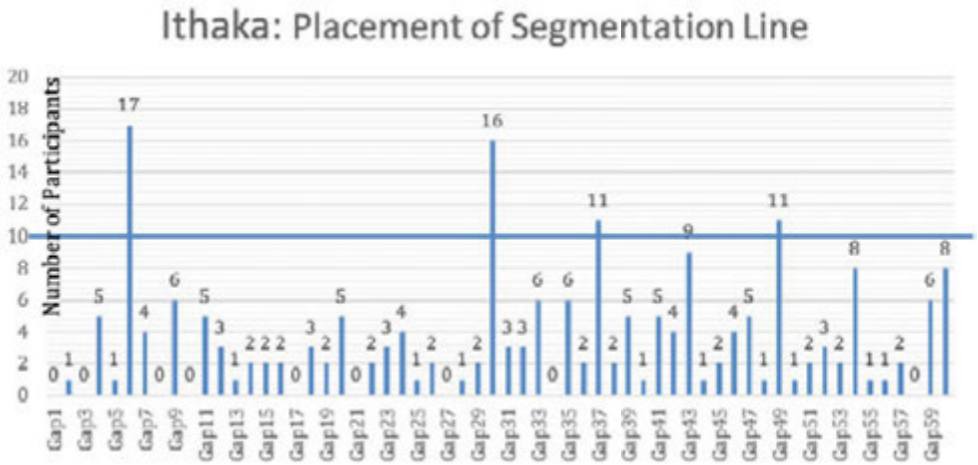


Figure 3.10: Placement of segmentation lines in Ithaka.

» Gap 49 represents a transition from the main character receiving a newborn, to him getting old and making a map. It includes changes of character (the appearance of the main character became old), environment (from baby room to study room with a fireplace), object (from no object to the map-making equipment such as scrolls and a pen), frame (from shorter to longer) and drawing style (the colour tone from light blue to warm orange and brown).

3.3.3 The panel group with one panel

Segmentation lines on both sides of a panel, creating an individual panel, were identified in total 45 times in 4 stories, in which 17 times were identified as "this panel belongs to both groups", and 28 times as "it's an independent panel". Twenty-seven participants (33.75%) identified individual panels in the experiment.

3.3.4 Reasons of segmentation

The participants were asked to choose a general reason for placing the segmentation line from nine options:

1. Change of character (action, facial expression, appearance, number of characters);
2. Change of object (appearance, movement, etc.);
3. Change of environment (location, weather, etc.);

4. Change of other symbols (motion line, impact star, etc.);
5. Change of text (character speaking, narrator's voice, sound);
6. Change of story time;
7. Change of frame/panel shape;
8. Change of camera angle (zoom in, zoom out, look down, look up, etc.);
9. Change of drawing style (colour, strokes, abstract/concrete, etc).

Selecting multiple options was possible. The result is described in Figure 3.11. "Environment change" (n=38) and "story time change" (n=37) were the main reasons which were identified. The second group included "text change" (n=23), "drawing style change" (n=21) and "character change" (n=20). "Object change" (n=6), "symbol change" (n=5), "panel shape change" (n=5) and "camera angle change" (n=2) were reported to have less influence.

The Lucky Ones has the lowest total number of reasons (n=23), while *In Spite of Everything* has 48, *Because It's There* has 36 and *Ithaka* has 50. Segmentation in different stories appears to be related to different reasons.

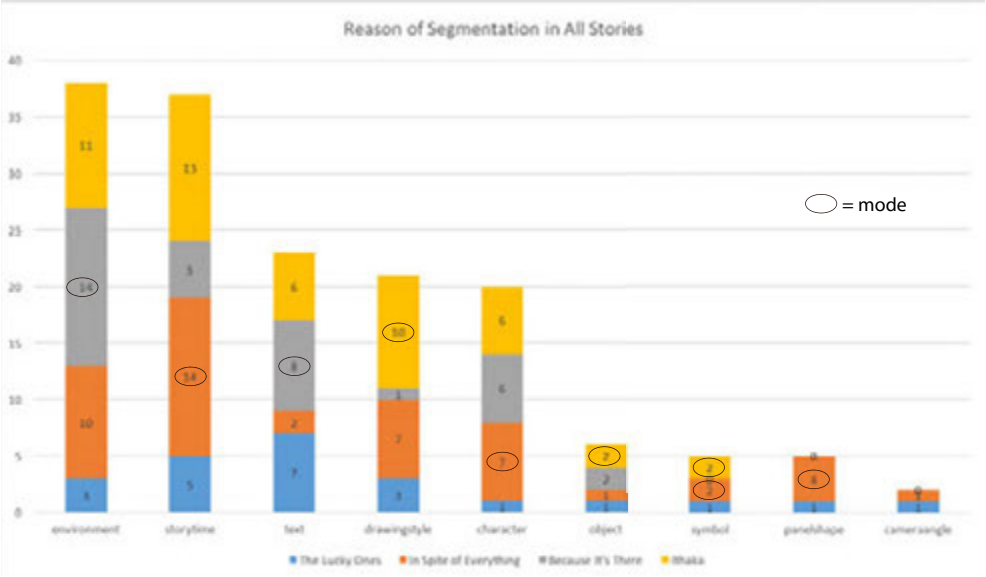


Figure 3.11: Frequencies for reason for segmentation in all four stories.

Text plays a major role in *The Lucky Ones*. Story time, environment, drawing style and character are the main reasons in *In Spite of Everything*. *In Because It's There*, environment and text are the main factors. Story time, environment and drawing style are most important in Ithaka. Certain reasons were not identified for certain story. No symbol change was identified in *Because It's There*. No panel shape change and camera angle change identified in *Because It's There* and *Ithaka*.

3.3.5 Perceived story time

Participants were asked to identify the perceived story time features from eight possible options:

1. goes forward;
2. goes backward;
3. contains flashback;
4. jumps to the future;
5. contains a time loop;

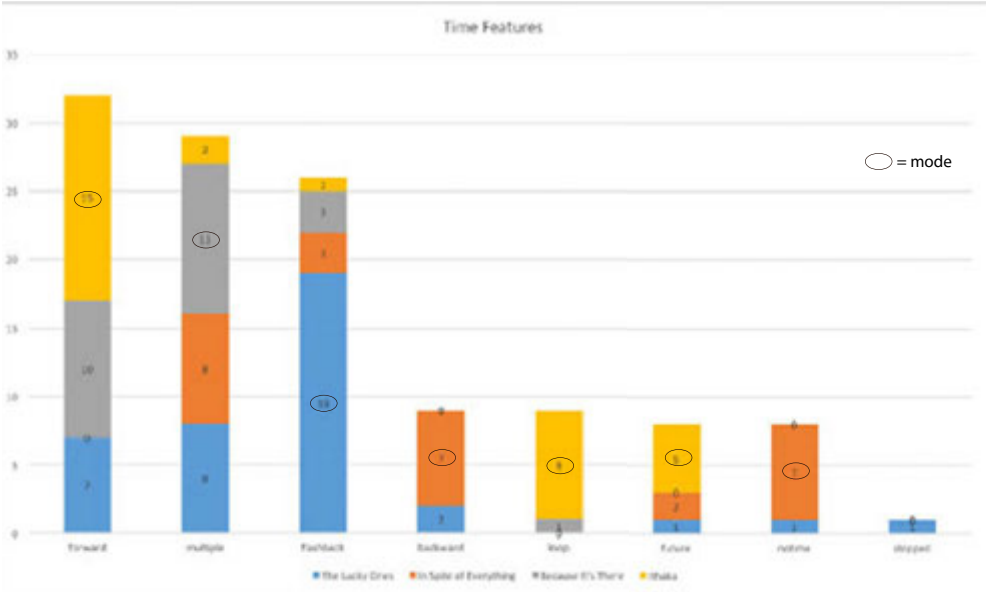


Figure 3.12: Frequencies of time features.

6. stops;

7. no time in story;

8. multiple timelines in story.

Selecting multiple options was possible. The result is described in Figure 3.12.

"Goes forward" (n=32), "multiple timelines in story" (n=29), and "contains flashback" (n=26) were the main time features which were identified. The other features were identified less: "goes backward" (n=9), "contains a time loop" (n=9), "jumps to the future" (n=8), "no time in story" (n=8), and "stops" (n=1).

In *The Lucky Ones*, there was no dominant agreement ("multiple timelines"=8, "backward"=7, "no time"=7, "flashback"=3, "future"=2). In *In Spite of Everything*, participants had clear agreement on the "flashback" perceived story time feature (n=19), while "multiple timelines" (n=8), "forward" (n=7), "backward" (n=2), "future" (n=1), "stops" (n=1), and "no time" (n=1) were also indicated. "Multiple timelines" (n=11), "forward" (n=10), "flashback" (n=3) and "time loop" (n=1) were identified in *Because It's There*. In *Ithaka*, the opinions included "forward" (n=15), "time loop" (n=8), "future" (n=5), "multiple timelines" (n=2), and "flashback" (n=1).

3.4 Discussion

3.4.1 The Influence of the Instruction Panels

As was described in the experiment design (Section 3.2.3), two instruction panels were included in the panel sequence display to help the participants in the beginning and the end of the task. Therefore, the first gap (Gap 1 in every story) and the last gap in each story are the gaps between an instruction panel and a story panel. The last gaps are: Gap 10 in *The Lucky Ones*, Gap 19 in *In Spite of Everything*, Gap 36 in *Because It's There*, and Gap 60 in *Ithaka*.

In *The Lucky Ones*, 4 participants placed a segmentation line in Gap 1, while 12 participants placed a segmentation line in Gap 10. In *In Spite of Everything*, one line was placed in Gap 1, and three lines in Gap 19. In *Because It's There*, one participant placed a segmentation line in Gap 1, while 10 participants placed a line in Gap 36. In *Ithaka*, no participants placed a segmentation line in Gap 1, and 8 participants placed a line in Gap 60. Among all these gaps, there were only two gaps in which 50% or more of the partic-

ipants agreed on placing a segmentation line: Gap 10 in *The Lucky Ones,* and Gap 36 in *Because It's There*. We assume that the participants should be able to distinguish the instruction panels from the story panels. However, no consistent result could be observed based on the segmentation lines. In other words, not every participant treated the gaps around the instruction panels equally.

One possible reason that there were two gaps among the instruction panels where 50% of the participants agreed on the segmentation lines, is that there were no other segmentation possibilities nearby. In *The Lucky Ones*, Gap 10 is the last gap, and in all the previous nine gaps there was no other panel where 50% or more of the participants agreed about the segmentation. Since the participants were asked to place segmentation lines wherever possible, Gap 10 is the most obvious difference from the other story panels. In *Because It's There*, the closest gap where more than 50% of the participants placed segmentation lines is Gap 25, 11 panels before Gap 36. This may suggest that the panel sequence segmentation has a relation to the number of panels. Readers may be able to identify a segmentation, only after a certain number of panels. From the current result, the smallest panel group is one panel (Panel 25 in Because It's There), and the biggest panel group includes 24 panels (Panels 7-30 in Ithaka).

3.4.2 General panel sequence segmentation pattern in each story

The identified segmentations and panel grouping varied between individual participants. This could be related to age, gender, education, cultural background, and personal experience. The general patterns within the individual stories are reported below.

In *The Lucky Ones* there is no specific pattern where over 50% of the participants agreed on segmentation lines. An interpretation of this could be that the participants found it hard to make segmentation lines, and therefore formed a group of all the panels. The responses from the questionnaire about the reasons for segmentation were also quite low and mainly relate to the change of "text". In relation to the question about time features, "multiple timelines", "backward" and "no time" received the highest attention. These two factors have a strong connection with the narrative. These results suggest that the difference in the text itself cannot lead to panel grouping when the narrative has no clear division and the time inside the narrative is vague. In other words, the narrative behind visual elements could play a major role in the decision of panel sequence segmentation.

In *Spite of Everything* is the clearest example in the four stories where the participants agreed about the segmentation. Three groups were identified by over 70% of the partic-

ipants. The questionnaire results show that the flashback of story time was identified as the primary cause, with the support of "environment", "drawing style" and "character". It can be concluded that a narrative change (narrative time jumps back or fast-forwards in this case) combined with visual aids such as changes in environment, character appearance, and colour can send a strong signal to the reader about segmentation.

Nine panel groups were identified in *Because It's There* according to the data collected. It is the comic author's intention in this story to use the different perspectives of two characters to create a comparison. As a result, "multiple timelines" and "forward" are reported as the important time feature in the story; "environment", "text", "character" and "story time" were considered as the primary reasons for panel sequence segmentation. Most of the segmentation lines were based on the switch of characters. This result suggests that even when the narrative structure is two parallel stories (the two character parties are used as a comparison instead of pushing the narrative forward), the character change combined with environmental change can also generate segmentations.

Ithaka has the longest forward-moving timescale among the four stories. There is a lifelong transition where the protagonist grows up from young to old, combined with a detailed description of a short duration about the monster-slaughtering moment. Four segmentations (Gaps 6, 30, 37 & 49) have received over 50% of the recognition rate. Gap 43 received almost 50% of the recognition rate (n=9). The participants indicated the following reasons for the panel sequence segmentation decision: "story time" (n=13), "environment" (n=11), "drawing style" (n=10), "text" (n=6), "character" (n=6), "object" (n=2), and "symbol" (n=2).

3.4.3 Panel grouping categories

There were not enough panel groups where 50% or more of the participants agreed on the segmentations, and therefore it is not sufficient to conclude a clear pattern. However, different categories of panel groups can be observed from the experiment. One category is a clear segmentation of the panel sequence based on the reader's understanding of the comics. For example, in a three-panel linear sequence, Panels 1 and 2 are segmented from Panel 3. In this case, two panel groups are identified: Group 1 with Panels 1 and 2, and Group 2 with Panel 3.

Another category is an overlap of two panel groups based on the understanding of the reader. For example, in a three-panel sequence, Panels 1 and 2 are considered as a group, while Panels 2 and 3 are also considered as a group. In this case, two panel groups are

identified: Group 1 with Panels 1 and 2, and Group 2 with Panels 2 and 3. Panel 2 is the overlap between the two panel groups. Two examples from Because It's There can be used to explain this category further (Figure 3.13). Panel 12: although the connection in the environment is strong with Panels 12, 13 and 14, the connection of character and narrative is strong with Panels 10, 11 and 12. The other example is Panel 25: an identified single-panel group (both Gap 24 and 25 have received segmentation lines by over 50% of the participants). Based on the results of the questionnaire, two participants indicated that the panel belongs to both the previous and next panel group. This difficulty to match it to one of the panel groups could be caused because the characters in Panel 25 changed, but the images and the connection of the text remain very similar.

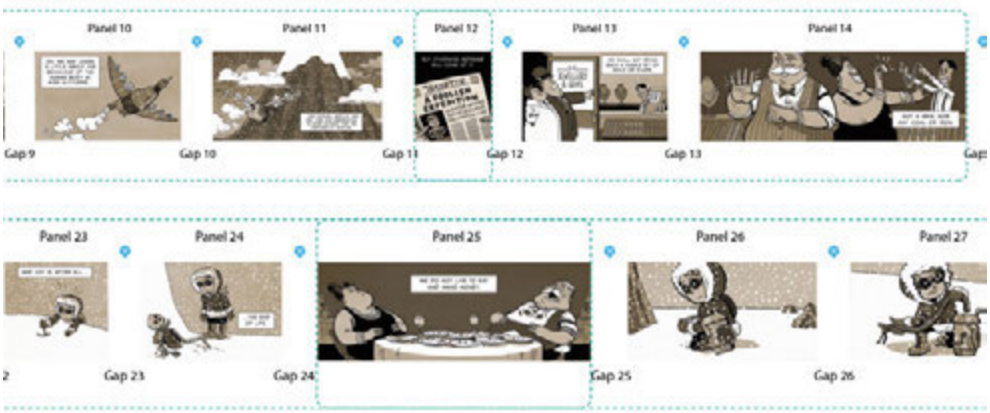


Figure 3.13: Identifying panel grouping categories.

Since there are two categories of the segmented panel group (one is without overlapping of each other, and one is with overlapping of each other), it is necessary to create a vocabulary to be able to differentiate between the different categories of panel grouping.

3.4.4 Limitation of the Experiment Design

Although the experiment included a visual instruction of the task in the beginning, it cannot be confirmed whether the participants fully understood the task. Some participants submitted the task without any segmentation lines. It cannot be determined whether this was because they didn't understand the task, missed the button, or did not identify any segmentations in the panel sequence. Furthermore, the questionnaire included several specialised terms such as "symbols" and "story time". Although we have conducted a pilot study before the experiment, we are not sure whether the participants

could fully understand the meaning due to the different languages of the participants. In future experiments, this could be improved by using visual aids to explain the specialised terms.

Another limitation of this study was that the answers about why the participant placed segmentation lines between the panels were not detailed enough. Before the formal test, a pilot test was executed with several participants to improve the procedure and phrasing. The whole experiment required around ten minutes to finish (the stories with more panels took longer). Since it was an online experiment, the tasks were kept intentionally short, since otherwise there could be a risk participants might pause or even quit the experiment. Under this time limitation, it was difficult to ask the participants for the detailed argumentation for each segmentation line. Instead, we only asked the participants to recall in general the reasons for all segmentation lines in the questionnaire. Although the results draw a general picture of the potential reasons, it is not possible to analyse the argumentation for each segmentation line. A detailed analysis of the identified segmentations should be conducted to clarify the underlying reasons.

3.5 Conclusion

So far in this dissertation, the terms panel sequence segmentation, panel groups, and panel group categories have been used to address the panel level units (both segmentations and groups). These concepts turned out to be crucial in understanding and designing d-Comics. Since there are no existing terms for these units, it is necessary to establish a new vocabulary in d-Comics, with detailed definitions of these panel-level concepts.

There are two types of panel groups that were observed from the previous experiment. One is with a clear segmentation of the panel sequence, the other is with an overlap of two panel groups both based on the understanding of the reader. The two types of panel groups and the segmentation are shown in Figure 3.14. Based on the experiment results we propose the following vocabulary to be established, in order to discuss the panel-level concepts more precisely.

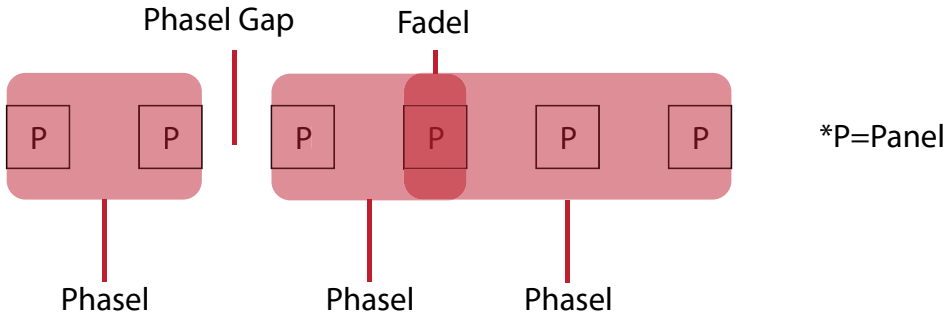


Figure 3.14: Demonstration of phasel, fadel and phasel gap.

3.5.1 Phasel

A *phasel* (created by combining "phase" and "sequel") in d-Comics is represented by one panel or multiple panels that belong to each other. The author cannot decompose these further into smaller phasels. A phasel describes a strong relation among a certain number of panels and a significant difference with other phasels, determined by the author's interpretation of storytelling.

From the previous experiment, the smallest phasel observed was a single panel phasel, and the largest phasel was a twenty-four-panel phasel.

3.5.2 Fadel

A *fadel* (created by combining "fade" and "sequel") is represented by one panel that the author considers to be part of both the previous phasel and the next phasel. A fadel describes an overlapping transitional relation between two phasels, and it contains both the fading of the previous phasel and the starting of the next phasel determined by the author's interpretation of storytelling.

From the previous experiment, some of the participants were able to identify the overlapped phasels, however, some readers just categorised the overlapped panel(s) into the previous or the next phasel.

3.5.3 Phasel Gap

A *phasel gap* represents panel-level segmentation. This concept is introduced to be able to distinguish from the visual gap between panels (also known as "panel gap" or "panel gutter"). As long as there are two panels, there must be a visual gap. However, the visual gap does not necessarily need to be a phasel gap. Only when two phasels are identified can the visual gap between these two phasels represent a phasel gap. In the case that a fadel is identified — which means that there are overlapping phasels — there cannot be a phasel gap between the overlapping phasels.

3.5.4 Examples

With this new vocabulary, the previous results of the experiment can be described more efficiently in order to further discuss the design space in d-Comics (Figure 3.15). For example, the story In Spite of Everything can be divided into three phasels, with two phasel gaps in-between the phasels. In the story Because It's There there is one panel which was identified to belong simultaneously to the previous and the next phasels; now this panel can be identified as a fadel.

3.5.5 Conclusion

In this experiment, the potential influences of the physical page structure were removed, such as the complex panel layout, and the different gap size between panels. The fact that participants were still able to make panel grouping — based on linearly presented panels on electronic devices — shows that a panel sequence, without the influence of physical pages, can still be segmented in d-Comics. From Experiment 1, two types of panel groups were identified: one is with a clear segmentation, and the other is an overlap of two panel groups, both based on the understanding of the reader. This finding answers how a panel sequence can be segmented in d-Comics. Based on this finding, a new vocabulary has been created. It includes the concepts *phasel, fadel* and *phasel gap*. This vocabulary will be applied in the following explorations and discussions.

The decisions by the participants to place segmentation lines seemed to be influenced by several factors. In order to investigate more precisely which factors can lead to phasels and fadels, the second research question — What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations? — is the next in line to be explored.

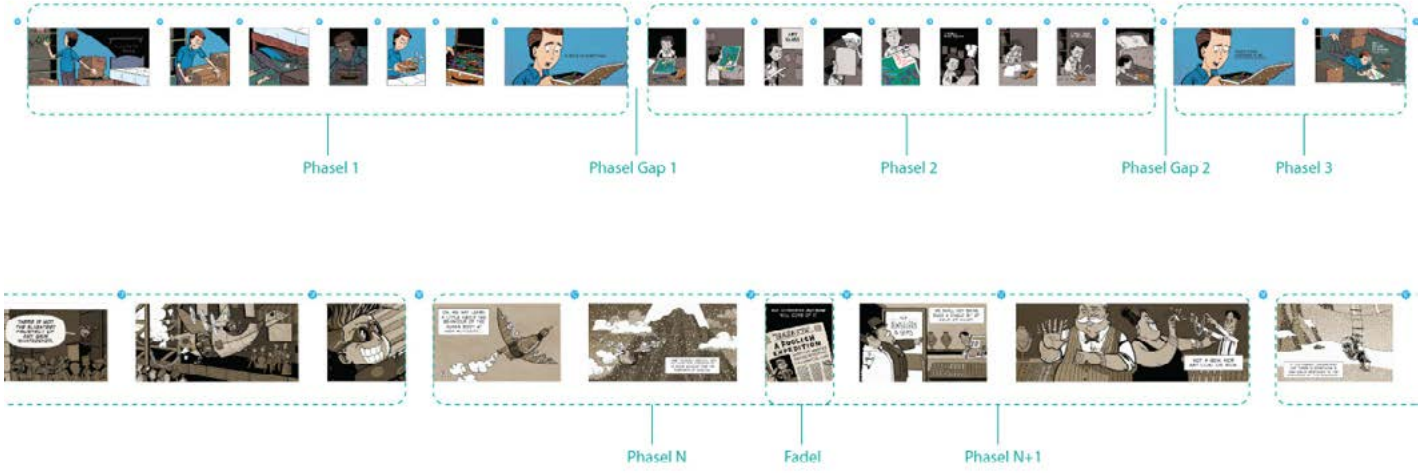


Figure 3.15: Examples of phasel, fadel, and phasel gap.


LIKE THIS?
FIRST LINE UP.
THEN... SEGMENTATION!!!
WWWHAT?
WHAT R U DOING?
IS THIS THE SOLUTION?
NOT YET THE SOLUTION,
BUT VERY IMPORTANT TO KNOW.

CHAPTER 4

Strategies for Panel Sequence Segmentations in d-Comics

Chapter 3 presented an online experiment that has been conducted to test how panel-level segmentation can be identified in d-Comics. The results of this test revealed that a linear panel sequence in d-Comics can be segmented into panel groups (phasels and fadels). A phasel is a regular panel group, while a fadel suggests an overlay between two phasels. This chapter will further explore the underlying reasons for identifying panel sequence segmentations in d-Comics. When creating printed comic books, the author can intuitively arrange the panels based on the existence of physical pages, and use this to communicate complex panel relations (Section 2.4.1). However, there is no existing research about how to communicate the intended segmentations from the author to the reader in d-Comics. The current webcomics normally apply the existing structure of a web page (Kogel, 2013). One story is contained on one web page, and the vertical height of the web page resizes, depending on the number of panels in the story. The transition between two comics stories (two panel sequences) relies on interaction such as a button click or by touching the screen. There are no other segmentation strategies considered within the panel sequence, but only on the full panel sequence level. However, before continuing with the interaction design based on the new vocabulary of panel sequence segmentation in d-Comics, it is necessary to answer the second research question: What could be the strategies for creating panel sequence segmentations in d-Comics? Under the scope of this question, the following questions will also be explored: are there any strategies for panel segmentation that are shared between printed comics and d-Comics? Are there any unique strategies that can only be applied in d-Comics?

Section 4.1 reviews the existing research about segmentation in comics. Section 4.2 introduces an experiment where a group of reviewers analysed the results gained from the first experiment. The result and discussions are reported in Section 4.3 and Section 4.4. Section 4.5 summarises the strategies of panel segmentation in d-Comics.

4.1 Introduction

Using segmentation to make sense of information is not only applied in the creation and reading of comics; in fact, it is universal among storytelling media (Gernsbacher, 1985; Magliano, Kopp, McNerney, Radvansky, & Zacks, 2012; Magliano & Zacks, 2011). "The world is presented to us as a stream of continuous information, but we can perceive this information as a series of discrete units. This process is called event structure perception, and the discrete units, or events, are defined as segments of time at particular locations that are perceived, by observers, to have beginnings and endings" (Zacks, Speer, & Reynolds, 2009). Based on empirical results of reading and film comprehension, Zacks and his

colleagues concluded that "processing situational changes during comprehension is an important determinant of how one segments ongoing activity into events and that this segmentation is related to the control of processing during reading" (Zacks et al., 2009). This statement can be considered as the foundation of understanding segmentation in comics.

When combining these principles about segmentation with the comics creation process as described in Section 2.1.2, it could be argued that the author defines segmentation during the conceptual interpretation and then uses visual forms to express the segmentation. However, the reader's understanding of segmentation may not match the author's initial purpose. In fact, it has been shown in Experiment 1 (Section 3.1) that the reader's understanding varies individually.

Before providing comic authors with strategies that can be used to create segmentations, it is necessary to investigate how segmentation occurs in comics. There are existing theories that can contribute to the understanding of segmentation in comics. The next sections will introduce segmentations that exist in narrative structure and spatial arrangement.

4.1.1 Narrative structure

As discussed in Chapter 2, comics as a storytelling medium contain a narrative, and the panels represent part of the narrative. In other words, the narrative has to be conveyed through the panels and a reader will generate the narrative in mind after reading the panels.

A narrative can be understood as a construction based on connected events (Herman, 2009; Martin, 1986). Therefore, there is also a connection between narrative events and panels. The segmentation of a panel sequence could partly reflect the segmentation of events in a narrative.

Similar discussions of segmentation can be found in the literature. Bateman et al. (2016) proposed an open, multilevel classification scheme for the visual layout of comics. Cohn (2013a) established a narrative structure for the visual language of comics by identifying categories such as peaks, initials, releases, establishers, prolongations, and orienteers. These categories have been verified through cognitive experiments where the different event categories were compared with the reaction of the brain. Cohn (2013a) proposes further that these categories can form hierarchies based on panels. Each panel can be

described by a category, and multiple categories could again be described by a category on a more global level. This description by categories can be compared to a panel sequence segmentation. Figure 4.1 shows an example of such hierarchical tree structure.

In Cohn's example of a narrative structure (Figure 4.1), the first two panels can be considered as a panel group because they all belong to one higher-level category. The next four panels belong to the second group since they are all part of a second higher-level category. Translated to the language created in the previous chapter, the first panel group is Phasel 1 and the second panel group is Phasel 2. Based on this it can be argued that the panel segmentation vocabulary described in this dissertation (phasel, fadel, phasel gap) can be supported by this narrative structure at the leaf level of the tree, since phasels cannot be further decomposed to smaller phasels.

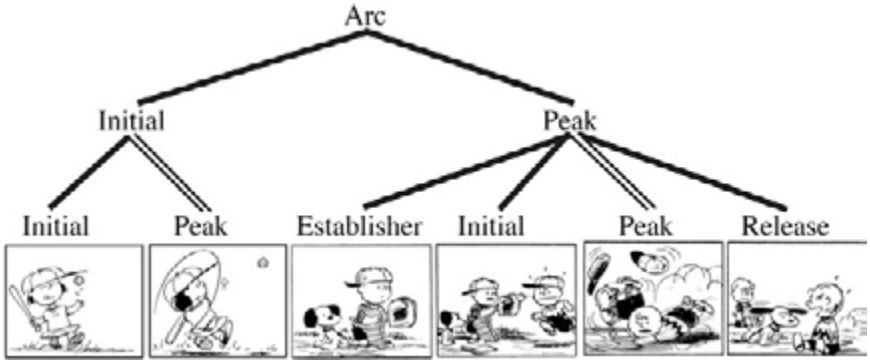


Figure 4.1: The hierarchical tree structure described by Cohn (Cohn, 2013b).

In a later discovered experiment of identifying segmentation with linear panel sequence, Cohn and Bender (Cohn & Bender, 2017) justified the connection of reader's decision of panel sequence segmentation and narrative categories.

4.1.2 Spatial arrangement

As has been discussed in Chapter 2, the author's interpretation has to be expressed through panels on a carrier. The illustrations in the panels, the spatial relation of the panels and the selection of the carrier are all part of the final construction that the reader will access. The interpretation of the author is conceptual, while the final construction that the reader will access is visible. This section uses the phrase ***spatial arrangement*** to refer to the visible part of comics. Section 4.1.2.1 will recap the panel creation elements and then discuss segmentation based on these elements. Section 4.1.2.2 will consider creating panel sequence segmentation in d-Comics.

4.1.2.1 Visual elements

In Section 2.2.2, eight visual elements of creating panels were introduced: environment, character, object, symbol, text, frame/panel shape, camera angle and drawing style. In Experiment 1 (Chapter 3) these elements were listed as possible reasons for panel sequence segmentation that the participants could choose. The results of the experiments showed that these elements do have an influence on the segmentation decision.

It is worth noticing that a segmentation can normally be identified because of a combination of multiple elements instead of a single one. For example, to express a jump backward in story time, the author used character appearance change, environmental change and drawing style change, while the key object remained the same (the comic story *In Spite of Everything*). The visual element changes are normally a reflection of the change in narrative or can be related to the author's consideration of storytelling (for example, planting a hint for an upcoming story). The visual elements discussed in this section can be further connected with the visual Gestalt theory (Palmer & Rock, 1994; Wertheimer, 1923) through the following principles: proximity, similarity, continuity, closure, and connectedness.

4.1.2.2 Distance between panels

A longer distance (space) between panels can be used to create a feeling of a longer duration of story time (McCloud, 1993). This means that the distance between panels could be used to create segmentations in the panel sequence. In printed comic books, the distance between the panels is obviously limited by the space that is available on the paper. However, the digital environment — as discussed in Section 2.3.2 — could provide a three-dimensional virtual space for placing panels. This means that a panel sequence doesn't have to be squeezed together as in a printed paper book, and wouldn't even need to be on the same two-dimensional plane. However, even when placing panels in an unlimited space, the distance between panels should still be limited in order to support the reading activity, instead of creating confusion. The digital discrete view on a screen, reported by Hou et al. (2017), can cause less good reading comprehension, feelings of fatigue, and psychological immersion. This result could be related with the changing distance of panels and the extra empty space between the individual panel and the screen.

It is important to address the panel distance since it is an aspect in d-Comics which offers unique possibilities enabled by the digital interaction. The distance in the digital environment is not a real physical distance. A combination of the reader's input and the display's output is required to create the feeling of moving over a distance in the digital environment. For example, two panels in d-Comics separated by a distance of 20 pixels can be visualised on the same screen at the same time; the reader doesn't have to perform any interaction to move this distance. However, the two panels cannot be visualised on the same screen at the same time if the distance between the two panels becomes 2000 pixels, since this distance would be over the screen size. In this case, the reader has to perform a specific input (such as using a finger to swipe on the screen) and the screen can provide a visual output that the canvas has been moved by the reader. The distance between the panels has been transformed into a relation between the user input and the screen output. In this example, the speed of the swiping motion of the finger is translated into a moving speed of the canvas. This notion will be further explained in Chapter 4 and Appendix VII.

4.2 Experiment design

As discussed in the limitations of Experiment 1 (Chapter 3), there are several issues that needed to be addressed: 1) the participants' understanding of the terminology in the experiment, and 2) the detailed reasons for each panel grouping decision. Therefore, for this experiment (Experiment 2) reviewers were invited to provide their detailed understanding regarding the results received from Experiment 1.

4.2.1 Materials

Firstly, a card set which visualised and explained the potential reasons for panel sequence segmentation was created (Appendix III) to help improve the reviewers' understanding. The reasons were adopted from the questionnaire in Experiment 1 (Appendix II).

However, based on observations from the experiment, one addition was made. According to the results, story time plays an important role in understanding panel sequence segmentation. Story time is different from the other visual elements because — besides visual elements — it can also be influenced by the personal interpretation of the reader. Therefore, "difference of story time" (reason nine) was added to the cards. By summarising the eight time features (Section 3.3.5) into more generic attributes of story time, we further divided this reason into "story time direction" and "story time duration" to receive

more detailed feedback. "Story time direction" can cover features 1, 2, 3, 4, 5 and 8. "Story time duration" can cover features 6 and 7, and can also capture the duration difference of different visual gaps.

The card set visualised nine reasons with examples for panel sequence segmentation. Reason 1 is "difference of character" that includes action, facial expression and appearance of the character, and the number of characters. Reason 2 is "difference of object" that includes appearance and movement of the object. Reason 3 is "difference of environment" that includes weather and location change. Reason 4 is "difference of symbols" that includes motion lines and impact stars. Reason 5 is "difference of text" that includes character speaking, narrator's voice, and other sound. Reason 6 is "difference of frame/panel shape" that includes different frame size and shape. Reason 7 is "difference of camera angle" that includes zoom in, look up, and look down. Reason 8 is "difference of drawing style" that includes colour, stroke, and from abstract to concrete. Reason 9 is "difference of story time" that includes difference of story time direction and duration.

Secondly, a training session was created to introduce the reviewers to how the provided card set should be applied. Four other examples from *SIR KEN ROBINSON: Full body education* (Than, 2014b) — from Gavin Aung Than, the same author of the stories in Experiment 1 — were selected (shown in Figure 4.2). The reasons were listed with coloured check boxes, which matched the colours of the card set. The examples and checkboxes were printed on a long paper roll (to fit the horizontal linear panel layout). The size of the paper roll was 29.7 × 84 cm (two A3 papers connected with the longer edges).

Thirdly, the four comic stories from Experiment 1 were exported from the web and printed on a long paper roll (Figure 4.3 shows part of one paper roll). The print on the paper roll contained the linear panel layout, two introduction panels, the crop icons between panels, and under the panels the complete set of reasons with the coloured checkboxes. The length of *The Lucky Ones* was 29.7 × 84 cm, *In Spite of Every Thing* was 29.7 × 126 cm, *Because It's There* was 29.7 × 252 cm, and *Ithaka* was 29.7 × 294 cm. The reviewer could indicate on the paper roll — using the checkboxes — the reason for every gap, especially for the identified segmentations.

Finally, the result of the segmentation by the participants of Experiment 1 was printed and shown to the reviewers. The goal of this step was to trigger discussion of the reviewers about the segmentations created by the participants of Experiment 1.

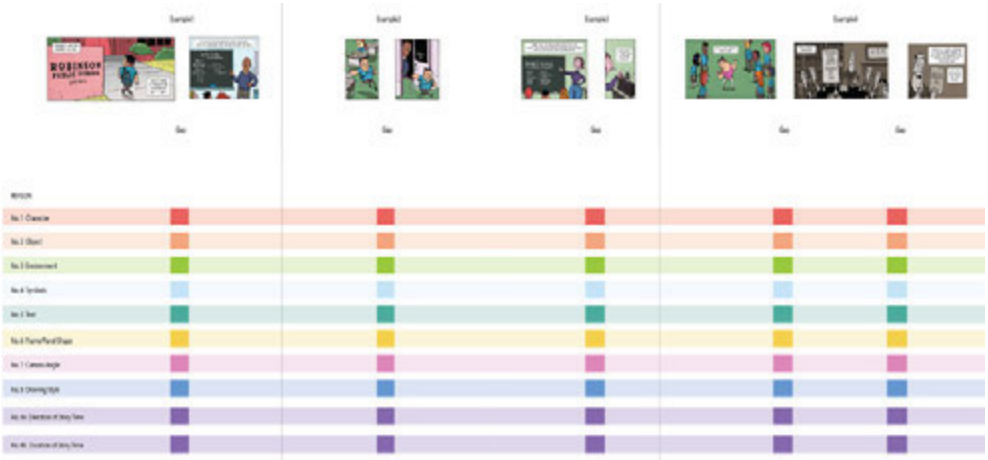


Figure 4.2: The layout of the training examples.

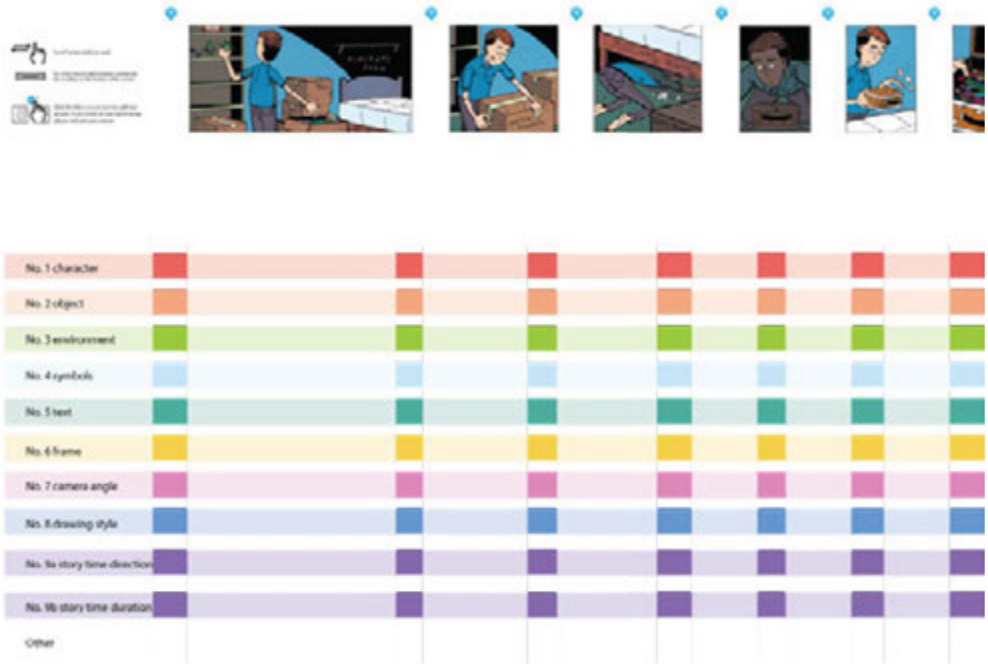


Figure 4.3: The layout of the experimental setting.

4.2.2 Procedure

Three reviewers were invited to justify the results from Experiment 1. The reviewers were all PhD researchers in the field of Industrial Design. One female and two male, with an average age of 29.7. The cultural background of the reviewers were: one Asian, one European and one American. Each reviewer was invited to an office where the test was conducted. First, the goal of the experiment was introduced, and then the card set with the reasons for segmentation was provided and introduced. After the reviewer had confirmed the understanding of the card set, the training session started.

In the training session, the full comic story was presented linearly on a touch-screen tablet (screen size 9.7 inches, resolution 1024 x 768 pixels). Simultaneously, a long paper roll was placed on a table with the same linear story and the coloured checkboxes to mark the reasons for segmentation. The reviewer could use the card set as a reference for the training task. As the investigator I was involved in this session to confirm the reviewer's opinions regarding the answers.

After the training session, the reviewer was provided, one by one, with each of the four comic stories which were also used in Experiment 1. Besides the interactive version on the tablet, a long paper roll was placed on the table for each story that could be used to fill in the reasons for each segmentation. After the reviewer had finished filling in the segmentation reason for each gap in each comic story, an interview was conducted. I asked the reviewer their opinions about the segmentation data received from Experiment 1. Each reviewer answered the questions for all four comic stories. The conversation was audio-recorded during the whole interview.

4.3 Results

The aim of this experiment was to investigate which specific elements in the panel sequences can influence the decision of segmentations. In this section, the data that resulted from the questionnaires and interviews from the reviewers will be analysed to find similarities among the reviewers. Two visualisation methods will be applied to inform the analysis. The intersection strategy will be used to visualise the reasons that all the reviewers agreed. The union method will be used to visualise all the reasons combined for each gap by all the reviewers, no matter if there was only one reviewer who considered it or all of them. The category and colours in the visualisations match with the colours used in the questionnaire. To provide a clear comparison between the different segmentations in each story, both the intersection and union visualisation will be discussed.

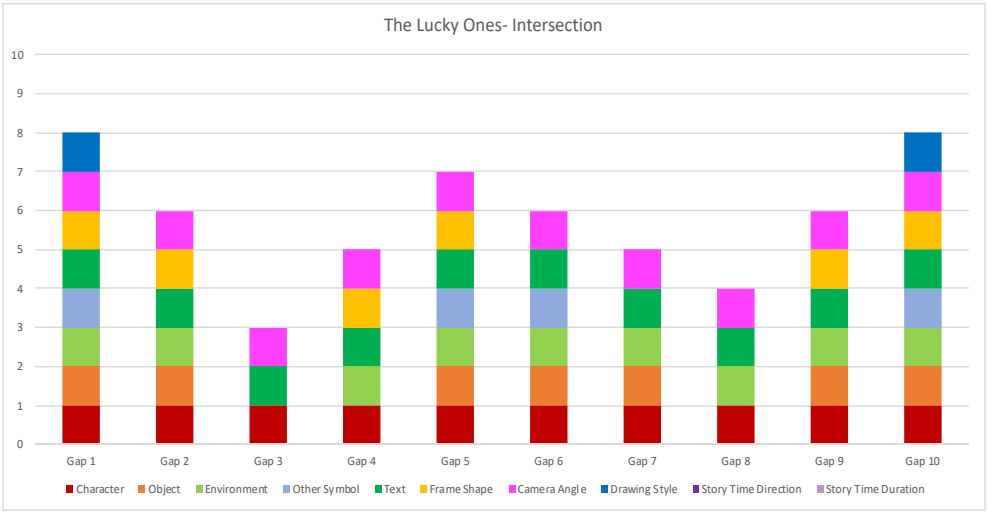


Figure 4.4: Intersection of the reasons for segmentation of The Lucky Ones.

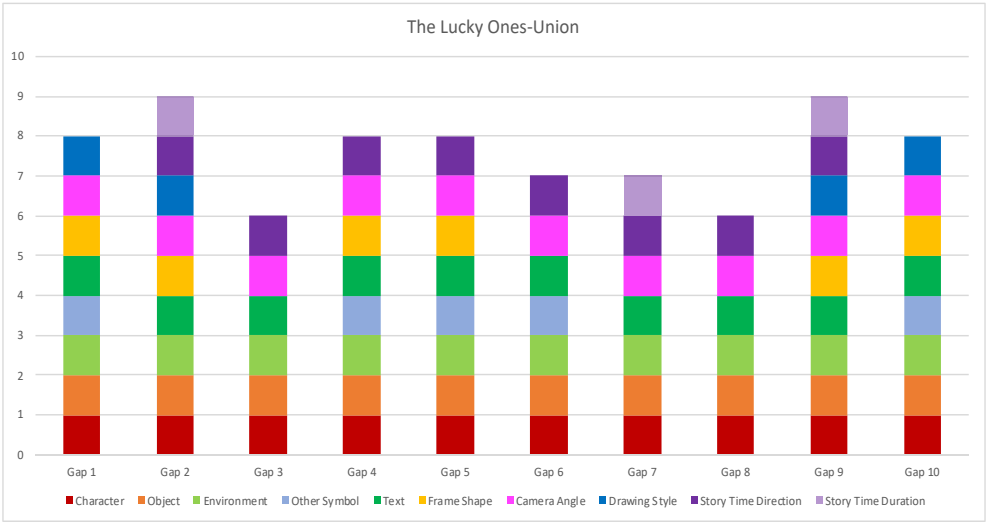


Figure 4.5: Union of the reasons for segmentation of The Lucky Ones.

The Lucky Ones: Figure 4.4 shows the intersection visualisation based on all of the reviewers' opinions. The change of character, text and camera angle are considered to be important reasons for each gap by all reviewers. Excluding Gaps 1 and 10 (transition between introduction image and story content), the highest number of reasons appears in Gap 5, while the lowest in Gap 3.

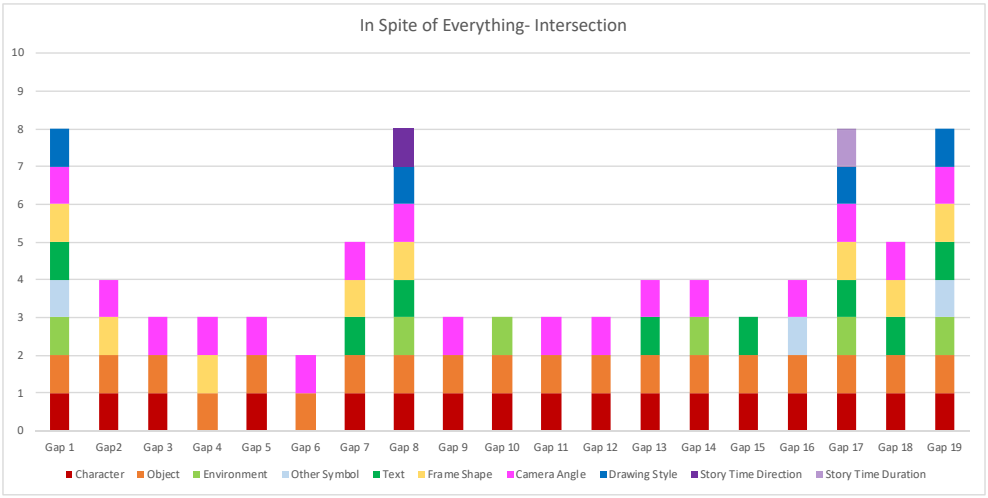


Figure 4.6: Intersection of the reasons for segmentation of In Spite of Everything.

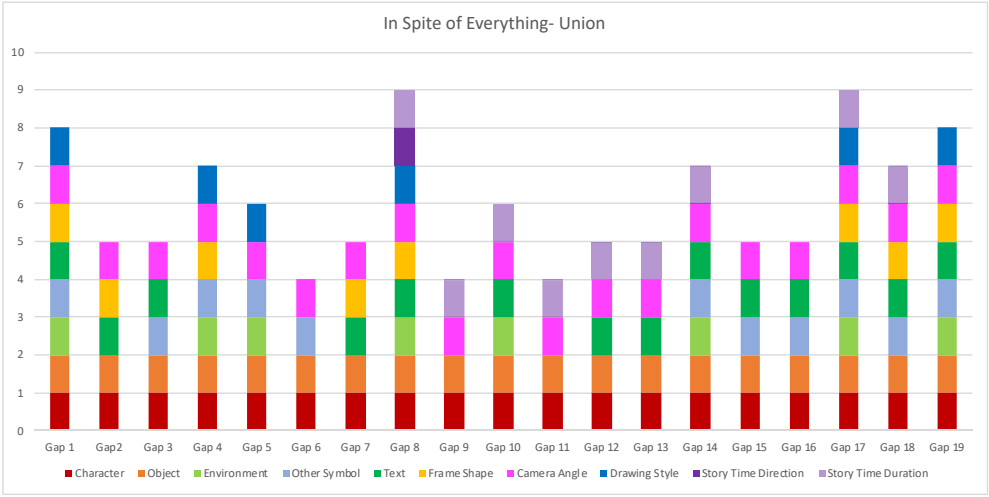


Figure 4.7: Union of the reasons for segmentation of In Spite of Everything.

Figure 4.5 shows the union of all the reviewers' opinions combined. In this diagram, the differences between the gaps appear to be less obvious compared to Figure 4.4. The major difference between the intersection (Figure 4.4) and union (Figure 4.5) is the consideration of story time. The reviewers explained that the story time is going backward in the panels. It is mainly because of the visual clues, such as the appearance of the characters becoming younger. In other words, the narrative is conveyed through the panels placed in space. The reviewers pointed out during the interview that they didn't consider any segmentations because the time direction was constantly going backward.

Additionally, according to the text in the panels, the story happens in the narrator's mind, which meant that, although the memories of the narrator are moving backward in time (based on the images), the actual story is moving forward (based on the narration text). According to the interview, all reviewers agreed that the panels in this story are hard to be segmented.

In Spite of Everything: Figure 4.6 shows the intersection of the reviewers' opinions about the reasons for segmentation. After excluding Gap 1 and 19 — because these are transitions between introduction image and story content — Gap 8 and 17 contain more reasons related to segmentation than the rest of the gaps. Figure 4.7 shows the union of the reviewers' opinions related to the reasons for segmentation.

Comparable to Figure 4.6, the higher number of reasons for Gap 8 and 17 are still there. These results are consistent with the segmentations of the panel sequence created by the participants of Experiment 1. The reviewers confirmed that the story can be divided into three groups, with the segmentations at Gap 8 and Gap 17. The most important reasons for this segmentation are caused by changes in story time and supported by the change of the character's appearance and the change of colour.

Because It's There: Figure 4.8 shows the intersection of the reviewers' opinions about the reasons for segmentation. The differences between the gaps in this diagram are subtle. Excluding Gap 1 and 36 (transition between introduction image and story content), the highest number of reasons appears in Gap 3, 12 and 14, while the lowest is in Gap 32.

Figure 4.9 shows the union of the reviewers' opinions related to the reasons for segmentation. By adding all the individual opinions of the reviewers, Gap 6, 10, 11, 12, 14, 19, 21, 24, 25, 33 and 35 become the gaps with most reasons. Gap 3 is not part of this, and Gap 27 replaces Gap 32 to become the lowest one.

In Experiment 1 the gaps 3, 7, 12, 14, 19, 21, 24, 25 were considered as important segmentations of the panel sequence. In this story — although less obvious than The Lucky Ones — the identified segmentations of the panel sequence from Experiment 1 can be matched with the reasons of the reviewers in Experiment 2. During the interview, the reviewers confirmed that there were various reasons related to the segmentations in this story. For example, Gap 3 is recognised mainly because of the story time duration change and environmental change, while Gap 19, 21, 24 and 25 are more related to the change of characters.

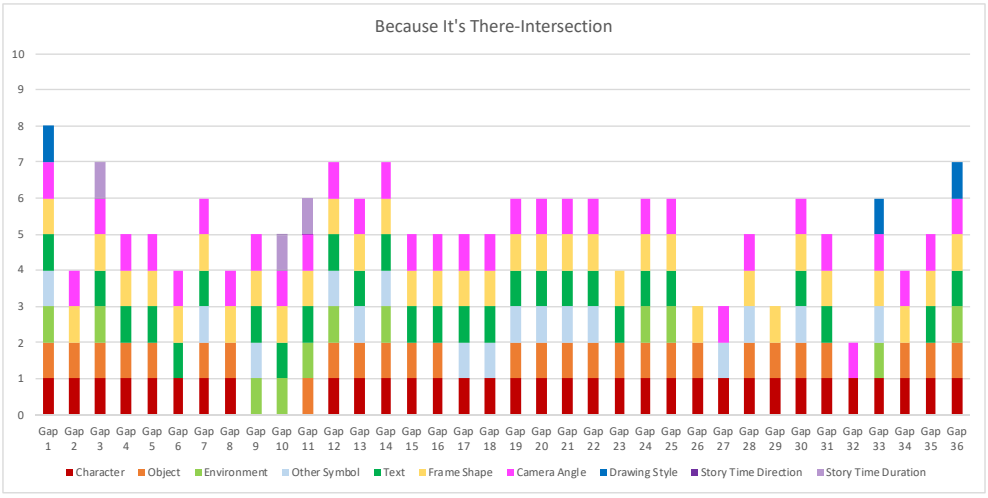


Figure 4.8: Intersection of the reasons for segmentation of Because It's There.

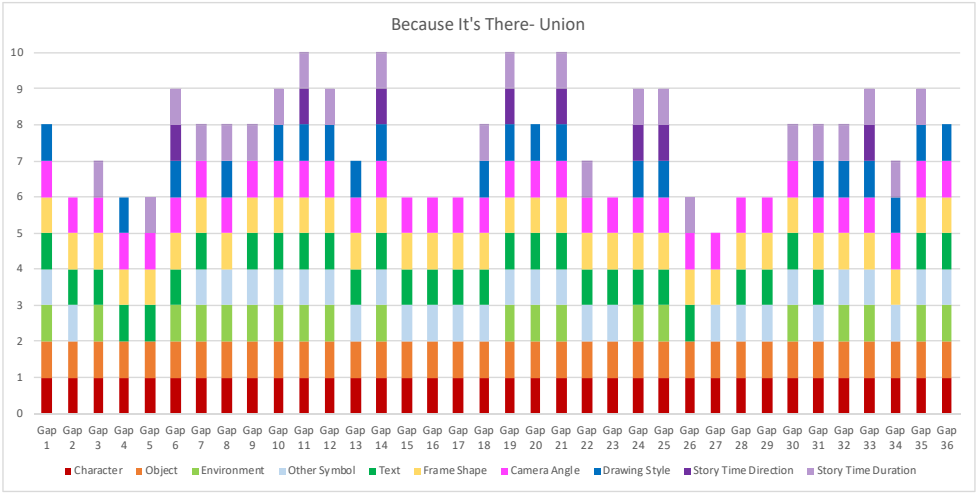


Figure 4.9: Union of the reasons for segmentation of Because It's There.

The findings related to Gap 6 and 11 are more surprising because the reviewers attributed a relatively high number of reasons. However, the participants of Experiment 1 didn't consider these as clear segmentations. Upon discussion with the reviewers, it was suggested that the gap next to these special cases contains strong indications about the same reason — the reader may perceive one panel for segmentation, but the segmentation could be identified at the two visual gaps related with this panel — the visual gap before this panel or after. One reviewer also described that these reasons can "build up" the narrative.

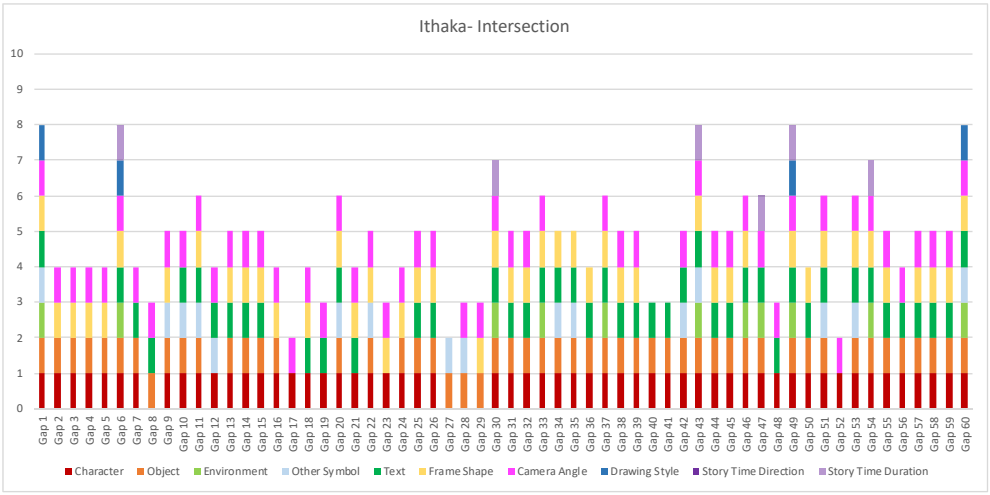


Figure 4.10: Intersection of the reasons for segmentation of Ithaka.

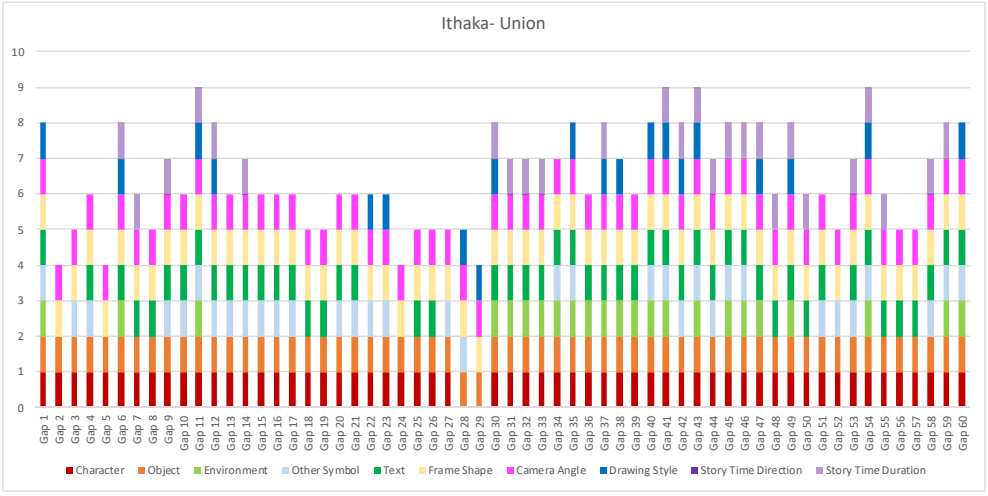


Figure 4.11: Union of the reasons for segmentation of Ithaka.

Ithaka: Figure 4.10 shows the intersection of the reviewers' opinions about the reasons for segmentation. Besides Gap 1 and 60 — which are the transitions between introduction image and story content — the highest number of reasons for segmentation appear in Gap 6, 43 and 49. The lowest number can be found in Gap 17, 27 and 52.

Figure 4.11 shows the union of the reviewers' opinions related to the reasons for segmentation. By adding all the individual opinions of the reviewers, Gap 11, 41, 43 and 54 became the gaps with most reasons for segmentations (9 reasons). Gap 6, 12, 30, 35, 37,

40, 42, 45, 46, 47, 49, and 59 have the second highest number of reasons for segmentation (8 reasons). The general pattern of intersection and union matches with the result from Experiment 1. All the gaps that were indicated as segmentations by at least 50% of the participants of Experiment 1 (Gap 8, 30, 37, 49) also have a high number of reasons as suggested by the reviewers in Experiment 2.

4.4 Discussion

All three reviewers confirmed that the panel segmentation patterns from Experiment 1 were valid and could be interpreted with the materials provided. The reasons for panel sequence segmentation in d-Comics are complex. The influence of story timeline, narration texts, and other visual elements can be observed from the designed experiments. However, it remains difficult to compare the intensity of the reasons for the segmentation. Due to various factors such as age, gender, cultural background, personal experience and evoked emotion by the story of the readers, the focus of identifying segmentation in d-Comics can be different.

4.4.1 Number vs intensity

The current measurement of how a panel sequence can be segmented is based on the listed reasons such as the story time, character and colour. By using the "intersection" and "union" method to describe the reasons that the reviewers mentioned, the results matched in general the segmentations from the first experiment. However, there are still exceptions. When reviewers were invited to explain the exceptions, the intensity was increased. This meant that the perceived intensity of certain elements could overrule the influence of the number of elements.

However, it is not yet clear how the intensity of visual elements can exactly influence the segmentation. The results of both Experiments 1 and Experiment 2 showed that the text elements and the other visual elements do not necessarily have to be synchronised in the panels. For example, in The Lucky Ones the texts flow forward through the panels. However, the images represent the story time going backward. There is a vast amount of research which indicates that the relationship between image and text is complicated (Carrier, 2000; Cohn, 2013a; Groensteen & Miller, 2013; Martinec & Salway, 2005). Image and text may have a different influence on how a narrative is understood by the reader.

4.4.2 Relation among segmented panel groups

Another fact that could be observed from Experiment 2 is the influence of the existing segmentations. For example, when the panels between two segmentations contain a longer story time, the reviewers tended not to make any new segmentations with a shorter story time, even if the panels with the shorter story time contained a comparable number of panel sequence segmentation reasons. Although the panels are presented linearly, the comprehension of the story is accumulated in the mind (braiding in Groensteen's (2009) word), and there exist hierarchies in the segmentations. This observation matches Cohn's (2013a) narrative structure with hierarchies in comics cognition.

However, using Cohn's tree structure to explain the segmentation can raise additional questions. How many layers of hierarchies can there be to represent a structure? And when a panel belongs to multiple layers of hierarchies, how many categories can one single panel belong to? For example, the third panel in Figure 4.1 belongs to the establisher category in the second panel group, but can be part of the peak category when discussing a higher layer panel group in the hierarchy. Does it mean that a single panel can have multiple roles in different layers of the hierarchy of the narrative structure? Can a panel group also have multiple roles, such as the fadel introduced in Section 3.5? How can we design for these hierarchies in d-Comics?

4.4.3 The missing interaction

Interaction has been discussed by researchers in relation to reading activity. Iser (1979) discussed the "action of reading", as well as the "interaction between reader and text" and the "interaction between reader and author". Sims (1997) made it explicit that interactivity in the learning process can contribute to a better understanding of the content. McCloud (2000) pointed out that interaction is crucial for d-Comics. However, there is hardly any existing research that systematically discusses the reading process of comics, and how to design interaction between the reader and the comics in the context of d-Comics.

As discussed in Chapter 2, the main difficulty of digitalising comics is caused by the change of carriers. One of the challenges caused by the absence of physical pages in electronic devices is moving through panel segmentations (Section 2.4.2). Once there is a segmentation between panel groups, in order to move through panels, interaction needs to be designed. Interaction should not only be embodied *with* segmentation, but also a strategy *for* expressing segmentation.

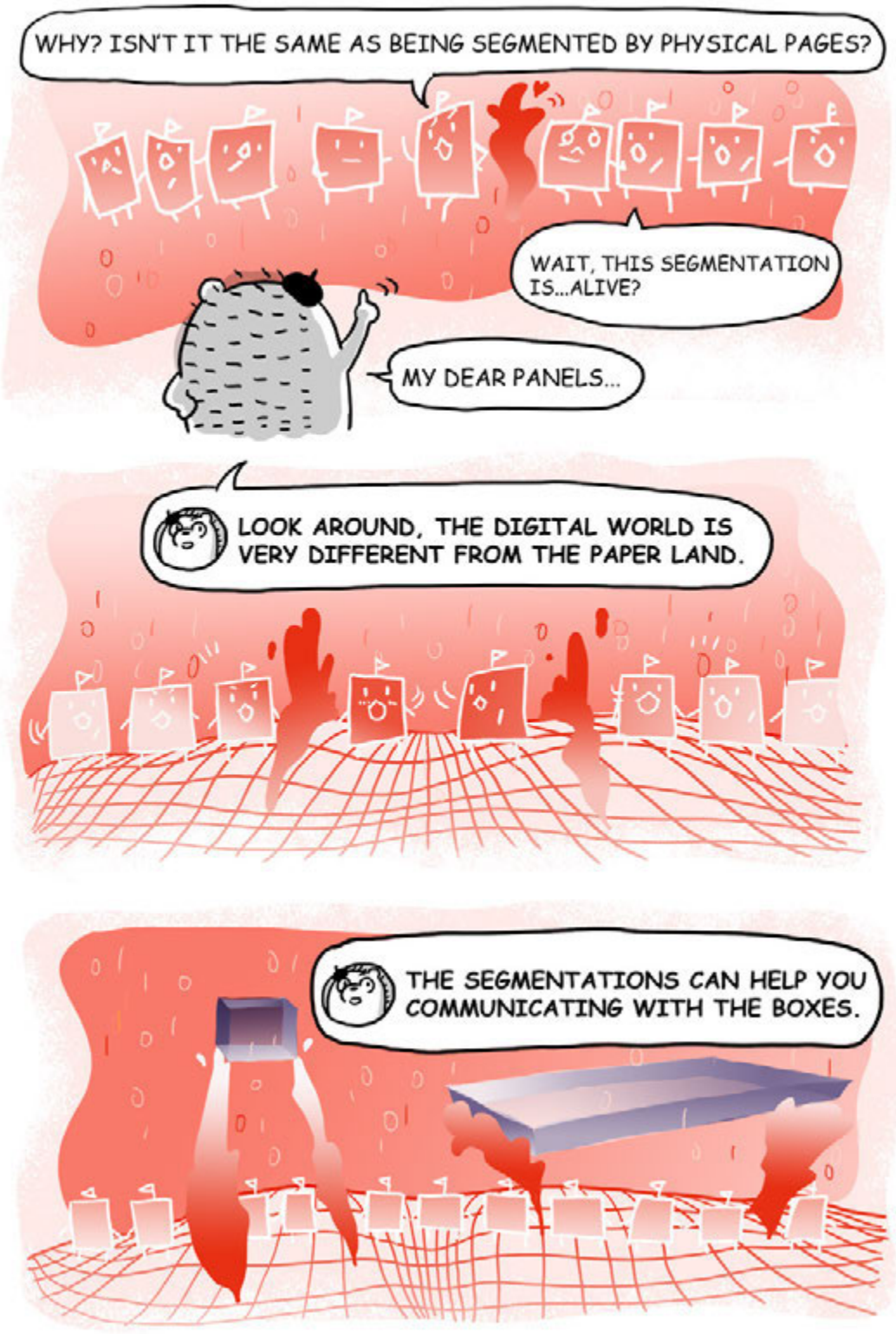
However, before exploring how to design interaction for segmentation in d-Comics, the general pattern of how a panel sequence is segmented should be identified first. Experiments 1 and 2 were dedicated in clarifying the understanding of panel sequence segmentation. To be able to conduct the experiments, basic interaction was applied to allow the reader to scroll the screen to read the panels and tap an icon between two panels to indicate segmentation. But no further interaction was designed for exploring the expression of segmentation, nor compared for effectiveness.

4.5 Conclusion

This chapter investigated the reasons for panel sequence segmentations in comics. Section 4.1 introduced two ways that segmentation can be caused in comics: by the narrative structure and by the spatial arrangement. Nine elements including the narrative structure (story time) and the spatial arrangement (environment, character, object, symbol, text, frame/panel shape, camera angle and drawing style) were summarised for analysing the detailed reasons for panel sequence segmentation. Section 4.2 described an experiment that aimed to analyse in more detail the panel sequence segmentation results from Experiment 1. Besides a confirmation of the earlier results, the outcome of the experiment provided reasons why the segmentations were identified.

The results of Experiment 2 show that individual readers have different understanding of, and preferences for, these strategies. For example, some readers were not that sensitive to changes in duration of the story time compared to others. Some of the readers focused more on how the characters change, some used the changes of the environment as a reference, and some were more influenced by the changes in colour tone. Even for the same reader, there was not necessarily a consistency among the influencing factors: a reader could create segmentations based on different strategies. Therefore, although the author can apply the three strategies to communicate the consideration of the segmentation, the reader's understanding of the segmentation cannot be assured.

In Section 4.4.3 interaction was discussed as a strategy for panel sequence segmentation in d-Comics. But the effect of interaction as a strategy, and the relation among the strategies remain unexamined. The next chapter will focus on investigating how to apply the results from Experiments 1 and 2 in designing segmentations in d-Comics, and further seek the answer to the second research question.


WHY? ISN'T IT THE SAME AS BEING SEGMENTED BY PHYSICAL PAGES?
WAIT, THIS SEGMENTATION IS...ALIVE?
MY DEAR PANELS...
LOOK AROUND, THE DIGITAL WORLD IS VERY DIFFERENT FROM THE PAPER LAND.
THE SEGMENTATIONS CAN HELP YOU COMMUNICATING WITH THE BOXES.

CHAPTER 5

Applying Segmentations in Designing d-Comics

The goal of this chapter is to apply the new vocabulary created in Chapter 3 and to investigate how interaction can be used as a strategy for segmentation in d-Comics. This chapter will discuss Experiment 3, which explores the effect of different interactions on the reader's understanding of panel sequence segmentation. The previous discussion about interaction and segmentation will be used as the background when considering the interaction strategy. To focus on interaction, the influence of narrative structure and spatial arrangement (discussed in Chapter 4) will be limited. Existing comics could have been adapted for this research. However, this could lead to challenges because the narrative structure and spatial arrangements would need to be modified while maintaining the information and the drawing style. Therefore, for this experiment, an original d-Comics was created.

5.1 Introduction

Different carriers of comics will cause different panel segmentation arrangements and require different interaction. Because of the different segmentation levels in printed comic books (Section 2.4.1), there is a range in how much effort a reader has to spend to continue reading a printed comic book. For example, using eye movements to move the focus from panel to panel is the basic interaction. When a page is finished, the reader has to use a hand or hands to flip to the next page to follow the story. If there are several volumes of the comics, the reader has to find the next book by physically moving to a bookshelf or a bookstore. Therefore, the whole reading process can be seen as different actions performed by the reader and different feedback expressed by the comics. However, when reading d-Comics with a touch-screen device, a finger tapping action could trigger various feedback such as moving to the next panel, switching to the next volume, purchasing another digital volume, etc.

In the Human-Computer Interaction literature and practices, there are paradigms and interaction strategies that could be applied to d-Comics to support panel sequence segmentation. Principles of interaction that can be related to panel sequence segmentation in d-Comics will be introduced in the following sections: input of the reader (Section 5.1.1), and output of the d-Comics (Section 5.1.2).

5.1.1 Interaction: input of the reader

The input of the reader is based on interaction possibilities that follow the capabilities of the carrier on which the comics is displayed. With a book this can be flipping the pag-

es, or on an electronic tablet this can be tapping or swiping on the screen. The input is necessary to continue reading the panel sequence. In the experiments described in this dissertation, the carrier used was a touch-screen tablet. As shown in Figure 2.6, the input of a reader for this carrier can include *tap, drag, slide, hold, swipe, etc.*

When considering the reading process as a timeline, the interaction moments (based on the reader's input) can be regarded as segmentations. According to the research about action-specific perception, people perceive the environment based on their ability to act in it (Witt, 2011). Miller (2008) stated "in interactive narratives, and your smallest building blocks are your decision or action points — the places where the user can make a choice or perform an action". The reading time of printed comics can be described as a linear line, segmented by the action of a page-flip, the reaction of the page-flipping, and the continuation of reading by eye movements. Similarly, the reading time of d-Comics can be described as a linear line segmented by the input of the reader, the output of the screen, and the reading by eye movements.

The design choice of the interaction may have an influence on the reader's understanding of the segmentation of d-Comics. Imagine, for example, when reading d-Comics the required input to move between panels is a swipe gesture, whereas at a phasel gap, the reader has to *drag* for a duration of two seconds to activate the next panel. This may create an understanding for the reader that the panels before the input are different from the panels that appear after. To respond to the reader's input, a corresponding output needs to be designed; this will be discussed in the next section.

5.1.2 Interaction: output of the d-Comics

The output refers to the feedback of the comics based on the reader's input. The output can appear differently on different comic carriers. In printed comic books, the output of the reader's input (flipping a page) is that the physical page is turned from one side to the other. The panels on one side disappear, and the panels on the other side of the page appear in front of the eyes of the reader. Since the physical page doesn't exist in the digital environment, both the input and the output have to be specifically designed.

There are various possibilities for designing the output for touch-screen devices. Rauterberg et al. (Rauterberg & Szabó, 1995) described a classification for "n-dimensional" user interface design. This classification can be used to describe the depth of a visual and audio interface on an electronic device. The comic panel sequence consists of multiple images, which means that the classification can be applied to describe the output

method when designing d-Comics. For example, the "visual depth presentation effects" category can be used to describe the range from "one image" to "multiple images". The "visual depth perception mechanism" category can be used to describe the range from "monocular" to "movements". Appendix VII describes several exploratory design prototypes which adopted some of these categories.

As described in Section 2.3.2, all the panels in the digital environment have to share one single screen space to be displayed. This means that only a certain number of panels can be displayed at the same time. The reader is in control of changing the displayed panels (as the output of the screen) enabled by the input. This can create the feeling for the reader that the panels are delivered to the screen. During the process of panel delivery, the visual appearance of the panels could change. For example, the new panels can move into the screen space from left to right. And therefore, the spatial arrangement in d-Comics is connected with interaction.

5.2 Experiment design

5.2.1 Methodology

For the experiment, a panel sequence was created with twenty-four panels and eight phasels in the panel sequence. To observe the effect of interaction as a segmentation strategy, the other two segmentation strategies (narrative structure and spatial arrangement) had to be controlled. Based on this, different interactions were designed to support the expression of phasel segmentations.

To further investigate the effect of interaction on the expression of segmentation, a Latin-squared test design with two factors was created. The factors were speed change (with vs. without) and motion lines (with vs. without) as response to the input from the reader (Section 5.2.2.2). Therefore, the same panel sequence had four conditions with different interactions. One of the four conditions was a control group (without speed change and without motion lines).

To observe the effects of different conditions, a within-group test was conducted. Every participant went through all four conditions. To control learning effects, 24 (the factorial of 4) possible order sequences are covered. Thus, 24 participants were required. Each participant was randomly allocated to one of these fully permutated sequences. The results will be further analysed by measuring the majority's phasel recognition pattern, and by analysing the effect of the two factors.

5.2.2 Materials

A twenty-four-panel comic named Hedgehog Day was created, describing a typical work day of a cartoon character (a hedgehog) (Appendix IV). The full story time was twenty-four hours, which was equally distributed into twenty-four panels with each panel representing a moment in the day of the character.

5.2.2.1 Design of the panels

Because the aim of this experiment is to explore how interactions can express panel sequence segmentation, we tried to keep the other influences on panel sequence segmentation — such as narrative structure and spatial arrangement — as constant as possible. Therefore, there are no obvious twists or jumps in the narrative. However, even when trying to limit the narrative structure, in a story there will always be a force to push the story forward. In this case, the actions of the character are changing during the 24-hour time-span and so does the corresponding environment.

The drawing style of the panels is simple and clear, in only black and white. Almost no text is used, and no symbols are applied. The frame shape and size are identical for each panel, as well as the visual gaps between the panels. No visual elements are used to directly indicate the story time. For example, no shadow to indicate day or night. The change in time can only be observed from the actions of the character (such as eating, sitting, talking, walking, etc.) and the environments that fit the actions (such as dining table, office, meeting room, park, etc.).

After the panel sequence was created, eight phasels (seven phasel gaps) were identified by me as the author (Figure 5.1). The intention of the author was to use the phasel gaps to communicate a faster-moving story time compared to the phasels. For example, in Phasels 1 and 2 the author wants to express that the character is staying at home, and slowly getting prepared for work (Phasel 1). Then — in the phasel gap — there is an increase in story-time speed, as the character arrives very quickly at work (phasel gap 1). In Phasel 2 the work pace of the character becomes slow again. In other words, the author did not want to use the narrative structure or the spatial arrangement to communicate the difference in story time between phasel and phasel gap. Instead, the aim was to use the timing and visual appearance of the interaction as a strategy of panel sequence segmentation in the design of d-Comics.

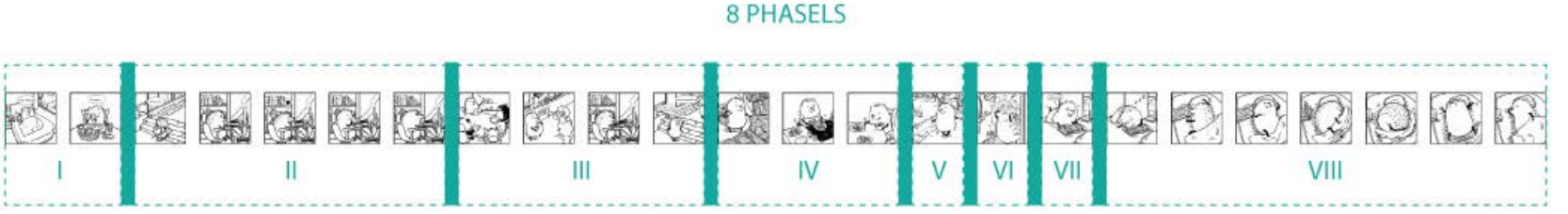


Figure 5.1: The twenty-four-panel-comics with 8 phasels

5.2.2.2 Design of interaction

The goal of this experiment was to investigate how interaction could be used as a panel sequence segmentation strategy. It was intended to express differences in the story time between a phasel (time passing slowly) and a phasel gap (time passing fast). The interaction between the reader and the d-Comics should be able to present these differences in speed. The web-based d-Comics was presented as a linear panel sequence on a touch-screen tablet. When the left side of a panel was tapped the sequence moved backward, and when the right side of the panel was tapped the sequence moved forward.

A common way to express the increase in speed is to use motion lines (Cohn, 2013b; Cohn & Stephen, 2015; McCloud, 1993). The object or character to which the motion lines are attached should be recognised by the reader as moving faster, compared to the ones without motion lines. Therefore, one of the ways in this experiment to present the change in story time is by using motion lines in phasel gaps to indicate that the story time is faster than within phasels. If the motion lines would always be displayed in the phasel gaps, the segmentation would be based on the difference in spatial arrangement. However, if the motion lines only appear as a reaction to the reader's input during the reading process — for example, swiping the touch-screen to advance to the next panel — it should be considered as part of the interaction (Figure 5.2).

Figure 5.2: Motion lines appear at the phasel gap.

Another way to create an interaction-based panel sequence segmentation is to create a link between the speed of the visualisation and the differences in story time. For example, the speed with which the phasels and phasel gaps are delivered — when they move in and out of the visible area of the screen after a tap — could change based on the story time. The differences in the story time are represented by different panel delivery speeds between phasel and phasel gap.

It could be possible to experiment with other input methods, such as swiping or pinching the screen. However, for the purpose of the experiment, it was decided to keep the

input method the same, and rather focus on the output visualisations. The two output methods — display of motion lines and the change of delivery speed — are the direct visualisations sufficient for expressing the author's design intentions of story time.

Four conditions with or without the two output methods were created based on the same d-Comics (Table 5.1). Condition 1 used both the motion lines and speed change, conditions 2 and 3 only used one of the output methods, and condition 4 was the control group which uses none of the output methods. In condition 1, the reader normally observed that the panel sequence moves from panel to panel with a duration of 2 seconds after a tap. However, if a phasel gap occurred between two panels, the duration of the panel sequence movement after a tap was only 1 second. Within this 1 second the motion lines would also appear. In condition 2, the duration of the panel sequence movement was 2 seconds, but changed to a duration of 1 second when a phasel gap occurred. In condition 3, the duration of the panel sequence movement was always 1 second, and motion lines would appear when a phasel gap occurred. In condition 3, the changes in story time difference were expressed only through the use of motion lines. In condition 4, the duration of the panel sequence movement was always 1 second, and there were no further changes when a phasel gap occurred.

Table 5.1: Four Latin-squared test conditions of interactive transitions between phasels.

	With Speed Change (S+)	**Without Speed Change (S-)**
With Motion Lines (M+)	S+M+ (Condition 1)	S-M+ (Condition 3)
Without Motion Lines (M-)	S+M- (Condition 2)	S-M- (Condition 4)

5.2.2.3 Design of questionnaire

A questionnaire was designed to collect basic information from the participants and to test their basic understanding of comics ("Before-Test Questionnaire" in Appendix IV). Furthermore, a feedback questionnaire was designed to collect the data related to the panel sequence segmentation and about the duration estimation ("In-Test Questionnaire" in Appendix IV). The panels were aligned in a circle to prevent any predetermined segmentation (as in a circle there is no start and end point). Furthermore, a circle layout would not have to be broken and could fit easily into a page layout.

5.2.3 Procedure

The experiments were conducted in a meeting room with chairs for the researchers and the participant, a table, pens, a touch-screen tablet for interacting with the d-Comics, a smart phone for audio-recording and experiment documents (including the consent form and the two questionnaires). The tablet included an introduction d-Comics (Figure 5.3) to instruct the participants about the tasks and the four conditions that would be displayed in a fully permutated order for this within-group study.

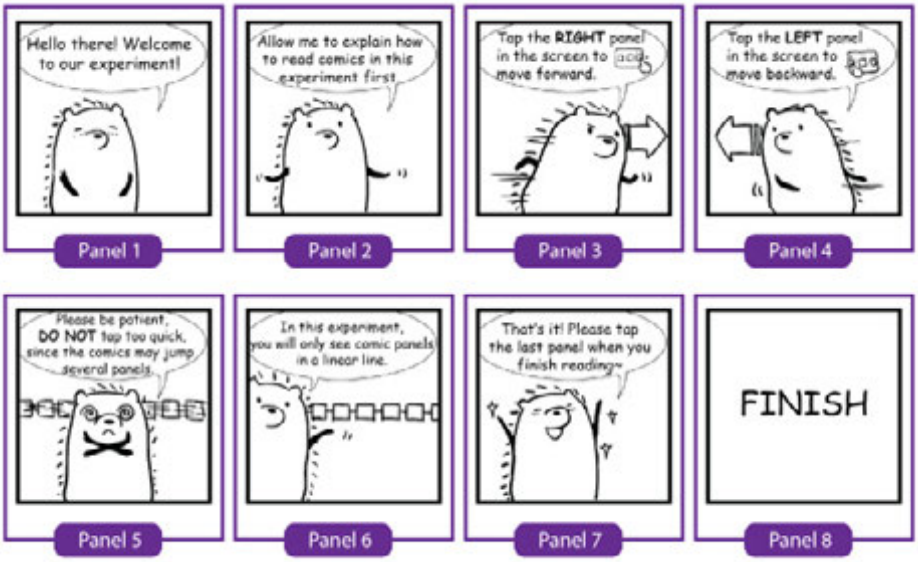


Figure 5.3: Panels of the introduction d-Comics.

During the experiment, the participant had to fill in several forms: a consent form, a test questionnaire with general information questions (i.e. about the comic reading experience and about the understanding of the comic style) and then four feedback questionnaires to be filled in after interacting with each test condition. In each feedback questionnaire, the participant had to indicate their segmentation decisions and the reasons about the segmentation decisions. At the end of the experiment, the participant was interviewed for general feedback about the experiment.

5.3 Results

5.3.1 Variables & data structures

Before conducting the data analysis, the variables and data structure will be introduced in this section.

5.3.1.1 The two independent variables

As described in Section 5.2.1 and Section 5.2.2.2, two factors were designed to investigate the effect of interaction: the motion lines factor and the speed change factor. The two factors will be considered as the two independent variables in the analysis.

5.3.1.2 The dependent variables

There were four situations that appeared in participants' segmentation results compared to the intended segmentation from the author (Table 5.2). The categories in the table describe how the segmentation identified by the participant matches the intended segmentations from the author. The intended segmentation refers to the eight phasel gaps described in the experiment design. If the participant identified segmentation at these phasel gaps, the answer was considered as correct (S1). If the participant didn't identify a segmentation at these phasel gaps, the answer was considered as incorrect (S3). The not intended segmentation refers to the other 16 gaps that are not phasel gaps. If the participants didn't identify a segmentation at these panel gaps, the answer was considered as correct (S4). If the participant identified a segmentation at these panel gaps, the answer was considered as incorrect (S2).

Table 5.2: Four possible outcomes of the coding scheme to compare the results from the participants with the intention of the author.

	Participant identified segmentation	**Participant did not identify segmentation**
Intended segmentation	Correct (S1)	Incorrect (S3)
Not intended segmentation	Incorrect (S2)	Correct (S4)

We named the reader's (i.e. participant's) phasel recognition at each visual gap as RGap, and the author-intended phasel gaps as IGap. Two dependent variables are summarised from this table: IGapCorrect — the correct number of RGaps compared with IGap (S1 + S4); IGapIncorrect — the incorrect number of RGaps compared with IGaps (S2 + S3)

To further conduct the main analysis, we introduce one more dependent variable: IGapPercTot — the correct percentage of each RGap compared with IGap. Because the main analysis will be conducted with a between-group method, IGapPercTot is divided into four groups: IGapPercTotC1 represents IGapPercTot in condition 1. IGapPercTotC2 represents IGapPercTot in condition 2. IGapPercTotC3 represents IGapPercTot in condition 3 IGapPercTotC4 represents IGapPercTot in condition 4.

5.3.1.3 The covariate

In order to observe more significant effects in the analysis, we compared the author-intended phasel gaps (IGap) and the majority's (over 50% of the participants identification) identified phasel gaps (F5Gap) as the covariate: F5GapPercTot — the correct percentage of each RGap compared with F5Gap. Also, F5GapPercTot is divided into four groups: F5GapPercTotC1 represents F5GapPercTot in condition 1. F5GapPercTotC2 represents F5GapPercTot in condition 2. F5GapPercTotC3 represents F5GapPercTot in condition 3. F5GapPercTotC4 represents F5GapPercTot in condition 4.

5.3.1.4 Data structures

A data sheet was created in SPSS. It captures the reader's phasel recognition at each visual gap (RGap) in each condition. A segmentation line indicated in the questionnaire is counted as 1, otherwise 0. We call this data structure the Reader's Gap Structure (RGS). Then we introduced the author-intended phasel gaps (IGap) and the majority's (over 50%) identified phasel gaps (F5Gap) with the same calculation rule. The Intended Gap Structure (IGS) and the majority's identified gap structure (F5GS) were created.

5.3.2 Standard deviation

5.3.2.1 Participants

Twenty-four participants (15 female and 9 male) were recruited from the Eindhoven University of Technology. Their age ranged from 19 to 30, with a mean of 23.58. Except for two, all participants had prior experience with reading comics. Interestingly — but not unexpectedly — most participants (19 out of 24) indicated that they had read comics digitally before, either on the Internet or with special software (such as a smart phone or tablet application). Based on the participants' answers from the first questionnaire (the "Before-Test Questionnaire" in Appendix V), all participants were able to recognise and understand the drawing style and content of the d-Comics in the experiment.

5.3.2.2 Phasel recognition

Figure 5.4 shows the total number of identified segmentations in each visual gap combined for all the four conditions. The author intended the segmentations to be placed at Gaps 2, 7, 11, 14, 15, 16, 17 and 24. Therefore, any segmentation placed in another visual gap is considered incorrect. In the case where all the participants would place the segmentations correctly in all four conditions, the number of correct segmentations should be 96 (four conditions, 24 participants). In Figure 5.4 the correct gaps are coloured green, and the incorrect gaps are red. The line on the y-axis represents the threshold of half of the correct/incorrect rate (48). Gap 24 is the gap between the first and last panel. In 91 cases the gap was identified as a segmentation, which means that every participant could recognise this gap as a phasel gap. The correct phasel gaps, which were identified in more than 50% of the segmentations, are Gap 17 (67.71%), Gap 11 (57.29%) and Gap 14 (56.25%). Gap 2 (46.88%) and Gap 7 (42.71%) were almost identified in more than 50% of the segmentations. Gap 16 (36.46%) and Gap 15 (26.04%) received a lower identified rate. Gap 14 to Gap 17 are all individual phasel gaps and therefore difficult to be recognised or remembered. In general, the designed phasel gaps received a higher segmentation rate than the other visual gaps.

Gap 3 (64.58%) and Gap 10 (61.46%) received more than 50% of the segmentation rate, although they were not intended segmentations by the author. As described in Section 5.2.2.1, in the story there were still some character action changes and environmental changes to keep the panel sequence moving forward in the story time. Gap 3 and Gap 10 contain environment transitions that might influence the participants' decision.

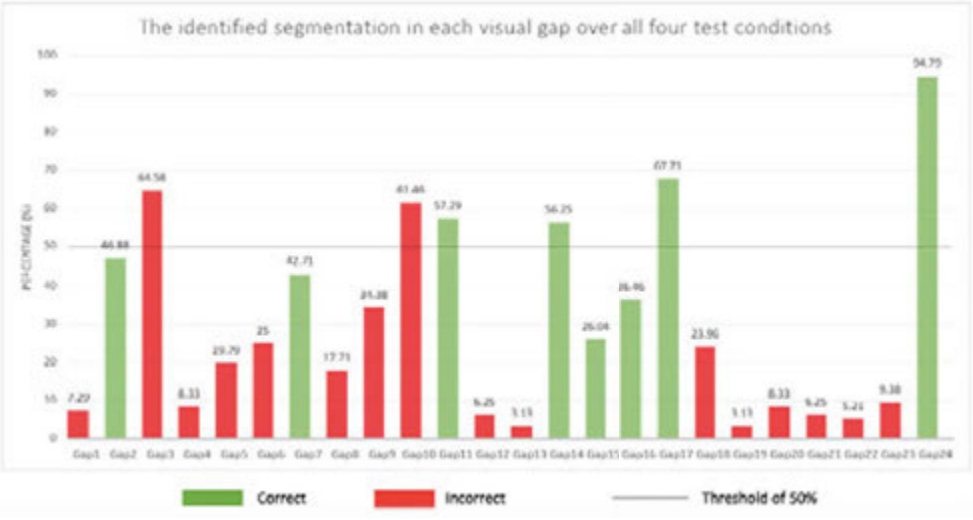


Figure 5.4: The total amount of identified segmentations in each visual gap over all four test conditions.

5.3.3 Main analysis

5.3.3.1 IGapCorrect & IGapIncorrect

Each participant answered the "In-Test Questionnaire" for identifying segmentation in each condition, for four different conditions. In each feedback questionnaire, the maximum segmentations that could be made in one panel sequence was twenty-four. The first visual gap (between Panels 1 & 2) was identified as Gap 1, the second visual gap (between Panels 2 & 3) as Gap 2, and so on, until the visual gap between Panel 24 (the ending panel) and Panel 1 (the starting panel) as Gap 24 (Section 11). Therefore, the total number of segmentations that a participant could identify within one condition was 24, and within all four conditions was 96. From the condition point of view — since each condition contains the data collected from 24 participants — the maximum total number of identified segmentations is 576.

As explained in Section 5.2.2.2, condition 1 used both the motion lines and the speed change output, while conditions 2 and 3 both used only one of the outputs (respectively, speed change and motion lines), and condition 4 was the control group which used none of the output. The results of the correct segmentations by the participants are (from high to low): condition 1 (420 correct segmentations), condition 3 (419), condition 2 (414), condition 4 (402). The results for the incorrect segmentations by the participants are: condition 4 (174 incorrect segmentations), condition 2 (162), condition 3 (157), condition 1 (156) (Figure 5.5). Condition 4 is the control condition and received the most incorrect answers (174).

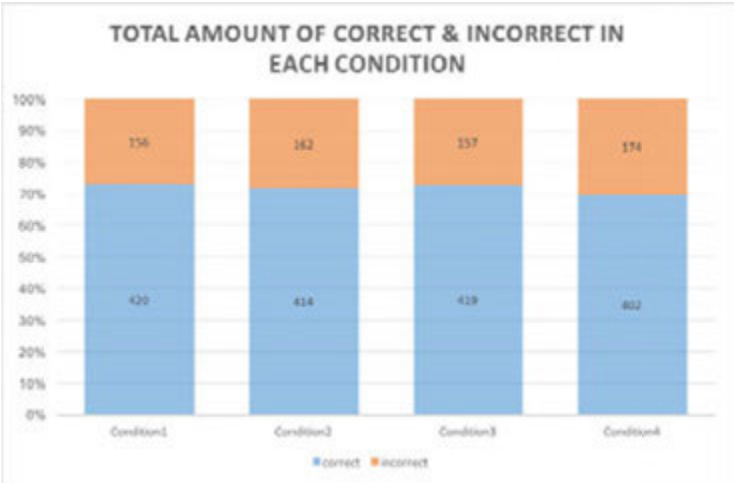


Figure 5.5: The total number of IGapCorrects & IGapIncorrects in each condition.

5.3.3.2 MANCOVA

To investigate the influence of the two designed factors (motion lines and speed change) to the reader's phasel recognition, further analysis was conducted. To observe the effect of the two factors (speed change and motion lines) of interaction, a MANOVA with repeat measurements was conducted. The dependent variable is IGapPercTot. No significant result was found. We suspect that the personal preference could influence the reader's phasel recognition. Thus, a MANCOVA with F5GapPercTot as the covariate was conducted. Several effects became significant. The significant values are marked yellow in the following tables. The full data can be found in Appendix VI.

Table 5.3: Measure IGap Identification.

SpeedChange	MotionLines	Dependent Variable
1 (with)	1 (with)	IGapPercTotTC1
	2 (without)	IGapPercTotTC2
2 (without)	1 (with)	IGapPercTotTC3
	2 (without)	IGapPercTotTC4

Table 5.4: Descriptive Statistics.

	Mean	Std. Deviation	N
TC1 Percentage of all I-gaps correctly identified	72.92	9.11	24
TC2 Percentage of all I-gaps correctly identified	71.88	15.65	24
TC3 Percentage of all I-gaps correctly identified	72.74	10.35	24
TC4 Percentage of all I-gaps correctly identified	69.79	12.24	24

Table 5.5: All effects without covariate.

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Powerc
Speed	**Pillai's Trace**	0.005	.103b	1	19	0.752	0.103	0.061
Motion	**Pillai's Trace**	0.065	1.311b	1	19	0.266	1.311	0.193
Speed * Motion	**Pillai's Trace**	0.101	2.146b	1	19	0.159	2.146	0.285

As shown in the tables, most significant values appear with the motion lines factor. The interaction of the two factors is also significant. The effect of speed change as a factor is not significant. Speed change contributes only if the motion lines factor is given.

Table 5.6: All effects with covariate.

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Powerc
Speed * F5GapPercTotTC1	**Pillai's Trace**	0.018	.343b	1	19	0.565	0.343	0.086
Speed * F5GapPercTotTC2	**Pillai's Trace**	0.03	.584b	1	19	0.454	0.584	0.112
Speed * F5GapPercTotTC3	**Pillai's Trace**	0.016	.309b	1	19	0.585	0.309	0.083
Speed * F5GapPercTotTC4	**Pillai's Trace**	0.004	.073b	1	19	0.791	0.073	0.058
Motion * F5GapPercTotTC1	**Pillai's Trace**	0.244	6.123b	1	19	0.023	6.123	0.651
Motion * F5GapPercTotTC2	**Pillai's Trace**	0.541	22.360b	1	19	0	22.36	0.994
Motion * F5GapPercTotTC3	**Pillai's Trace**	0.125	2.711b	1	19	0.116	2.711	0.346
Motion * F5GapPercTotTC4	**Pillai's Trace**	0.39	12.124b	1	19	0.002	12.124	0.91
Speed * Motion * F5GapPercTotTC1	**Pillai's Trace**	0.028	.551b	1	19	0.467	0.551	0.109
Speed * Motion * F5GapPercTotTC2	**Pillai's Trace**	0.511	19.894b	1	19	0	19.894	0.988
Speed * Motion * F5GapPercTotTC3	**Pillai's Trace**	0.282	7.451b	1	19	0.013	7.451	0.736
Speed * Motion * F5GapPercTotTC4	**Pillai's Trace**	0.229	5.657b	1	19	0.028	5.657	0.617

5.4 Discussion

5.4.1 Interactions as a segmentation strategy

5.4.1.1 The third strategy

As reported in Section 5.3.3.2, no significant value was found when conducting a MANOVA with only IGapPercTot as the dependent variable to investigate the effect with the two factors (speed change and motion lines). However, after including F5GapPercTot as the covariate, several significant values were found. We believe this result can be interpreted as the effects of the factors is masked by the personal tendency to follow their own segmentation structure. In another word, the interaction can affect reader's identification of the panel sequence segmentation, but the personal preference still plays an important part in the process.

With this result, we can add interaction as the third strategy together with the narrative structure and spatial arrangement.

5.4.1.2 Limitations of interaction as a segmentation strategy

The reported result also showed that only motion lines and the combination of motion lines and speed change can affect the reader's segmentation identification. Only the chosen speed change cannot have a significant effect. From the answer of the question of the reason for making segmentation, several participants mentioned that only speed change without visual aid feels like a display delay of the tablet instead of recognising it as part of the author's intention.

The difference in duration to express fast or slow changes in story time was chosen to be 1 second and 2 seconds. According to the results, the experiment condition (condition 2) which only used the speed change didn't influence the reader's understanding of story time. The combination of speed change with motion lines was needed to convey the story time change. But how short can the duration be, so that the reader will still sense the difference? And how long can the duration be before it becomes an obstacle to reading? How much visual feedback needs to be displayed so that it is still recognisable but will not cause a cognitive overload?

Thus, the chosen speed change effect as a panel sequence segmentation strategy has limitations. The segmentation created by interaction is not as absolute as the physical

page. The effect may not be recognised by the reader. It requires further exploration to investigate the effect of different interactions, and the combination with narrative structure and spatial arrangement.

5.4.1.3 Distinguishable segmentation

As reported in Section 5.3.2.2, Gap 14, 15, 16 and 17 were not identified as phasel gaps by more than 50% of the participants. One reason could be that Panels 15, 16 and 17 are all designed as single-panel phasels. In this case, the reader sees the same interaction feedback at every phasel gap frequently. Therefore, there is no clear difference in interaction feedback between the three phasels (three panels). Thus, when creating phasels in a panel sequence it is necessary to take into consideration how to design distinguishable segmentations:

1. *The same interaction is applied to every panel.*
   There are no differences in interaction, and the segmentation cannot be conveyed.

2. *Different interactions are applied to different panels within a phasel.*
   There are too many variations in the interaction, and the reader might misunderstand the relation among the panels within a phasel.

3. *The same interactions are applied to all the panels in different phasels, but the interaction in the phasel gap is different.*
   Whether the segmentation is understood would depend on the number of differences of the interaction in the phasel gap compared to the other interactions.

4. *The same interaction is applied to all the panels in a phasel.*
   It could help the reader to understand the connection between the panels within the phasel.

5. *All the panels in one phasel have the same interactions but are different from all the panels in another phasel.*
   It may help the reader to understand the differences between phasels.

5.4.2 The existence of fadel

Section 5.3.2.2 also showed that Gap 3 and 10 were identified as phasel gaps by more than 50% of the participants, although these were not intended as phasel gaps by the author. Gap 2 and 11 are the author-defined phasel gaps. As we can see from Appendix

IV, Panel 3 (between Gaps 2 & 3) describes the main character leaving home and walking into the university, while Panel 10 (between Gaps 10 & 11) describes the character leaving university. The character in these two panels is in a phasel that the previous status is fading out and the next status is starting to build up. This panel status fits the definition of fadel, as discussed in Section 3.5.2. This type of transitional panel has a connection with both the previous and the next phasel. But due to the fading connection both content wise and visual wise, the panel sequence segmentation may not be identified by the readers accurately. The panel can be identified as an independent phasel, but can also be identified to belong to the previous or the next phasel.

The result from this experiment again suggested that besides phasel as a clear panel sequence segmentation, there exists another category of the recognised panel sequence segmentation which is not that clear. A fadel represents one phasel that moves subtly to another.

5.4.3 Author's intention vs reader's identification

The result described in Section 5.3.2.2 showed that the reader's identification of segmentation can be different from the author's intention. Readers have different preferences of identifying segmentation. The current panel sequence segmentation strategies (narrative structure, spatial arrangement, interaction) can be considered as a framework of categorising the preferences of a reader. With more further study of the readers' preferences, panel sequence segmentation in d-Comics can be better designed. The author can define and strengthen the expression of the segmentations to let the majority of the readers understand. If a study of the preference of the independent reader is conducted, a d-Comics with personalised panel sequence segmentation can also be created.

The panel sequence segmentation categories we observed and defined (phasel and fadel) are a vocabulary to capture how panels are grouped in d-Comics, without the existence of physical pages. Although we can study whether the reader can recognise the intended segmentation, it is the author's decision which panels belong or don't belong to each other. There is no absolutely correct segmentation in d-Comics. Defining segmentations is the freedom of the author based on the storytelling intention. For example, Panels 15 and 16 in Ithaka (Appendix I), from the collected readers' identification, both belong to a phasel starting from Panel 6 until Panel 30. However, from the perspective of the author, a segmentation in Gap 15 (between Panels 15 and 16) could be created to generate suspense — The warrior swings his sword towards the monster. What will

happen next? Can he hit the monster? What's his movement? What's the reaction of the monster? Will the monster attack? — Because a segmentation exists, the reader cannot immediately verify any guess until moving through the segmentation.

The example revealed that the three strategies of designing panel sequence segmentation are not always unified. An author-intended segmentation can be segmented by one or two or three strategies, while the left one or two is/are still connected. The example discussed can be seen as having a strong connection both in the narrative structure (it's in an ongoing fighting process) and the spatial arrangement (except for the movements of the character and camera angle, the environment, object, drawing style remain the same). Thus, it would be the role of interaction to meet the author's intention of creating suspense.

5.4.4 How to apply strategies for segmentation

For d-Comics creators, how to apply the three strategies for different screens after the segmentation in the panel sequence have been defined? For example, in Experiment 1, the largest phasel identified was a 24-panel group (Panels 7-30 in Ithaka). On a smart phone, this phasel might have to be displayed one panel at a time, while on a 9.7-inch tablet it might have to be segmented into more than three panel groups.

Screen space < *Phasel display space* : When the screen space is smaller than the display space needed for all the panels in one phasel, it is certain that the visual space of a phasel will be segmented. To communicate the concept of a phasel in this situation would mean strengthening the connection of panels within the phasel with the three strategies. For example, unified frame colour or background, and the same feedback of all the panels in reacting to the reader's input can be applied to indicate the connection.

Screen space = *Phasel display space* : When a phasel fits the screen space, it is the layout within the phasel that needs to be arranged according to the author's storytelling intention. However, it is unlikely that all phasels in the comic story contain the same number of panels. It is more likely that one phasel fits the screen space while many others don't. In this case, the segmentation design of the fit phasel should also be coherent with the rest phasels.

Screen space > *Phasel display space* : When the screen space is large enough to display more than a phasel needs, the panels in the phasel could be scaled with the same proportion within the range of acceptable resolution. In this case, the segmentation be-

tween phasels can still contain all three strategies. If panels that belong to different phasels are displayed at the same time on the screen, we can only use the narrative structure and elements in the visual space strategy to create distinguishable segmentations.

The detailed ways of applying the strategies require further study of the author's segmentation intention, and more cases.

5.4.5 The challenges of designing d-Comics

The challenges described in Section 2.4.2 can now be discussed with the existing results.

Challenge 1: Segmentation of panels caused by different screens : The phasels in comics developed for Experiment 1 could consist of between one and twenty-four panels, based on the interpretation of the reader. This might cause a problem for devices with different display sizes. A small-screen device cannot display a phasel with a large number of panels, while a large-screen device will have quite some empty display space if the phasel has a small number of panels.

When a small-screen device needs to display d-Comics, it is almost inevitable that visual segmentations within the phasel have to be generated. However, we have learned that the segmentation of panels in d-Comics is not only visual, but also about the combination of narrative structure, spatial arrangement and interaction. A possible solution when segmentations within a phasel need to occur due to limited display size is to use other strategies to indicate the relation. For example, visual cues can be given by using the same coloured frames of panels which are members of the same phasel, and other frame colours for panels which are a member of different phasels, and for a fadel, the frame colour could be a combination of the adjacent phasels. The interaction could also use, for example, different interaction mechanisms such as scrolling panels horizontally in the same phasel while scrolling panels vertically in the next phasel.

When a large screen is displaying d-Comics, a single phasel could be displayed with a large area of negative space around it, or multiple phasels could be displayed at once. The former maintains the correlation of panel segmentation and the visible/invisible status. The latter would show phasel(s) when the phasel(s) shouldn't necessarily be visible. In this situation, we can use the combination of visual and interaction strategies to maintain the visible and invisible status. For example, only one phasel at a time is lightened, while the other phasels on the screen are darkened and blurred. The interaction of the reader will influence the status of the panels.

In general, it is necessary to consider the expression of connection when d-Comics are displayed on small-screen devices, while on large-screen devices it is more important to consider the expression of distinction.

Challenge 2: Segmentation of panels caused by the reader : The experiment setting in Experiment 1 allowed readers to have full control over the scrolling of the panel sequence, no matter whether the panels are fully visible or not. However, based on the results of Experiment 1 it was concluded that the readers were still able to identify segmentations. This would mean that the interpretation of the segmentations is not only dependent on the visual segmentation. After all, there are still the narrative structure and several visual cues such as character and environment that can express the segmentation. However, to strengthen the expression, more spatial arrangement and interaction can be added.

Challenge 3: Moving through segmentation : In printed comics the page-flip interaction integrates two aspects: it allows the reader to move through the panel segmentation, and it changes the visibility of the panels. The interaction in d-Comics also can allow the reader to move through the panel segmentation but does not necessarily change the visibility of the panels. This is defined by the attributes of the new carrier. Therefore, besides using the segmentation strategies to express phasels, it could be possible to design a distinguished interaction mechanism for changing the visibility of the panels. For example, when phasels are placed in a three-dimensional space (see the prototypes described in Section 14), moving through panels within a phasel could be done through movements on a horizontal axis. Switching between phasels could be achieved while moving the electronic device back and forth, or as more complex angles in 3D space.

How to design for moving through segmentations in d-Comics is still a challenge, since it requires a balance between recognisable distinction and unification. The purpose of designing for segmentation is to attract readers to continue reading. If the design is too complicated and requires readers to split their attention from the comics itself, it will create a reading experience which is less pleasant. To fully explore the design space and develop a deeper understanding of moving through segmentations, it is necessary that a wide range of practitioners have the possibility to develop different alternatives.

5.5 Conclusion

Experiment 3 applied the understanding of panel sequence segmentation framework found in Chapter 3 with a design for segmentation based on two strategies identified in Chapter 4: narrative segmentation and spatial arrangement. The interaction was designed to observe the effect as a panel sequence segmentation strategy.

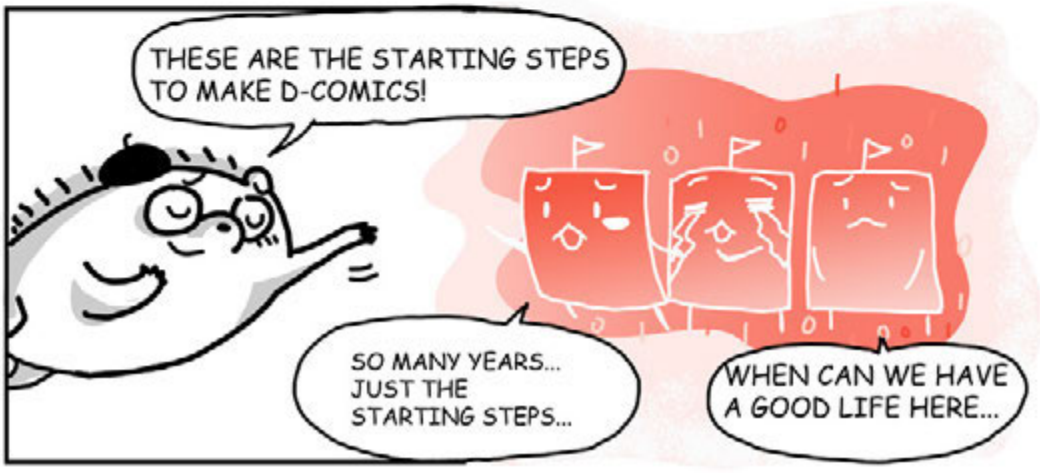
The results showed that the understanding of panel sequence segmentation and the strategies of panel sequence segmentation can be applied when creating d-Comics. Also, the interaction can be considered as a strategy for expressing panel sequence segmentation.

Thus, the answer to the second research question (What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?) can be updated. There are three strategies for the segmentation in d-Comics: narrative structure, spatial arrangement, and interaction.

The three strategies are strongly connected with one other. The narrative structure relies on the spatial arrangement to be conveyed. Furthermore, for the reader to be able to read the panel sequence in d-Comics, the interaction method needs to be defined. This method should specify the input the reader can perform as a trigger and the output that is used for the panel delivery. A typical segmentation should be a combination of segmentation in the narrative structure, with more spatial arrangement differences (such as the change of environment, character, text, colour, etc.) than non-segmentation gaps, and with recognisable interaction difference from non-segmentation gaps. However, a segmentation with the author's intention of building suspense can have a strong connection in the narrative structure and the spatial arrangement, but only by applying interaction to create the segmentation.


FIRST, DEFINE SEGMENTATIONS
WITHOUT ANY BOX.


N
S
I
THEN, USE STRATEGIES TO ADAPT THE DISPLAY IN DIFFERENT BOXES.


THESE ARE THE STARTING STEPS TO MAKE D-COMICS!
SO MANY YEARS... JUST THE STARTING STEPS...
WHEN CAN WE HAVE A GOOD LIFE HERE...

CHAPTER 6

Conclusion

This dissertation studied the topic of creating segmentations in panel sequences in d-Comics. It started from the observation that there is a trend in comics in which printed paper books are transitioning to digital environment and electronic devices (Chapter 1).

6.1 Answers to the research questions

Based on this transition, background information was provided about how comics are constructed and what the benefits are of printed paper books compared to the current digital environment (Chapter 2). It was observed that physical paper offers a natural segmentation of panel sequences. However, in the new carrier, which is based on the digital environment and electronic devices, this natural segmentation is challenged. These challenges are: 1) segmentation of panels caused by different screens; 2) segmentation of panels caused by the method of reading (for example, what if the reader pauses interaction in between two panels?); and 3) large design space combining the virtual visual space (3D possibilities and infinite canvas) and potential interactions (offered by the sensors and the input devices). To be able to respond to these challenges, it was first necessary to investigate whether a similar segmentation unit as the page in paper comics also exists in d-Comics. This research question was further broken into two sub-questions: How is a panel sequence segmented in d-Comics? What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?

Q1: How is a panel sequence segmented in d-Comics?

The results from Experiment 1 (Chapter 3), 2 (Chapter 4) and 3 (Chapter 5) showed that panel sequences in d-Comics can be segmented. Moreover, we discovered two types of panel sequence segmentation and grouping units from Experiment 1. As an answer to the first research question (How is a panel sequence segmented in d-Comics?), a new vocabulary was proposed to address the findings. It includes phasel, fadel and phasel gap. The phasel (created by combining phase, sequel and panel) in d-Comics is a set of panels that belong to each other. This set of panels cannot be further decomposed into smaller phasels. A phasel describes a strong relationship among a certain number of panels and a significant difference with other phasels determined by the author's consideration of storytelling. The fadel (created by combining fade and sequel) is a set of panels that the author considers to belong partly to the previous phasel and to the next phasel. Therefore, a fadel describes an overlapping transition between two phasels. It contains both the fading out of the previous phasel and the fading in of the next phasel, as determined by the author's consideration of storytelling. The phasel gap represents phasel-level

segmentation. It is to be distinguished from the regular visual gap between panels (also known as the panel gap or panel gutter). As long as there are two panels, there must be a visual gap. But the visual gap does not necessarily need to be a phasel gap. Only when two phasels are identified can the visual gap represent a phasel gap. When a fadel is identified — which means there are two overlapping phasels — there cannot be a phasel gap between the overlapping phasels.

The new vocabulary is one of the main contributions from this research. It captures a panel-level organisation that can be applied to the design of d-Comics by the author and can be understood by the reader.

Q2: What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?

In Experiment 2, the principles of segmentation in d-Comics were further investigated. Two strategies of expressing segmentation in d-Comics were identified and examined: the narrative structure (story time) and the spatial arrangement (environment, character, object, symbol, text, frame/panel shape, camera angle and drawing style). Interaction as a potential strategy was addressed but not investigated due to the experiment settings.

The new vocabulary and three strategies (narrative structure, spatial arrangement and interaction) were applied in Experiment 3. Besides studying the application of the strategies, we also wanted to explore how the interaction could be used as a separate strategy to influence the reader's understanding of segmentation. The results showed that the vocabulary and strategies can be applied when designing d-Comics.

A MANCOVA test with two factors (Motion lines and Speed change) in interaction design was conducted to analyse the results in Experiment 3. The dependent variable was the author-defined phasel gaps where the factors were applied. By including the reader-identified phasel gaps (more than 50% of all participants) as the covariate, significant effects of the Motion lines and the combination of Motion lines and Speed change were found. This result showed that interaction can be a strategy for panel sequence segmentation in d-Comics. The second research question (What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?) is answered — There are three strategies of the segmentation in d-Comics: narrative structure, spatial arrangement, and interaction.

The three strategies are strongly connected with each other. The narrative structure relies on the spatial arrangement to be conveyed. Furthermore, for the reader to be able to read the panel sequence in d-Comics, the interaction method needs to be defined. This method should specify the input the reader can perform as a trigger and the output that is used for the panel delivery.

6.2 Segmentation of panels in d-Comics and printed comics

As discussed in Chapter 2, the essence of comics is sequentiality. In theory, a panel sequence doesn't need to be segmented if the canvas is long enough. The segmentation is caused by the physical constraints of the carriers. In this dissertation, we mainly compare two carriers: books with pages for printed comics, and screen-based electronic devices for d-Comics. The segmentation vocabulary created should be considered as a categorising method for designing the display of panels in d-Comics. The segmentation can reflect the author's interpretation of storytelling, the narrative categories, and the reader's comprehension of the comics. The segmentation can lead to the layout design within the display space. The segmentation is the main space for designing interaction that can support the author's storytelling intention. In other words, segmentation in d-Comics is not equal to emptiness. There is no panel in the segmentation, but there is interaction design. Segmentation is the white space that the author leaves, but it is also the imagination space for the reader.

The panel sequence segmentation in printed comics and d-Comics: This dissertation has discovered and described a panel-level relation (phasel, fadel, and phasel gap) that is independent of carriers. This level of segmentation, decided by the author, exists before the panel sequence is placed into the carrier. The panel sequence segmentation in printed comics is fixed with the carrier. The relation of segmented panels to fit in one page with this physical page is exclusive. The spatial layout of the panels on that printed page is also fixed. The segmentation caused by physical pages is not the same concept as phasel and fadel. The number of panels a phasel/fadel contains may not fit in one page (or a spread) — with the materials in Experiment 1, the number of panels in one phasel can reach to 24. In this case, a phasel will be physically segmented by pages.

However, screen-based electronic devices can use the combination of display and interaction to create the feeling of an infinite canvas. This means segmentation in d-Comics can be completely mapped with the author-intended segmentations. But since there are different sizes of the screen-based electronic devices, the spatial arrangement of the segmented panels could be different.

The segmentation strategies in printed comics and d-Comics: We identified three strategies for panel sequence segmentation in d-Comics: narrative structure, spatial arrangement, and interaction. Both printed comics and d-Comics share the same narrative structure since it's abstract and therefore not affected by the carrier. The other two strategies can be also found in printed comics, but are predetermined by the physical pages. In printed comics, the spatial arrangement is subject to the physical size of the page, while the interaction is to flip the page.In d-Comics, the author can determine the choice of the strategies. The screen-based electronic devices can display a large canvas (can even be a virtual 3D space) to place panels. There are more interaction possibilities such as tapping, swiping, scrolling, dragging, pinching to zoom, etc.

Designing panel sequence segmentation in printed comics and d-Comics: In printed comics, the author has to fit the storytelling intention with the physical pages. For example, if a phasel is supposed to have six panels, but a page can only fit five, the author has to either mix the content to reduce the number of panels, or reduce one panel. In another example, if a phasel is supposed to have two panels, but the page can fit more, the author can stretch sizes of the two panels, or add more panels to the phasel, or leave empty space on the page. The two examples show that the design of panel sequence segmentation in printed comics is constrained by the physical pages. However, in d-Comics, the intended segmentation doesn't have to be compromised by the physical pages. More design of spatial arrangement and interaction can be considered to fit the storytelling purpose.

This understanding of panel sequence segmentation in d-Comics should be considered as a new framework for the creation of d-Comics, with the potential to change the traditional process of creating comics.

Page-based panel sequence segmentation uses the page as a starting point; although this has several benefits, it can also force unnecessary segmentation within larger phasels. However, based on our framework, the author can first create the panels without the box (page), and then decide how the panels can fit into different types of boxes (displays of electronic devices) by deciding the panel relations. To be more specific, the author can create panels first without considering how they fit on a concrete carrier. When the panel sequence is finished, the author should decide the relations (segmentations and connections) of the panels. The author can apply the strategies to strengthen or weaken the connections and segmentations among panels to convey the panel level relation for different electronic devices. The spatial relation and interaction may vary between different devices, but the author's storytelling intention can remain coherent.


MAKE MORE D-COMICS!
WE WANT A BETTER LIFE!
I KNOW...I WILL, BUT...
...PANELS,
LOOK! THIS PERSON CAN ALSO SEE YOU!
WOW! GREAT! CAN YOU HELP US?

CHAPTER 7

Discussion

This chapter contains the limitations of the research (Section 7.1) and discussions (Section 7.2), and outlines future work (Section 7.3).

7.1 Limitations

This section outlines several limitations of this research. Firstly, in Section 7.1.1, the limitations caused by the decision to focus on linear panel sequences. Secondly, in Section 7.1.2, the limitations caused by available technologies and time. And finally, in Section 7.1.3, the influence of personal preference on segmentation.

7.1.1 The linear panel sequence layout of d-Comics

As discussed in Chapter 2 and implemented in Experiment 3, the linear relation of panels is the basic starting point, while a non-linear relation (panel layout inside a page) is normally caused later due to the limitation of the carrier (such as the size of a page).

The linear reading order allows the reader to move from one panel to the next panel, which is spatially located next to the previous one. Non-linear relations can enable the reader to have more possibilities because multiple panels can be spatially juxtaposed on a page or the screen. For example, after finishing a page, a reader could easily read back the first panel or see the size differences between all the panels without turning the page to sense the author's storytelling intention. Such possibilities allow the reader to gain more information than a linear panel sequence could convey. For example, the meaning of the starting panel or a comparison of the emphasis conveyed by the different sizes of the panels.

So far, this dissertation only examined the segmentation strategies of the basic linear (horizontally positioned) panel sequence arrangement. Other spatial relations are not yet investigated, such as vertical panel arrangement, zigzag panel placement, multiple panel sequences, a three-dimensional virtual space in which the panels are placed in a grid, or placement in three dimensions so that the touch-screen device becomes a viewfinder for the reader to search panels. Moreover, the possibilities that are offered by a digital environment are not investigated in detail. For example, hyperlinks can change the linearity of the panel sequence.

7.1.2 The experiment equipment & technology choice

The design prototypes that were made in order to conduct the experiments in this dissertation are based on available technologies: mainly touch-screen devices and web-based programming languages. In a typical scenario, the reader would read the d-Comics on a 9.7-inch screen and change the panels by using their finger to swipe the screen. This technology constrains the display space and the available interaction methods between the reader and d-Comics.

Other technologies, such as virtual reality could provide different possibilities: for example, by displaying panels in a three-dimensional virtual space and using different hand gestures or body movement to trigger the panel delivery. Due to the time limitations of this research, several design prototypes were created, but not further investigated. The descriptions of these prototypes are included in Appendix VII.

7.1.3 The further relation of panel segmentation strategies

The results from Experiments 1 and 2 showed that different panel segmentation strategies could have different influences on segmentation. For example, change of character, environment and colour are more easily noticed. Moreover, it can be difficult to compare the visual elements between panels because each panel contains multiple elements. Different visual elements can all influence the reason why a reader identifies segmentation: for example, the intensity of visual elements, the total number of visual elements, the location of visual elements within a panel, and whether certain visual elements appear or disappear.

Experiment 3 showed that the personal preference plays an important role in identifying segmentation (i.e. individual readers have different sensitivities for different elements). This phenomenon has also been observed from the questionnaire result of Experiment 1 and the interview of Experiment 2.

This dissertation identifies three strategies for panel-level segmentation in d-Comics. The relation of the strategies is strongly connected with each other: the narrative structure relies on the spatial arrangement to convey; interaction defines how a reader can read through the panels based on the spatial arrangement. But what about the effect of a visual element such as environment or character? And how to design for readers with a different personal preference of segmentation? These questions require further study for a better understanding of panel segmentation strategies.

7.2 Discussion

Based on the empirical studies and explorations with segmentation in d-Comics previously described, this section collects general discussions regarding understanding the essence of segmentation and interaction in d-Comics (Section 7.2.1), the difference between segmentation in d-Comics and other storytelling media (Section 7.2.2), and the connections of this research with the field of Human-Computer Interaction (Section 7.2.3).

7.2.1 Visible & invisible

The panel sequence segmentation caused by physical pages inherently creates two different status of panels: visible and invisible. It happens on a double-page spread basis. The visible area is the currently open spread, and the invisible areas are the previous and the next pages in the same volume. The visible area and the invisible area are constantly changing during reading when the page is turned. Figure 7.1 illustrates the moment when a reader is reading the spread of page 3 & 4. In this case, the spread of page 3 & 4 is the visible space, while the previous spread (page 1 & 2) and the next spread (page 5 & 6) are physically covered by the visible spread and therefore invisible.

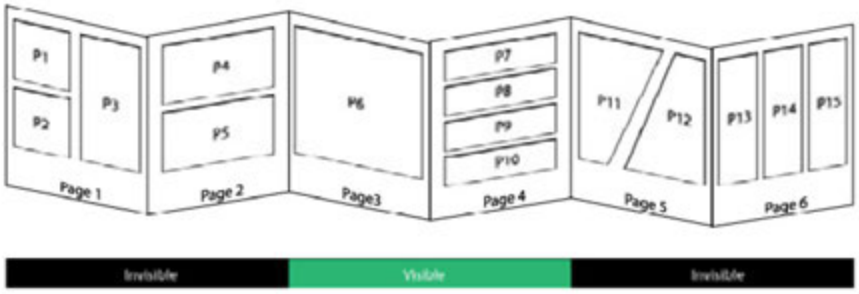


Figure 7.1: The visible and invisible spreads.

Interaction — page-flipping in printed comics — can change the status of the panels. The action of flipping a page is essentially the choice of the reader to transition between visible and invisible. It defines which spread (two pages) should be visible, and therefore the rest of the pages will be invisible. Because of the physical existence of paper, once a spread is open in front of the reader, the rest of the pages are covered by these two pages. The interaction between a reader and a printed book can be described as: the input of the reader is flipping a page, the output of the book is that one spread becomes visible while the rest is invisible.

This transition of invisible to visible is crucial for the comic reading flow. The reader knows that there are more panels printed on the rest of the pages: they are just invisible. The reader cannot see all the panels at once, and that's how curiosity, suspense, surprise, emphasis and storytelling pace can be built. *During the reading process, the unknown becomes known, while new unknowns are generated.*

The understanding of visible and invisible can also be used to explain the interaction in d-Comics. Although there is an infinite virtual space for placing panels, because there are many different screen sizes, the number of visible panels will be different on each device. Furthermore, since the digital canvas that holds the panels can be moved (such as scrolled and zoomed), the relation between panels and the screen is no longer as fixed as panels with physical pages. It means that a certain panel could have a third status besides being visible and invisible: partly visible and partly invisible. In Section 2.4.2 we addressed this issue as a challenge of segmentation in d-Comics. Moreover, this means *in some situations when reading d-Comics that the reader's input cannot always change the status of the panels from visible to invisible, or vice versa.* After scrolling the digital canvas once, some visible panels can remain visible, some visible panels can become partly visible and partly invisible, and some invisible panels can become visible.

The segmentation of a panel sequence, the visible and invisible status of the panel sequence, and the page-flipping interaction are well integrated into printed comic books and therefore easy to understand. The digital carrier, on the other hand, can provide unlimited virtual space and multiple interaction methods. Therefore, there could be one interaction for the reader to move through panel sequence segmentation, while another interaction for changing the visible and invisible status of panels inside one segmented panel group: for example, tapping a button to move to the next phasel, while scrolling up and down to read the vertically placed panels inside the current phasel.

7.2.2 d-Comics vs other storytelling media in digital environment

Storytelling in the digital environment and on electronic devices has rich possibilities. Novels, the d-Comics, animations or movies and video games can all be accessed from the same electronic device. Applications such as interactive novels, animated d-Comics, or video games containing animations, are blending the boundaries between individual storytelling media. McCloud used a set of criteria to differentiate what should and should not be included in d-Comics (McCloud, 2000). These criteria consisted of image, text, audio, and interaction. McCloud argues that when animation (dynamic image se-

quence within a panel) and audio are involved, the reading flow will be broken. However, interaction is an opportunity for designing d-Comics. The research described in this dissertation acknowledged this opinion, by excluding audio and animations within panels and focusing on the design space created by interaction for the panels in d-Comics.

Figure 7.2 describes how storytelling media can be allocated in coordinates of the image sequence display frequency and the required interaction frequency.

» *Printed textbooks* require a low level of interaction, mainly page-flipping. Printed textbooks contain a limited number of images, therefore, the image frequency is low.

» *Printed comic books* require the same low amount of interaction, mainly page-flipping. This category contains more images compared to a textbook, but less than a movie.

» Depending on how the *movie* is played, the movies can be separated into two main situations: the movies being played in a cinema, and the movies being played at home with a digital video player. The former provides no control for the audience. The latter can provide a variety of ways to interact with the movie. However, if a movie requires too much interactivity to continue, it could be categorised as a video game with some movie clips. The video games provide a certain number of image sequences to ensure the player is immersed. However, compared to the movies, video games require more active interaction input from the player.

» The *d-Comics* contains an equivalent number of images as printed comic books. However, more interaction is required than a printed comic book. This is because – as discussed earlier – a screen-based electronic device can provide multiple options for the reader's input and carrier's output. For example, the reader's input could be a tap, swipe, drag or pinch of the image that is displayed on the screen. The carrier's output could be to show an image, show an animation, or show no reaction. While displaying an image, there are also many categories such as a zoom in/zoom out, blurring/sharpening, and colour change. While displaying an animation, the display of the image sequence can be simultaneous as a reaction to the reader's input. The combination of the reader's input and the carrier's output can have many possibilities. The blue area with dash line aims to show that the boundaries of d-Comics with the related media are discussable. D-Comics displayed on a tablet can mimic printed comic books by limiting the interaction, with only swiping on the corners of the tablet. D-Comics can introduce higher image display frequency during the reader interaction with the tablet, so that it would be close to animation. D-Comics can require different or more active input from the reader to continue reading, which would blur the boundaries of d-Comics with video games.

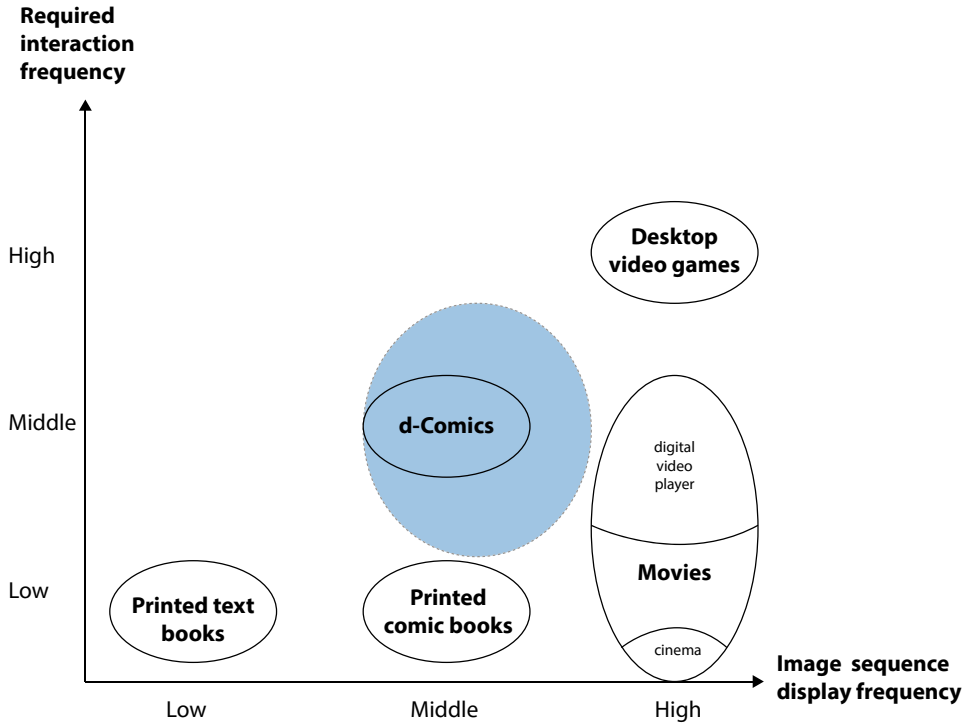


Figure 7.2: d-Comics vs other storytelling media.

As discussed in Section 7.2.1, the interaction of comics can change the visibility of the panels. From this aspect, a movie is an automatic process with a fixed frequency that turns images in an image sequence from invisible to visible and back to invisible at the same location. This process can be interrupted by the audience (for example, by pausing or jumping backward/forward), but the unfolding of the image sequence does not rely on the audience. Reading textbooks and comics are active processes where the reader is in control of changing the content status. However, the segmentation of the page is (in most cases) not integrated with the segmentation of the content. Printed comic books integrate the content segmentation and panel visibility with interaction. However, d-Comics can have separate interactions for content segmentation and changes of panel visibility. The amount of interaction in d-Comics should be limited, while in video games there could be many interactions applied. The difference is that the interaction in video games mainly serves the gameplay, and not the segmentation.

The main principle of comic reading is still about reading static image sequences, where the reader's imagination can fill in the image gaps. Only by enabling the reader to decide on their own the reading time and reading path can it be ensured that readers have their freedom of reading pace. Therefore, the priority of interaction design in d-Comics is about allowing the reader to move through panels. Defining the concept of phasel and fadel can help the author to consider where to apply interaction to support the interpretation of storytelling, especially segmentations.

7.2.3 Panel sequence segmentation & other applications in HCI

One conclusion drawn from Chapter 5 is that the design of interaction should be combined with both the narrative structure and spatial arrangement in order to convey the author's storytelling intention of segmentation. This notion might be generalised and applied to other applications in the realm of Human-Computer Interaction that are related to communicating static image sequences on electronic devices, and that require user interaction.

For example, in digital photo collections, each photo could be compared to a panel, and therefore the photo collection as a set of panels. Current photo collections can be sorted using various metadata. For example, sort by time, sort by location, sort by person, combinations of these data, or manual sorting. These elements could be translated into the vocabulary of comics, like story time, environment and character. When the photos are categorized and segmented with a narrative, different strategies can be implemented for the storytelling purpose. For example, a traveler wants to share the adventure during a vacation with the whole family. First, the order of the photos needs to be defined. Then, phasels can be created using segmentation. To control the storytelling effect, strategies such as colour and interaction can be applied to support the display. If one phasel content is photos about mountain climbing, and the next phasel is about celebrating the peak view, the interaction input that the storyteller can be designed to convey the difficulty of mountain climbing. This can be realized by making the usual feedback speed of transitioning to the next phasel relatively slower.

The design of instant messaging software can be another example. Another example of an application area where segmentation strategies could be applied is in instant messaging software. The current messaging tools only define two parties: the user, and the other participant(s) involved in the conversation. The messages are listed chronologically based on when they were delivered. Longer messages take more space on the screen.

However, sometimes in a conversation, especially when multiple people are involved, there could easily be a mix-up because multiple topics are being discussed. Based on the understanding of phasels, a topic can be clustered and marked with a different colour background. When the participant selects a certain topic, they could highlight the messages related to that topic. Different interaction (such as shaking the electronic device or rotating the interface) can be designed to switch between the topics (similar to interaction to switch between phasels).

Some theories from the HCI community could also be applied to this research to understand the findings better. For example, some studies have tried to create attributes of interaction in order to know what can be manipulated when designing interactions. Lim et al. (2007) established an interaction Gestalt theory to support artefact design and user experience. These attributes are: connectivity, continuity, directness, movement, orderliness, pace, proximity, resolution, speed, state, and time-depth. Within the theory, attributes such as movement, resolution, and speed, must be applied on either a visual or a physical object.

7.3 Future Work

This dissertation mainly discussed how comics changed due to the development of electronic technology, focusing especially on the displaying and reading aspects. There are also other aspects of comics which are changing:

» *Distribution:* To gain access to a comic story, the reader doesn't have to buy a book from the bookstore or borrow it from a friend but can purchase and download it from the Internet to read it on an electronic device. The distribution channel is not limited by geographical location. Readers everywhere in the world can quickly receive the comics and authors can find a global audience. Furthermore, the reader can easily collect and carry hundreds of thousands of comic series with a single electronic device, read comics anytime and anywhere, and switch from series to series with simple user interaction. Can segmenting the content contribute to the distribution of d-Comics? For example, the reader can access several phasels instead of purchasing the whole content.

» *Creation:* There are many electronic drawing input devices such as Wacom tablets and comics creation software and platforms such as Comic Studio (computer software) and Rage Comic Generator (application). There are online publishing platforms and programming languages to support creating and publishing d-Comics with interaction. The layout and graphics of comics are easy to alter digitally. It is not necessary to worry about

an accidental ink dot that can ruin the whole page. Instead, the new challenge is about designing a reading experience for different electronic devices.

» *Author-reader communication:* In the print age, a reader could send a letter to the author or publisher to comment on the comics. Some comments might be selected and published several months after the comics were released. Nowadays, the comic author can post comics directly online, and readers can leave comments under the post. Sometimes, author and reader can communicate in the comment area. Moreover, the author can even create an online poll to let the readers vote for their expected following up of the story.

The d-Comics industry is going through a forming process. It has plenty of space to grow. We hope that this research can contribute to the understanding of d-Comics, and the general comics industry. But it is a long way to go from this understanding to a flourishing new industry. A great amount of practice should be conducted in order to find a systematic and practical creation method. New tools (software, hardware and bridging methods) should be created to empower more people to be able to create d-Comics and gain access to d-Comics. During this time d-Comics are created for experimentation and exploration, and it is still necessary to be able to use the drawing tablet, image editing software (such as Adobe Photoshop and Illustrator) and programming software. Behind the final d-Comics published online, the author has to learn not only storytelling and drawing comics, but also skills using software and programming. Originally, making comics is not supposed to be such highly technical work. Also, there are more aspects to consider such as the publication channels, interaction with readers, co-creation, etc. We should work towards a goal of making d-Comics a common and easy way of expression, recording, sharing, reading, and thinking.

We believe there is a value in the combination of content and interaction. When reading this type of d-Comics, the reader's input can fit with the narrative development. Instead of only flipping a page or clicking a button, the interaction can contain storytelling information that the reader can experience while moving forward through panels — this dynamic information cannot be captured by static images. Therefore, d-Comics cannot be easily copied by static images. The feeling of participating in the story will increase.

APPENDIX

I

Panel Numbers & Gap Numbers in Experiment 1

The Lucky Ones

Panel 1

Gap 1

Panel 2

Gap 2

Panel 3

Gap 3

Panel 4

Gap 4

Panel 5

Gap 5

Panel 6

Gap 6

Panel 7

Gap 7

Panel 8

Gap 8

Panel 9

Gap 9

Panel 10

Gap 10

Adapted from the original work of Zen Pencils:
RICHARD DAWKINS:
The lucky ones

Authorised by the author for research purpose.
The detailed information of the original work can be found after finishing the survey.

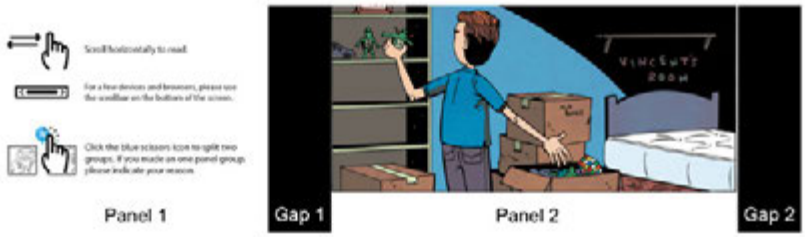
Please press here when

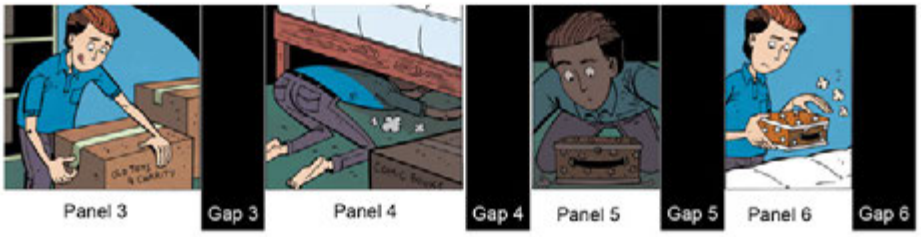
finished

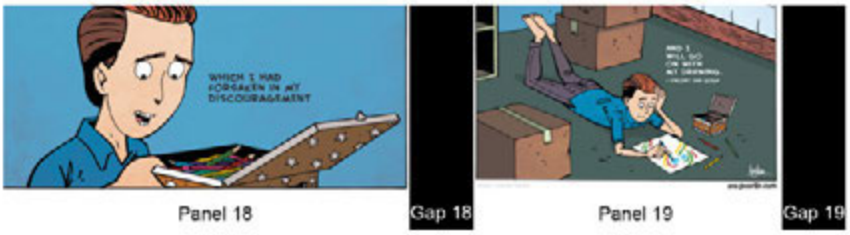
Go to the questionnaire

Panel 11

In Spite of Everything







Adapted from the original work
at Zen Pencils:
VINCENT VAN GOGH:
In spite of everything

Authorised by the author for
research purposes.
The detailed information of the
original work can be found after
finishing the survey.

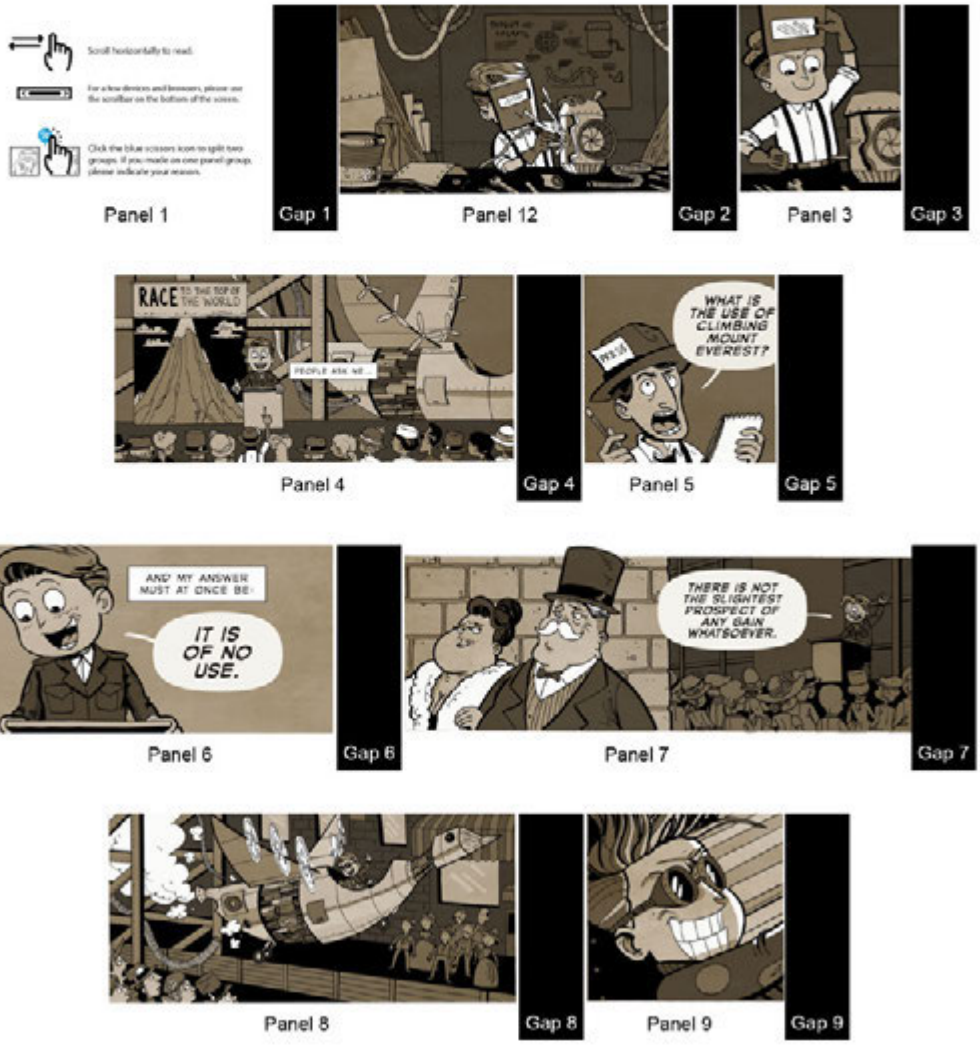
Please press here when

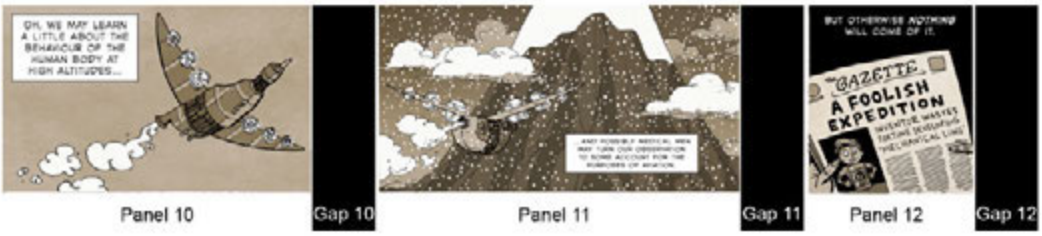
finished

Go to the questionnaire

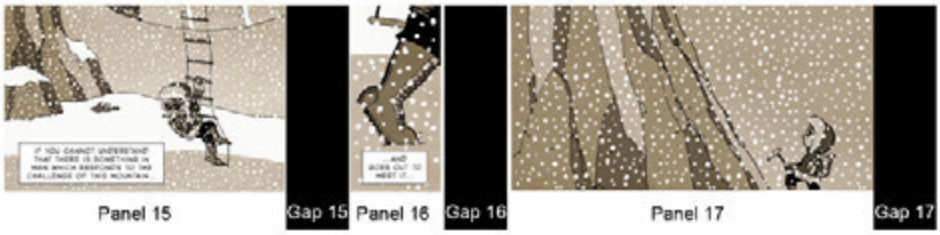
Panel 20

Because It's There




OH, WE MAY LEARN A LITTLE ABOUT THE BEHAVIOUR OF THE HUMAN BODY AT HIGH ALTITUDES...
BUT OTHERWISE NOTHING WILL COME OF IT.
GAZETTE
A FOOLISH EXPEDITION
Panel 10
Gap 10
Panel 11
Gap 11
Panel 12
Gap 12


JEWELLERY & GEMS
WE SHALL NOT BRING BACK A SINGLE BIT OF GOLD OR SILVER.
NOT A GEM, NOR ANY COAL OR IRON.
Panel 13
Gap 13
Panel 14
Gap 14


Panel 15
Gap 15
Panel 16
Gap 16
Panel 17
Gap 17


...THAT THE STRUGGLE IS THE STRUGGLE OF LIFE ITSELF...
...UPWARD AND FOREVER UPWARD...
Panel 18
Gap 18
Panel 19
Gap 19
Panel 20
Gap 20

Panel 21 Gap 21

Panel 22 Gap 22

Panel 23 Gap 23

Panel 24 Gap 24

Panel 25 Gap 25

Panel 26 Gap 26

Panel 27 Gap 27

Panel 28 Gap 28

Panel 29 Gap 29

Panel 30

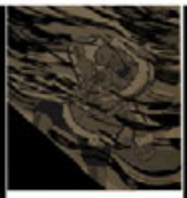
Gap 30

Panel 31

Gap 31

Panel 32

Gap 32



Panel 33

Gap 33

Panel 34

Gap 34

Panel 35

Gap 35

Panel 36

Gap 36

Adapted from the original work of Zen Pencils: GEORGE MALLORY. Because it's there.

Authorised by the author for research purposes. The detailed information of the original work can be found after finishing the survey.

Please press here when

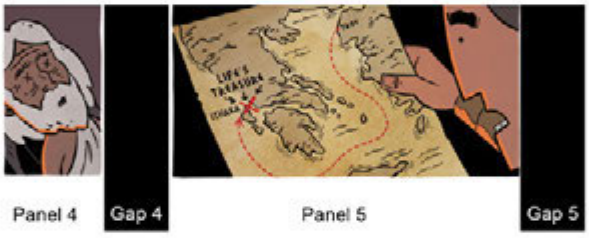
finished

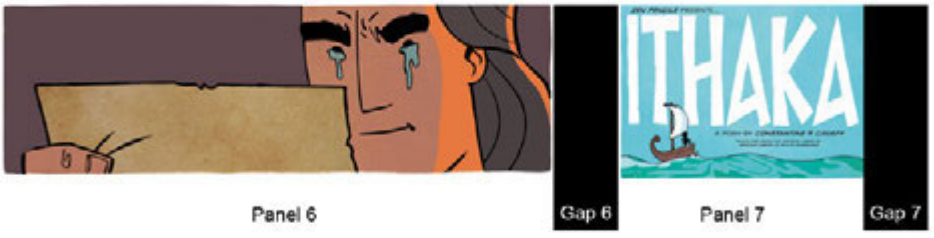
Go to the questionnaire

Panel 37

Ithaka


Panel 1
Gap 1
Panel 2
Gap 2
Panel 3
Gap 3


Panel 4
Gap 4
Panel 5
Gap 5


Panel 6
Gap 6
ITHAKA
Panel 7
Gap 7


AS YOU SET OUT FOR ITHAKA...
Panel 8
Gap 8
...HOPE THE VOYAGE IS A LONG ONE...
...FULL OF ADVENTURE, FULL OF DISCOVERY.
Panel 9
Gap 9
Panel 10
Gap 10

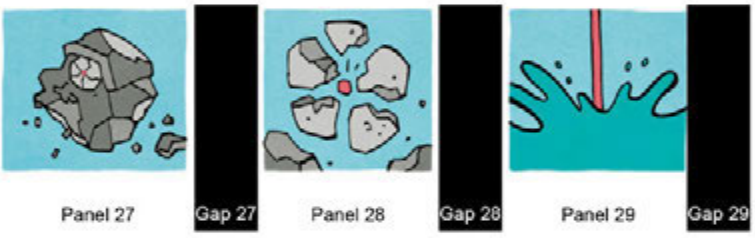
Panel 11 Gap 11 Panel 12 Gap 12 Panel 13 Gap 13

Panel 14 Gap 14 Panel 15 Gap 15

Panel 16 Gap 16 Panel 17 Gap 17 Panel 18 Gap 18 Panel 19 Gap 19

Panel 20 Gap 20 Panel 21 Gap 21 Panel 22 Gap 22 Panel 23 Gap 23

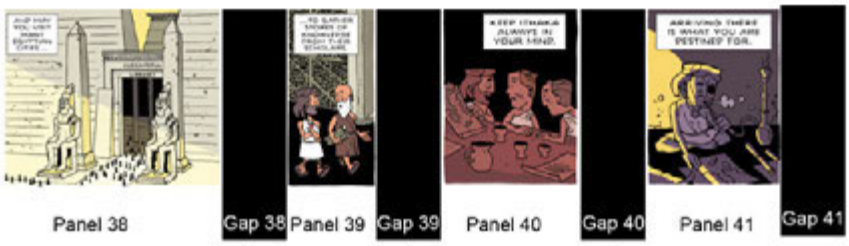

Panel 24
Gap 24
Panel 25
Gap 25
Panel 26
Gap 26


Panel 27
Gap 27
Panel 28
Gap 28
Panel 29
Gap 29


Panel 30
Gap 30
HOPE THE VOYAGE IS A LONG ONE.
Panel 31
Gap 31
MAY THERE BE MANY A SUMMER MORNING WHEN, WITH WHAT PLEASURE, WHAT JOY...
Panel 32
Gap 32

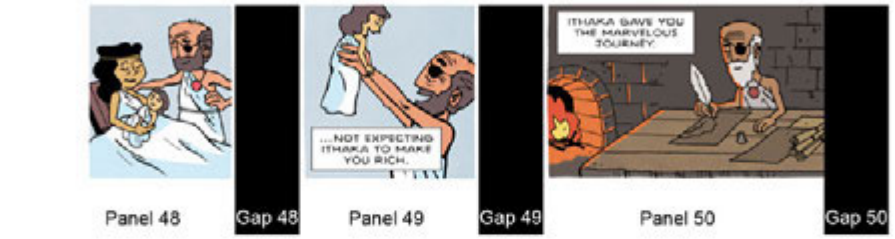

...YOU COME INTO HARBORS SEEN FOR THE FIRST TIME.
Panel 33
Gap 33
MAY YOU STOP AT PHOENICIAN TRADING STATIONS TO BUY FINE THINGS.
Panel 34
Gap 34


MOTHER OF PEARL AND CORAL, AMBER AND EBONY.
SENSUAL PERFUME OF EVERY KIND.
AS MANY SENSUAL PERFUMES AS YOU CAN.
Panel 35
Gap 35
Panel 36
Gap 36
Panel 37
Gap 37

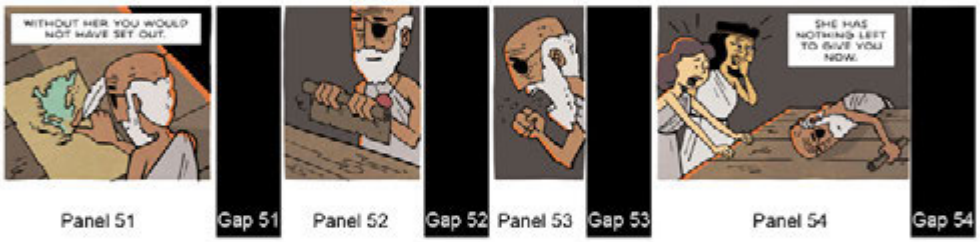

KEEP ITHAKA ALWAYS IN YOUR MIND.
Panel 38
Gap 38
Panel 39
Gap 39
Panel 40
Gap 40
Panel 41
Gap 41


BUT DO NOT HURRY THE JOURNEY AT ALL.
BETTER IF IT LASTS FOR YEARS...
Gap 42
Gap 43
Gap 44
Gap 45


...SO YOU ARE OLD BY THE TIME YOU REACH THE ISLAND...
...WEALTHY WITH ALL YOU HAVE GAINED ON THE WAY...
Panel 46
Gap 46
Panel 47
Gap 47



Panel 48 Gap 48 Panel 49 Gap 49 Panel 50 Gap 50



Panel 51 Gap 51 Panel 52 Gap 52 Panel 53 Gap 53 Panel 54 Gap 54

Panel 55 Gap 55 Panel 56 Gap 56 Panel 57 Gap 57

Panel 58 Gap 58 Panel 59 Gap 59 Panel 60 Gap 60

APPENDIX

II

Questionnaire in Experiment 1

Reading Experience Questionnaire

Great! You've finished reading the story and made panel groups. Now please answer some general questions. It's important to submit this survey so that we can receive the complete data.

* Required

How often do you read comics? *

- ◯ Not at all
- ◯ I only read a few when I was a kid
- ◯ I still read a little from social networks, news, etc.
- ◯ I read comics regularly
- ◯ I can't live without comics
- ◯ Other: _____

If you have read some comic books, do you enjoy reading printed comics?

	1	2	3	4	5	
I hate comic books :(	◯	◯	◯	◯	◯	I love comic book reading experience:)

What do you think of the time flow in the story? (multiple options are possible) *

- [ ] It goes forward
- [ ] It goes backward
- [ ] It has flash back part
- [ ] It jumps to the future
- [ ] It's a time loop
- [ ] It stopped
- [ ] There is no time in the story
- [ ] There are multiple timelines in the story
- [ ] Other: _____

Your age *

Your answer

Your gender *

Choose

Your native language *

Your answer

Your religion

Your answer

Your highest education level

Choose

Did you enjoy reading the previous comic story? *

	1	2	3	4	5	
Very Dislike :(	○	○	○	○	○	Very Like :)

How did you feel reading in this linear (left to right) way? *

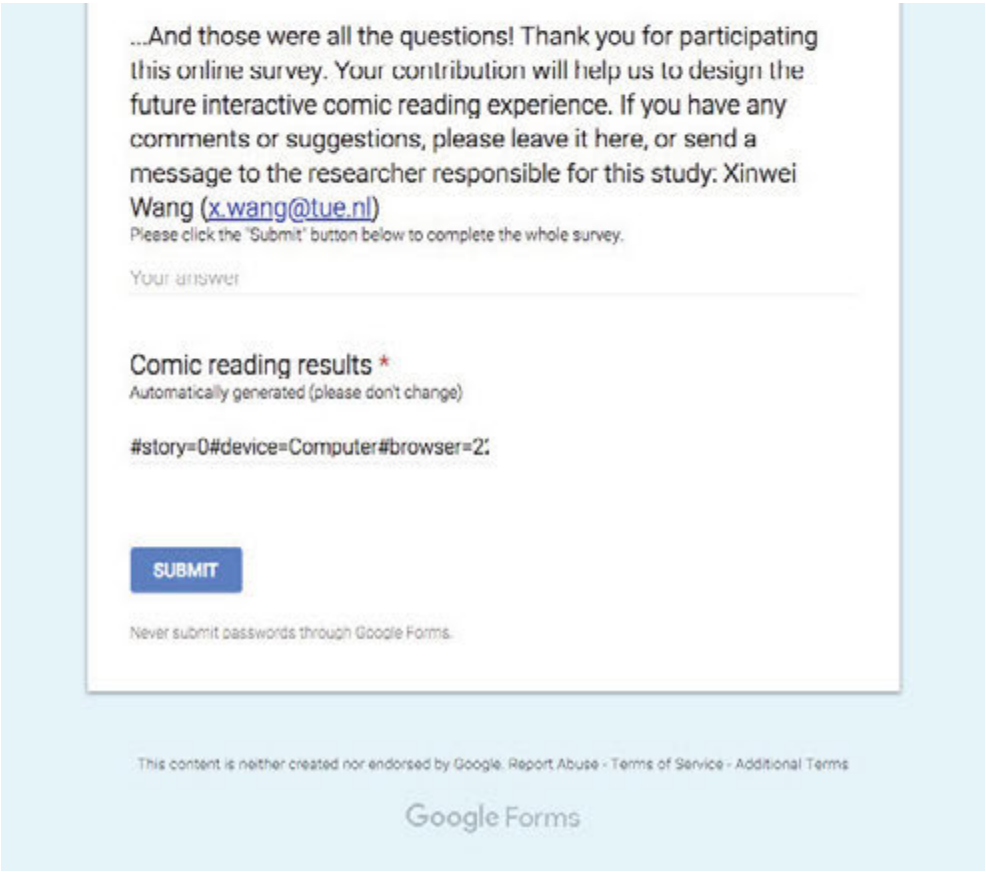
	1	2	3	4	5	
Very Uncomfortable	○	○	○	○	○	Very Comfortable

How long do you feel you have spent on reading the comics? *

Choose

Can you explain the reason you placed the boundaries to make groups? (multiple options are possible) *

- [ ] By change of character: action, facial expression, appearance, amount of character, etc.
- [ ] By change of object: appearance, movement, etc.
- [ ] By change of environment: location, weather, etc.
- [ ] By change of other symbols: motion line, impact star, etc.
- [ ] By change of text: character speaking, narrator's voice, sound.
- [ ] By change of story time
- [ ] By change of frame/panel shape
- [ ] By change of camera angle: zoom in, zoom out, look down, look up, etc.
- [ ] By change of drawing style: colour, strokes, abstract/concrete, etc.
- [ ] Other: _____

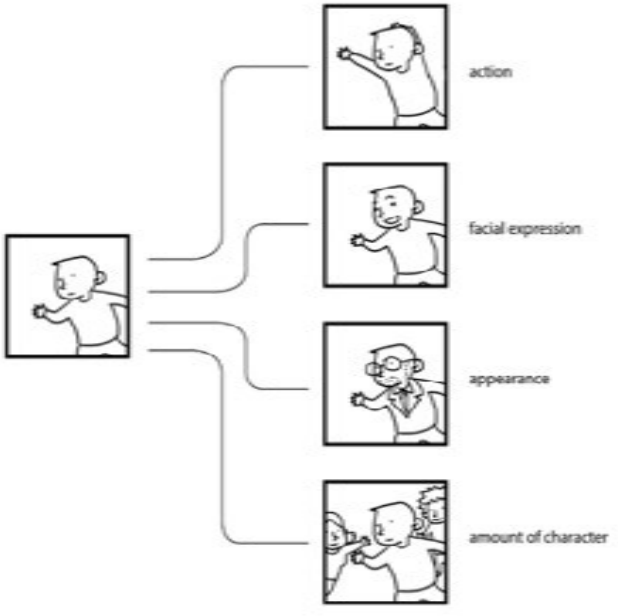

...And those were all the questions! Thank you for participating this online survey. Your contribution will help us to design the future interactive comic reading experience. If you have any comments or suggestions, please leave it here, or send a message to the researcher responsible for this study: Xinwei Wang (x.wang@tue.nl)
Please click the 'Submit' button below to complete the whole survey.
Your answer
Comic reading results *
Automatically generated (please don't change)
#story=0#device=Computer#browser=2
SUBMIT
Never submit passwords through Google Forms.
This content is neither created nor endorsed by Google. Report Abuse - Terms of Service - Additional Terms
Google Forms

APPENDIX

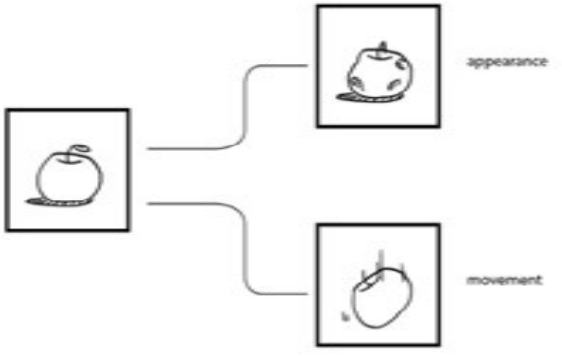
III

Card set used in Experiment 2

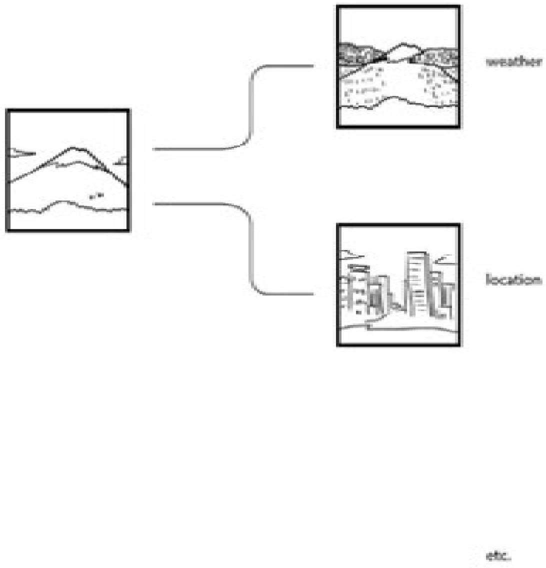
No.1: Difference of character



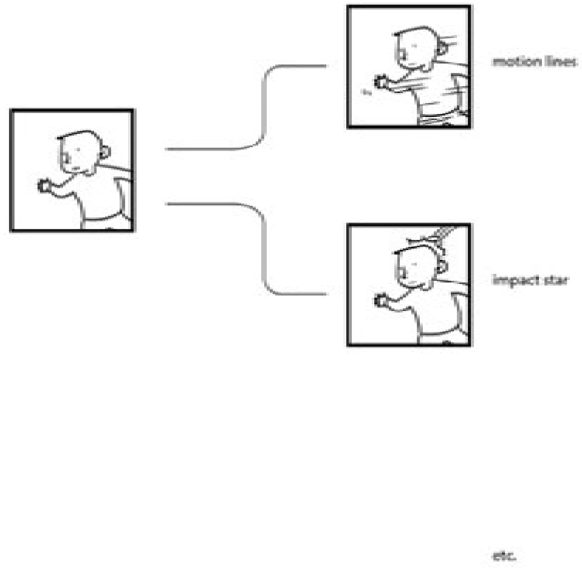
No.2: Difference of object



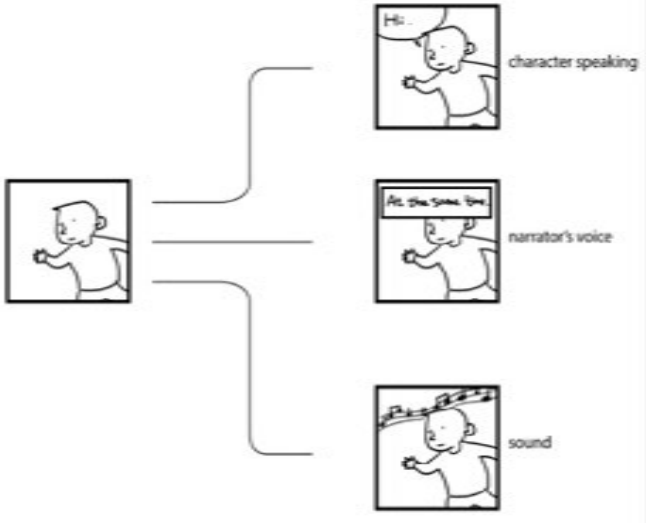
No.3: Difference of environment



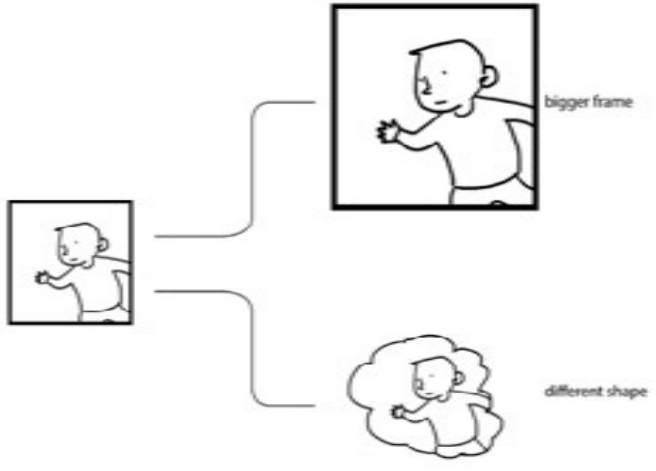
No.4: Difference of symbols



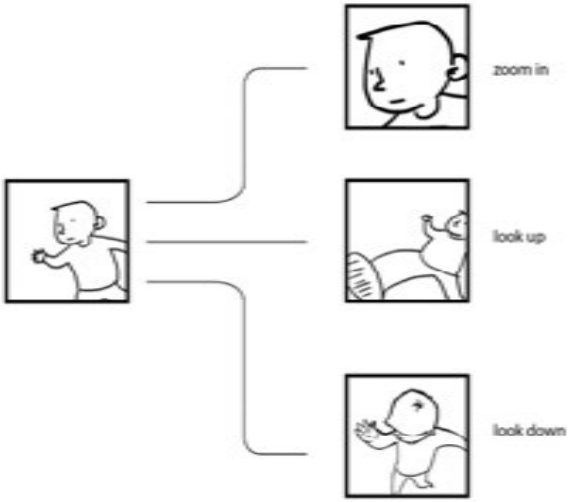
No.5: Difference of text



No.6: Difference of frame/panel shape

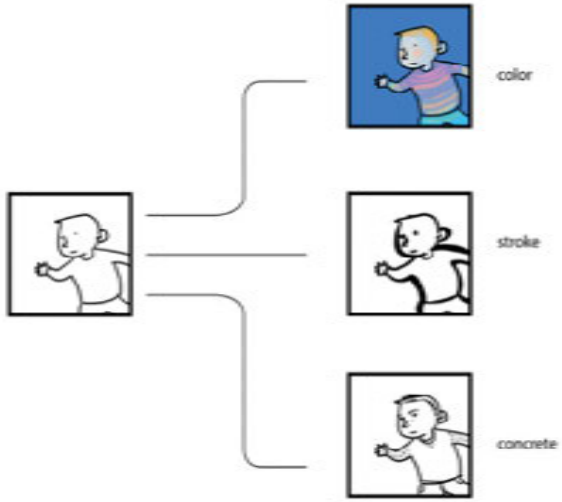


No.7: Difference of camera angle



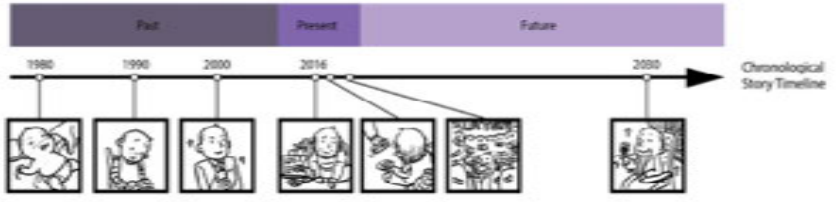
etc.

No.8: Difference of drawing style

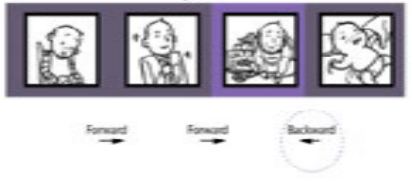


etc.

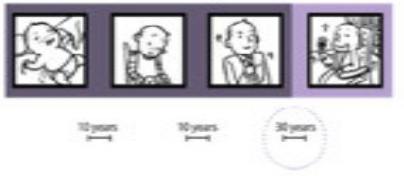
No.9: Difference of story time



Difference of direction of story time



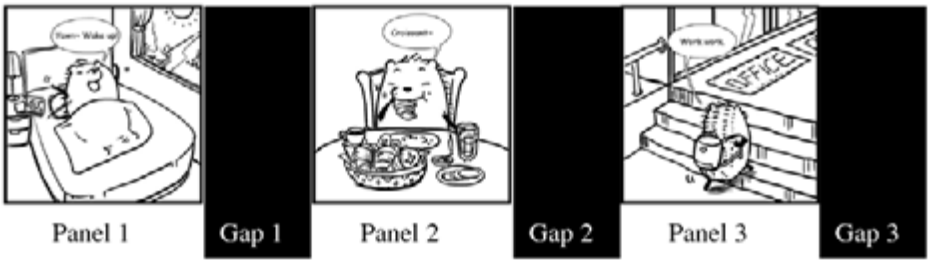
Difference of duration of story time



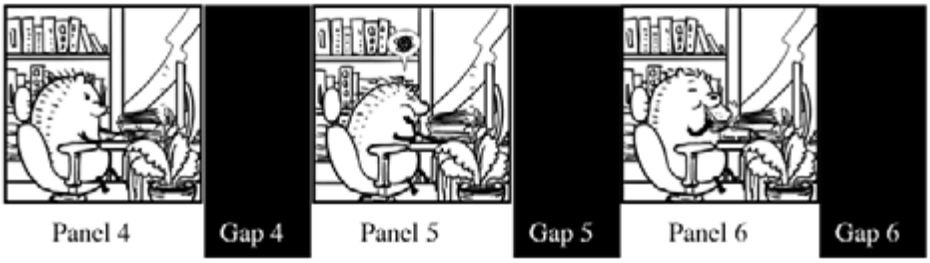
APPENDIX

IV

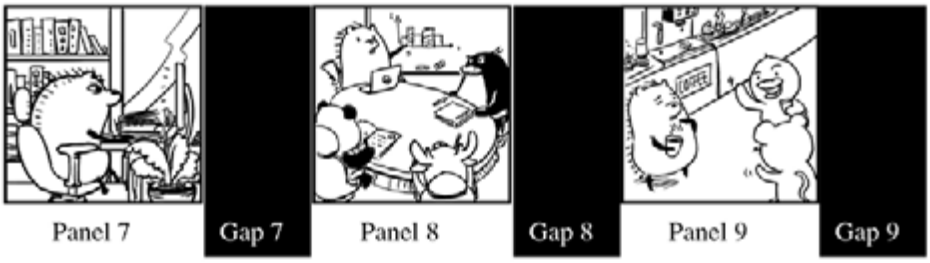
Panel Numbers & Gap Numbers in Experiment 3



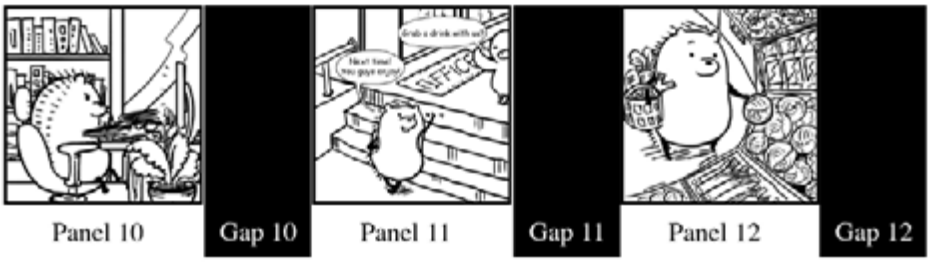
Panel 1 Gap 1 Panel 2 Gap 2 Panel 3 Gap 3



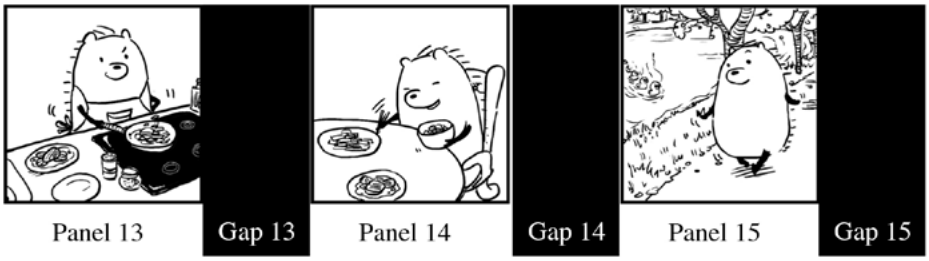
Panel 4 Gap 4 Panel 5 Gap 5 Panel 6 Gap 6

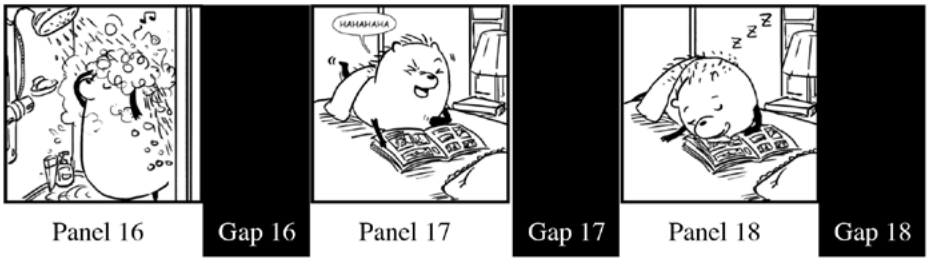


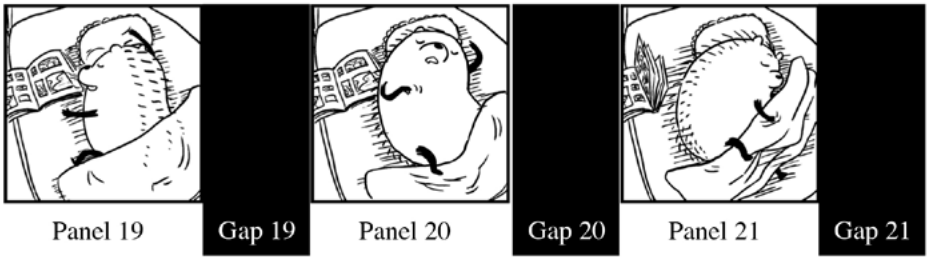
Panel 7 Gap 7 Panel 8 Gap 8 Panel 9 Gap 9

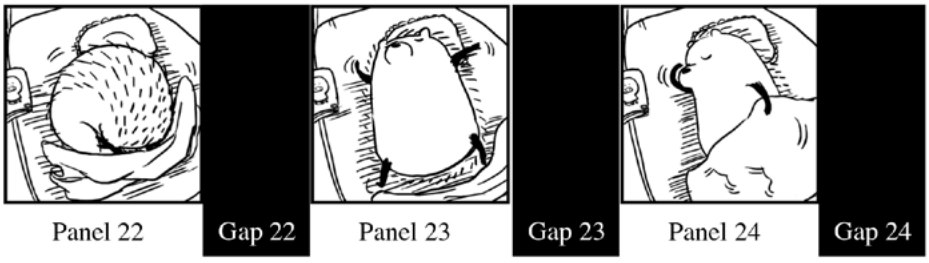


Panel 10 Gap 10 Panel 11 Gap 11 Panel 12 Gap 12


Panel 13
Gap 13
Panel 14
Gap 14
Panel 15
Gap 15


HAHAHAHA
Panel 16
Gap 16
Panel 17
Gap 17
Panel 18
Gap 18


Panel 19
Gap 19
Panel 20
Gap 20
Panel 21
Gap 21


Panel 22
Gap 22
Panel 23
Gap 23
Panel 24
Gap 24

APPENDIX

V

Questionnaires in Experiment 3

Date_____ Time_____ Participant No._____

Before-Test Questionnaire

Basic Information:

Age_____
Gender_____
Nationality_____

Comic Reading Experience:

1. How often do you read comics?

_____

2. Through what kind of media do you read comics? (e.g. books, new papers, web comics, comic app...)

_____

3. How would you describe the image on the right?

_____

_____

4. How would you describe the following image sequence?


_____

_____

5. How much do you like this drawing style?


Very Dislike


Dislike


Neutral


Like


Very Like

Date____ Time_____ Condition No._____ Order _____ Participant No._____

In-Test Questionnaire

Can you group the panels in the comics based on your reading experience?
(Please indicate different groups with lines in-between.)

Can you explain the reason of your decision?

_____

_____

_____

APPENDIX

VI

Main Analysis of Experiment 3

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Powerc
Speed	**Pillai's Trace**	0.005	.103b	1	19	0.752	0.103	0.061
	Wilks' Lambda	0.995	.103b	1	19	0.752	0.103	0.061
	Hotelling's Trace	0.005	.103b	1	19	0.752	0.103	0.061
	Roy's Largest Root	0.005	.103b	1	19	0.752	0.103	0.061
Speed * F5GapPercTotTC1	**Pillai's Trace**	0.018	.343b	1	19	0.565	0.343	0.086
	Wilks' Lambda	0.982	.343b	1	19	0.565	0.343	0.086
	Hotelling's Trace	0.018	.343b	1	19	0.565	0.343	0.086
	Roy's Largest Root	0.018	.343b	1	19	0.565	0.343	0.086
Speed * F5GapPercTotTC2	**Pillai's Trace**	0.03	.584b	1	19	0.454	0.584	0.112
	Wilks' Lambda	0.97	.584b	1	19	0.454	0.584	0.112
	Hotelling's Trace	0.031	.584b	1	19	0.454	0.584	0.112
	Roy's Largest Root	0.031	.584b	1	19	0.454	0.584	0.112
Speed * F5GapPercTotTC3	**Pillai's Trace**	0.016	.309b	1	19	0.585	0.309	0.083
	Wilks' Lambda	0.984	.309b	1	19	0.585	0.309	0.083
	Hotelling's Trace	0.016	.309b	1	19	0.585	0.309	0.083
	Roy's Largest Root	0.016	.309b	1	19	0.585	0.309	0.083

Speed * F5Gap-PercTot-TC4	**Pillai's Trace**	0.004	.073b	1	19	0.791	0.073	0.058
	Wilks' Lambda	0.996	.073b	1	19	0.791	0.073	0.058
	Hotel-ling's Trace	0.004	.073b	1	19	0.791	0.073	0.058
	Roy's Largest Root	0.004	.073b	1	19	0.791	0.073	0.058
Motion	**Pillai's Trace**	0.065	1.311b	1	19	0.266	1.311	0.193
	Wilks' Lambda	0.935	1.311b	1	19	0.266	1.311	0.193
	Hotel-ling's Trace	0.069	1.311b	1	19	0.266	1.311	0.193
	Roy's Largest Root	0.069	1.311b	1	19	0.266	1.311	0.193
Moti-on * F5Gap-PercTot-TC1	**Pillai's Trace**	0.244	6.123b	1	19	0.023	6.123	0.651
	Wilks' Lambda	0.756	6.123b	1	19	0.023	6.123	0.651
	Hotel-ling's Trace	0.322	6.123b	1	19	0.023	6.123	0.651
	Roy's Largest Root	0.322	6.123b	1	19	0.023	6.123	0.651
Moti-on * F5Gap-PercTot-TC2	**Pillai's Trace**	0.541		1	19	0	22.36	0.994
	Wilks' Lambda	0.459		1	19	0	22.36	0.994
	Hotel-ling's Trace	1.177		1	19	0	22.36	0.994
	Roy's Largest Root	1.177		1	19	0	22.36	0.994

Motion * F5Gap-PercTot-TC3	**Pillai's Trace**	0.125	2.711b	1	19	0.116	2.711	0.346
	Wilks' Lambda	0.875	2.711b	1	19	0.116	2.711	0.346
	Hotelling's Trace	0.143	2.711b	1	19	0.116	2.711	0.346
	Roy's Largest Root	0.143	2.711b	1	19	0.116	2.711	0.346
Motion * F5Gap-PercTot-TC4	**Pillai's Trace**	0.39		1	19	0.002	12.124	0.91
	Wilks' Lambda	0.61		1	19	0.002	12.124	0.91
	Hotelling's Trace	0.638		1	19	0.002	12.124	0.91
	Roy's Largest Root	0.638		1	19	0.002	12.124	0.91
Speed * Motion	**Pillai's Trace**	0.101	2.146b	1	19	0.159	2.146	0.285
	Wilks' Lambda	0.899	2.146b	1	19	0.159	2.146	0.285
	Hotelling's Trace	0.113	2.146b	1	19	0.159	2.146	0.285
	Roy's Largest Root	0.113	2.146b	1	19	0.159	2.146	0.285
Speed * Motion * F5Gap-PercTot-TC1	**Pillai's Trace**	0.028	.551b	1	19	0.467	0.551	0.109
	Wilks' Lambda	0.972	.551b	1	19	0.467	0.551	0.109
	Hotelling's Trace	0.029	.551b	1	19	0.467	0.551	0.109
	Roy's Largest Root	0.029	.551b	1	19	0.467	0.551	0.109

Speed * Motion * F5Gap-PercTot-TC2	**Pillai's Trace**	0.511		1	19	0	19.894	0.988
	Wilks' Lambda	0.489		1	19	0	19.894	0.988
	Hotelling's Trace	1.047		1	19	0	19.894	0.988
	Roy's Largest Root	1.047		1	19	0	19.894	0.988
Speed * Motion * F5Gap-PercTot-TC3	**Pillai's Trace**	0.282	7.451b	1	19	0.013	7.451	0.736
	Wilks' Lambda	0.718	7.451b	1	19	0.013	7.451	0.736
	Hotelling's Trace	0.392	7.451b	1	19	0.013	7.451	0.736
	Roy's Largest Root	0.392	7.451b	1	19	0.013	7.451	0.736
Speed * Motion * F5Gap-PercTot-TC4	**Pillai's Trace**	0.229	5.657b	1	19	0.028	5.657	0.617
	Wilks' Lambda	0.771	5.657b	1	19	0.028	5.657	0.617
	Hotelling's Trace	0.298	5.657b	1	19	0.028	5.657	0.617
	Roy's Largest Root	0.298	5.657b	1	19	0.028	5.657	0.617

APPENDIX

VII

Other Explorations

This section collects several exploratory design prototypes of d-Comics made through research. The first four prototypes can be accessed online. The last prototype needs to be accessed on a dedicated device and is therefore not available online.

Prototype 1: Background

As discussed mainly in Chapter 4, the spatial arrangement as a panel segmentation strategy has several aspects such as the spatial distance between panels and different visual elements. To express a phasel gap, the common practice would be to increase the spatial distance of the phasel gap (Figure appendix vii.1).

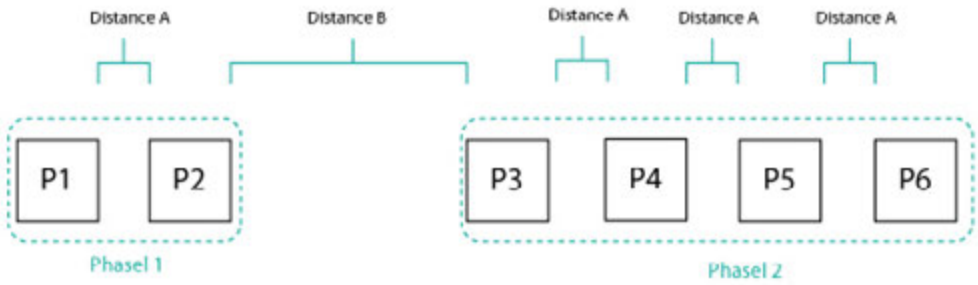


Figure appendix vii.1: Example of different distances between phasels.

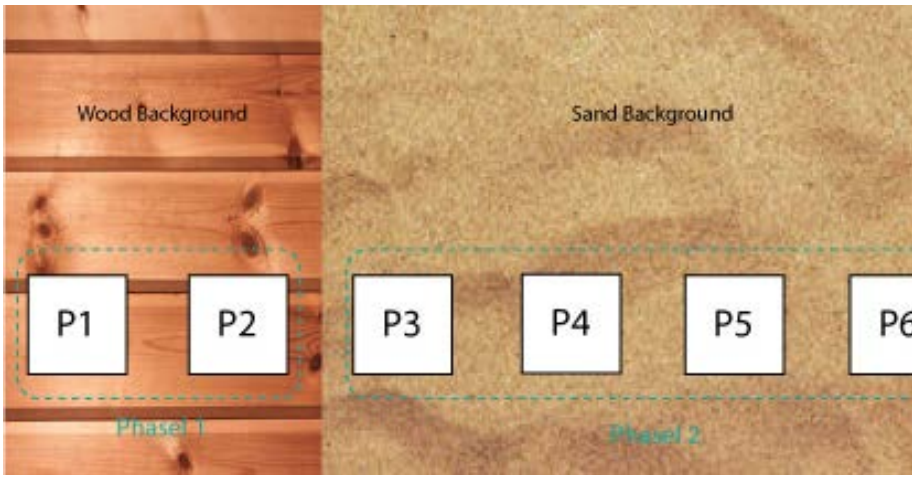


Figure appendix vii.2: An example of using differences in background to express segmentation.

Prototype 1 explores the "environment" aspect in the visual elements to express panel sequence segmentation. But instead of altering drawings inside panels, this prototype uses the space outside the panel. Each panel can be considered as one visual element, and the rest of the visual space displayed on the canvas would be the environment — since in the digital environment there can be different digital layers. Figure appendix vii.2 illustrates the appearance of prototype 1. A panel sequence is placed horizontally on a virtual canvas. The background (environment) of Phasel 1 is wood grain, while the background of Phasel 2 is sand. When the reader scrolls through the panel sequence, the background changes based on the current phasel to which the current panel (the panel in the centre of the display) belongs to.

Prototype 2: Moving Speed of the Background

In the digital environment, images can be placed on top of each other in virtual layers. This is different from print comics where there is only one static layer, including the background. Moreover, in d-Comics interactions can be used to move between different layers. For example, the user could drag the background, while the foreground remains at the same place. One existing example of separating panel layer from the background layer is *The Boat* from Huynh (2014). The foreground layer contains the static panels, while the background layer is one animated sea image. Another example of using layers can be found in Sutu's (2016) *These Memories Won't Last*.

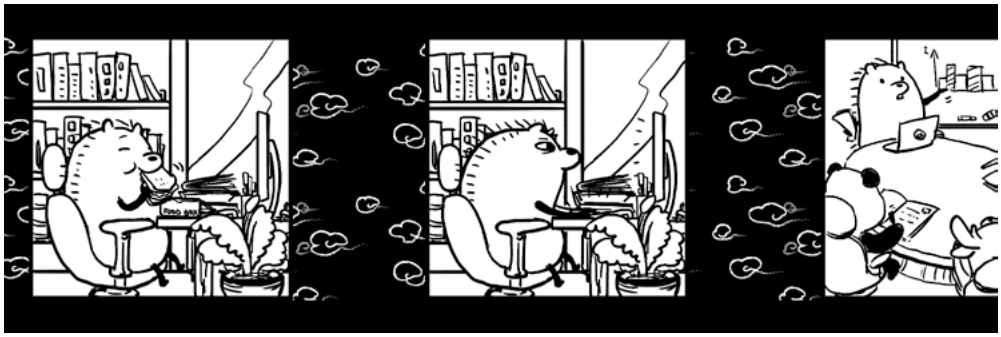


Figure appendix vii.3: A screenshot of Prototype 2

Figure appendix vii.3 is a screenshot of Prototype 2, which has two layers: the foreground layer for placing the panels, and the background layer for the cloud image. The panels are the twenty-four panels created in Experiment 3. The cloud image has been designed and programmed (using HTML, CSS and JavaScript) to occur constantly so that it appears as an infinite cloud background. The two layers all react to the same vertical scrolling

input. When the reader scrolls the panels, the moving speed of the front layer remains the same. However, the background layer moves faster when it is a phasel gap, and slower when it is a normal panel gap. The reader can observe the differences only when interacting with the d-Comics. Once the interaction is stopped, both the foreground and background become static.

Prototype 3: Shape Change

The idea of this prototype is to consider the panel gap as a visible object. Figure appendix vii.4 illustrates the mechanism of the prototype. Each panel gap has the same appearance when there is no input from the reader. The reader can scroll horizontally to move the panel sequence. In reaction to the reader's input, the visual gaps within a phasel change shape less dramatically than when there is a phasel gap. The visual effect is to mimic an elastic effect.

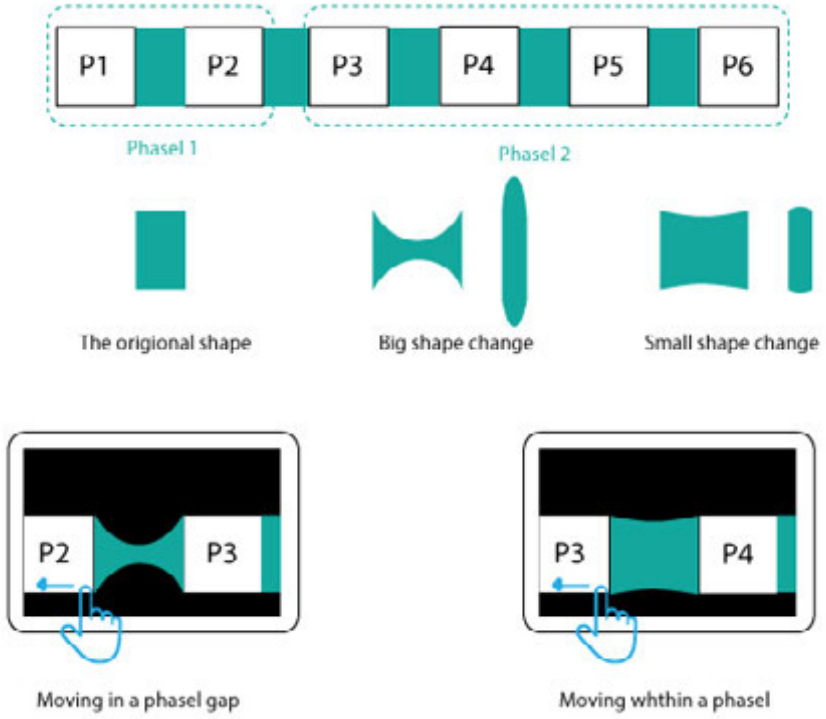


Figure appendix vii.4: A prototype in which different shape changes are used as the output to express segmentation.

Prototype 4: Zoom

Two existing examples of applying a zooming effect in d-Comics are McCloud's (2003) The Right Number and the zoom version of xkcd's Click and Drag adapted by Wesch (2012). Prototype 4 contains two sub-prototypes with different panel layouts: 4A and 4B (Figure 5). We used the twenty-four panels created in Experiment 3 with two different layouts. The prototypes were programmed with HTML, CSS and JavaScript. The zooming interaction relies on the two "zoom in" and "zoom out" buttons located on the bottom right of the screen.

Layout 1 starts with Panel 1 as the first stage. When zooming out, the presentation zooms to four, nine, sixteen and twenty-five panels in four steps. Layout 2 applies a zoom out starting from Panel 1 in the centre of the panel sequence, zooming to nine and twenty-five panels in only two steps. In both Layout 1 and 2, a guiding line has to be applied to indicate the reading order to the reader.

The reason that the two layouts with the same zoom interaction require a different number of steps is that we have defined that each zoom in input should make at least one more panel visible. Then because of the different layout, the required steps to view a certain number of panels are different.

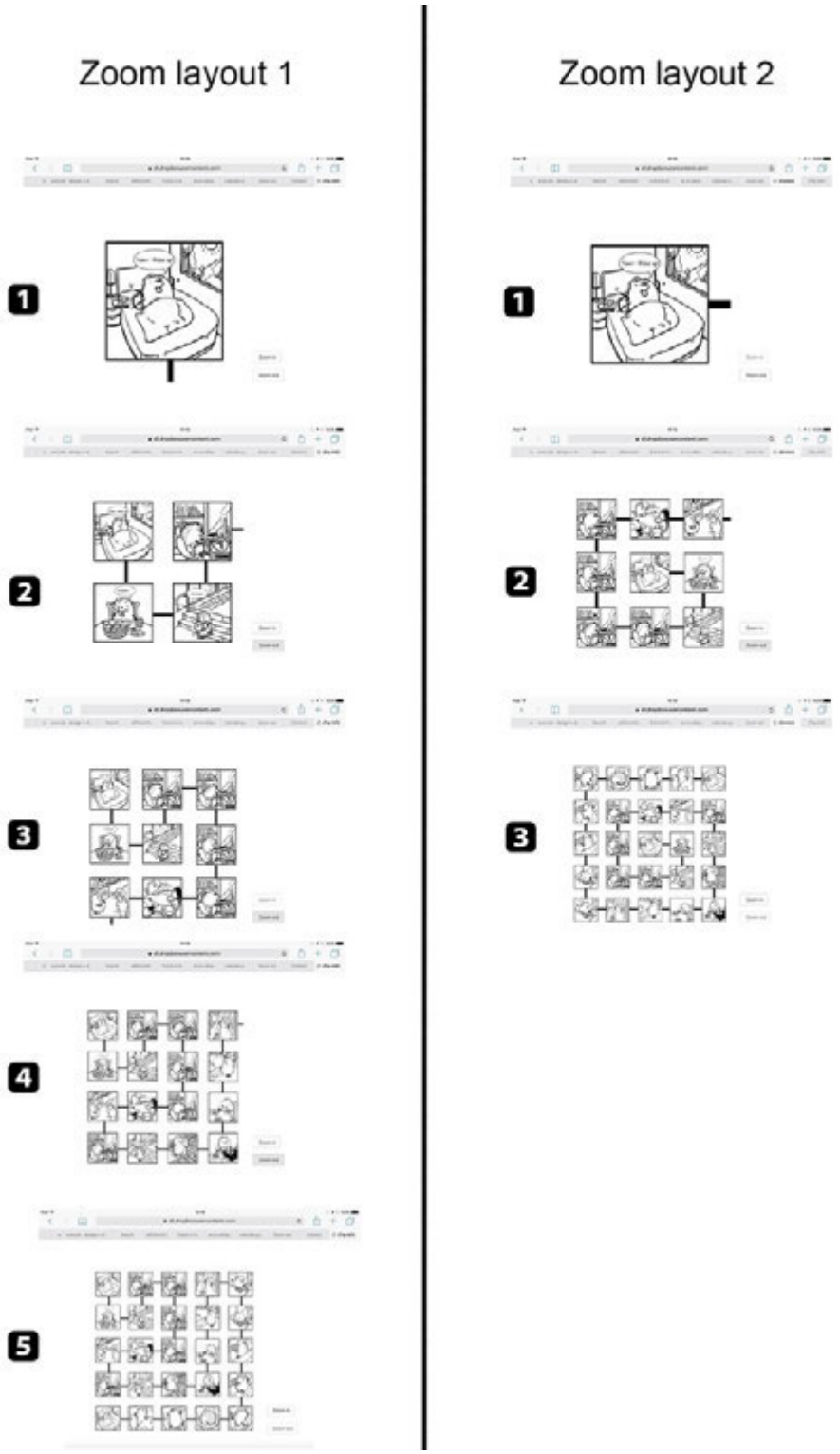


Figure appendix vii.5: Zoom layout 4A (layout 1) and 4B (layout 2).

Prototype 5: 3D Virtual Space

Prototype 5 aims to explore the three-dimensional virtual space. The eight phasels from Experiment 3 were adopted and placed in three-dimensional virtual space in Unity. As Figure appendix vii.6 shows, panels that belong to the same phasel were placed horizontally on the x-axis, while different phasels were located vertically on the y-axis. By converting this setting with ARToolKit, we were able to experience reading d-Comics in Augmented Reality from a tablet. Figure appendix vii.7 is a screenshot of the tablet used to read this prototype. The starting position was standing straight and holding the tablet perpendicular to the floor. By moving the tablet horizontally, we can see panels in the same phasel. By moving the tablet forward or backward, we can switch between phasels.

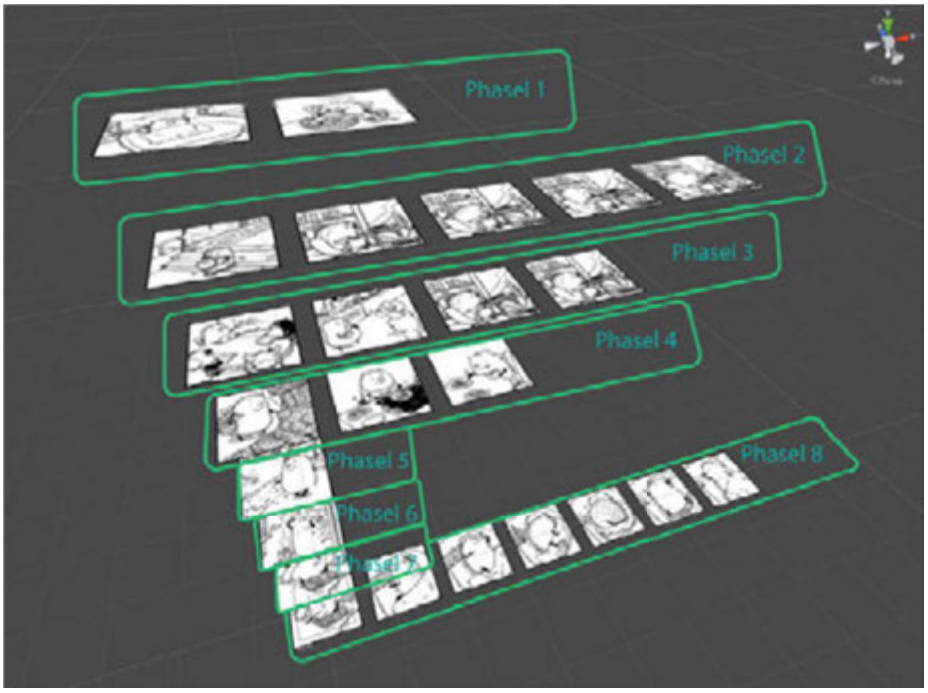


Figure appendix vii.6: An example of using the x-, y-, and z-axis to express segmentation.

Figure appendix vii.7: Screenshot of the Augmented Reality prototype made using Unity and ARToolKit.

The problem of this prototype is that when a small phasel is on top of a large phasel (for example, Phasel 1 and Phasel 2), the large phasel won't be visually covered. Therefore, when reading Phasel 1, the reader can already see some panels in Phasel 2. One solution could be to use an angle between the phasels to separate them on different axes. For example, Figure appendix vii.8 shows a rebuilt 3D virtual space where the phasels are rotated 90 degrees. The spatial arrangement will bring many interesting challenges, such as how to create a good 3D digital panel segmentation in virtual space.

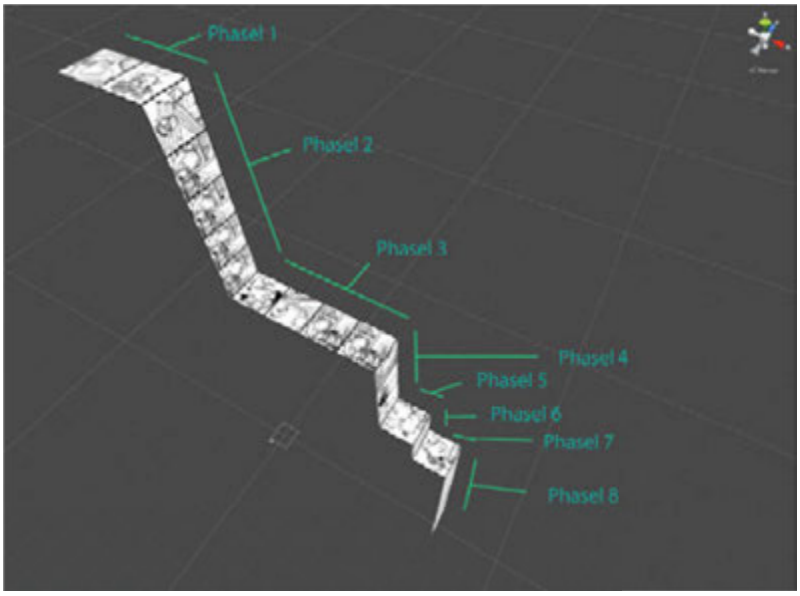


Figure appendix vii.8: Improved 3D scene where the rotation has been used to express segmentation.

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Summary

Comics are a storytelling medium. There are several practices which revolve around this medium: "the industry that produces comics, the community that embraces them, the content which they represent, and the avenues in which they appear [@Cohn2005]". For over a hundred years, comics were presented on paper-based carriers such as magazines and books. With the development of new technologies, the comics industry has the opportunity to embrace a new carrier – the digital environment in electronic devices.

The journey of the comics industry towards digitalisation started in 1980 as more and more comics appeared on this new carrier. This transformation between carriers changed not only how comics are displayed, but also how readers can read comics and how authors can create comics. Simple transformations of printed comics into digital formats will limit the development and expressions of digital comics. This research aims to explore how comics are constructed in the digital environment, to provide insight into designing digital comics (d-Comics) for electronic devices.

The research objective is to gain knowledge about comics and its carriers, to design for digital comics. The research started from wondering how the physical pages influenced comics – is there a unit in d-Comics similar to the page? This question has been broken into two sub-questions: How is a panel sequence segmented in d-Comics? What could be the strategies of the segmentation in d-Comics when designing panel sequence segmentations?

Three experiments were conducted to answer these research questions. Experiment 1 was a web-based experiment for collecting an understanding of how readers segment panel sequences in d-Comics: four panel sequences were analysed. Experiment 2 was an expert review to justify the results collected from Experiment 1 and provided a detailed analysis of the influence factors of panel segmentation in d-Comics. Experiment 3 was a lab-based experiment that built further upon the insights gained from Experiments 1 and 2. Moreover, by conducting a within-group test of the result, the effect of interaction design on the expression of panel sequence segmentation in d-Comics has been analysed.

The results from Experiment 1 lead to a general pattern of panel sequence segmentation. Segmentations of panels in d-Comics can create two types of panel groups: phasel and fadel. A phasel (created by combining "phase" and "sequel") in d-Comics is represented by one panel or multiple panels that belong to each other. The author or

the reader cannot decompose these further into smaller phasels. A phasel describes a strong relation among a certain number of panels and a significant difference with other phasels, determined by the author's interpretation of storytelling. Based on the results of the experiment, the smallest phasel has one panel, and the largest phasel has twenty-four panels. A fadel (created by combining "fade" and "sequel") is represented by one panel that the author or the reader considers to be part of the previous phasel and the next phasel. A fadel describes an overlapping transitional relation between two phasels, and it contains both the fading of the previous phasel and the starting of the next phasel determined by the author's interpretation of storytelling. Experiment 2 further justified the identified segmentations from Experiment 1 and established two strategies for segmentation: narrative structure and visual space. In Experiment 2, the two strategies were separated into nine categories: story time, environment, character, object, symbol, text, frame/panel shape, camera angle, and drawing style. The identification of segmentations between panels can be stimulated by implementing different categories or a combination of categories. The experiment shows that when more categories are implemented between two panels, there is a higher chance that a segmentation will be identified. Experiment 3 implemented the knowledge gained from the previous two experiments and explored the design of interactions for panel sequence segmentation in d-Comics. The results showed that the vocabulary and strategies could indeed be applied when designing d-Comics, and justified interaction is the third panel sequence segmentation strategy in d-Comics. The design of d-Comics should apply the panels' sequence segmentation strategies on the segmented panel sequence based on the author's storytelling intention.

The main contribution of this thesis is the establishment and description of a panel-level relation vocabulary (phasel, fadel, phasel gap) that is independent of the carrier. This vocabulary, together with the strategies of segmentation can be considered as the framework for the creation of d-Comics. The d-Comics author can create panels without considering the concrete carrier. Based on the relations between panels' segmentation strategies can be applied to strengthen or weaken the relations among panels. As a result, the spatial relations and interactions may vary among different electronic devices, but the author's storytelling intention can remain coherent.

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Curriculum Vitae

Xinwei Wang was born in Qingdao, China on the 1st of September 1985. After obtaining her high school diploma in 2004 at Qingdao No. 2 High School, she studied Industrial Design at Jiangnan University. She received her Master's diploma in 2010. After her Master's education, she worked as User Interface Designer, Interaction Designer and Animator in Beijing, China. She started a PhD project in 2012 at Eindhoven University of Technology with the funding from the Chinese Scholarship Council (CSC), the results of which are presented in this dissertation. During her doctoral work, Xinwei was a student project coach and expert in the Industrial Design Department at Eindhoven University of Technology, and conference secretary of the 8th International Conference on Design and Semantics of Form and Movement (DeSForM) in Wuxi, China. In 2016, Xinwei started to work as a part-time lecturer in the Industrial Design Department in Xi'an Jiaotong-Liverpool University, and joined the department as a full-time lecturer from 2018.

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