Applying Visualization in Digital Journalism: An Empirical Study on the New York Times

by

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Abstract

Visualization has long been used in journalism to facilitate news storytelling. Media outlets applying visualization techniques in the news articles to communicate information efficiently and intuitively. This thesis aims to explore the way that visualization is applied in digital journalism with the New York Times (NYT) as a study object. By exploring the way to choose and design a visualization format and to incorporate visualizations in news stories, we can have a general idea on how media outlets are using visualization in the news storytelling. The findings reveal, first of all the relationship between the news topic and the visualization format adopted; secondly, the principles of designing visualization in the news article; and finally, the news components that are most represented in visualization. The outcome is expected to provide a direction for media practitioners on how to apply visualization in the visual news report.

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Introduction

Journalism has changed dramatically in the digital age. The penetration of computer technology in the journalism industry has given birth to a new generation of approaches for news storytelling and presenting. The emerging concepts of computer-assisted reporting (CAR), computational journalism, and data journalism have demonstrated the significant impact of technology on the journalism industry. Visualization, one of the most widely used presentation approaches in digital journalism, has been proven to have a positive impact on the information communication. Combined with textual information, visualization can communicate information straightforwardly and intuitively. Therefore, more and more media outlets embrace visualization as an integral part of news storytelling. Their achievements, e.g. the Datablog of the Guardian and the yearly collection of visual stories and graphics of the New York Times (NYT), directly indicate the popularity of visualization in both media and audience groups. On the other hand, journalists today are also encouraged to be educated with not only the knowledge in journalism, but also the skills of designing and applying visualization effectively when producing news reports. To provide a good design reference for them, it is increasingly important to understand how media outlets incorporate visualization in their news reports. However, there is not much research that focuses on offering guidance to applying visualization in journalism. Thus, this study aims to provide a good reference for media practitioners by exploring and summarizing the way that successful media outlets incorporate visualization in the digital news. Specifically, this study can be divided into three parts, based on the design procedures of a visualization-incorporated news article. First of all, a journalist should select the visualization formats that will be used in the article. Afterwards, the detailed design and organization of the visualizations should be carefully conducted. Finally, after having well designed visualization

formats, journalists also need to integrate the visualizations in the news story. In all these three steps, there are design principles should be followed. However, as of today, few studies are reported specially for the design principles of visualization in news articles. As such, the study presented in this thesis aims to fill this gap by studying these three steps one by one.

As stated above, the first step is to choose a visualization format. As visualization can be represented in multiple formats, such as a map, slideshow, chart, and so on, journalists should make a decision on which format to choose based on the content to be visualized. Thus, this study aims to explore if there is a relationship between the news topic and the visualization format selected. Figuring out the relationship will provide possible criteria for journalists to choose the visualization format based on the news content they are trying to produce. The second part of this study focuses on the design of visualization format. Different from a single image, a visual news article usually contains several visualizations, which are consist of visual elements such as the dot, line, shape, or a series of images. How to organize the visualizations and the visual elements to make the visual story easy to read by the majority of readers is of great importance for the efficiency of communication. So, the second part of this study explores the principles that journalists follow when designing the visualization in digital news articles. After having an idea of how to choose and design a visualization format, the next step is to consider combining it with the main plot of the news story, which constitutes the third part of this study. As a storytelling form, most of the news articles use visualization to tell a vivid and convincing story. According to Bell (Bell, 1991), a complete news story structure consists of components like the actor, action, setting, background, follow-up, commentary, and attribution, which can be represented in visualization in different degrees. This part of the study aims to

explore how journalists apply visualization to represent the news story components, and points out using visualization in news storytelling in general.

This study picks one of the pioneer news media, the New York Times (NYT), as a case to explore adopting visualization in its digital news articles from the three perspectives illustrated above. The NYT is chosen since it is one of the most progressive media organizations in developing and practicing visualization in online news presentation (Royal, 2010). It has invested heavily in the practice of visual reports, including infographics and interactive visualization reports (Giardina & Medina, 2013). Exploring the way that the NYT incorporates visualization in news storytelling is expected to provide a direction for the media practitioners on how to apply visualization in news reports.

To conduct this research, data collection is the first step. To answer the three research questions, the data will be collected from three perspectives. First of all, the data of visualization formats appearing in the sample news articles will be collected, as well as the topics of the news articles. Next, the data on visualization format embodying the Affordance and Gestalt theories, two widely used theories in visualization design, will be collected based on certain criteria, which will be introduced in the following part. Finally, the data on the news components that are represented in visualization will be collected.

The following paragraphs will provide an outline of the thesis by introducing each chapter briefly.

In chapter 1, I will examine two key terms related to the research, i.e. digital journalism and visualization. The clear explanation of these two terms helps to define the scope of this study. In the digital journalism section, the evolving definition of digital journalism and its history will be

introduced to provide a clear context of the research. In addition, the evolution of journalism, as a form of a story, in the digital age will be introduced as well. On the other hand, visualization, the other important term in the study, will be demonstrated from the perspectives of its history and the types of data to be visualized.

Chapter 2 is a literature review regarding the previous studies on visualization in journalism. The main sections include the application of visualization in journalism, visualization format typologies, and its application in storytelling. Furthermore, three theories, as the main frameworks in this research, will be illustrated in detail.

In Chapter 3, the research questions and methodologies applied in this study will be introduced, including the data collection, data classification and quantitative analysis. The three research questions are in a continuum that constitutes the practice of incorporating visualization into the media practice. The questions start from looking for a way to find the proper visualization format based on news topic; then explore the design principles to follow when designing a visualization format; at last, it summarize the news story components that are suitable to be presented in a visualization format.

In Chapter 4, the results and findings of the study will be demonstrated. The relationship between news topic and visualization format is revealed and discussed at the beginning part. In addition, this study also finds that the NYT implements the two visualization design theories by following a series of the principles of the theories. Moreover, it is found that some of the news components are frequently represented in visualization, which includes the action, actor, and setting. The possible reasons are discussed in this chapter to explain the findings as well.

1. Key Terms and Theoretical Frameworks

1.1 Digital Journalism

Digital technology has brought revolutionary changes to the journalism industry. The impacts are reflected in threefold: making journalists a role as the essential intermediary force in democracy; providing the media professional rich resources; creating its own type of journalism(Deuze,1999). With the impact of communication technology and the redefining of information demand of the audience, a new term comes into being: digital journalism.

What is digital journalism? There is not a widely recognized definition yet. Rather, the definition of digital journalism is a moving target with the change of technology and the concept of journalism (Kawamoto, 2003). Most of the scholars try to define the digital journalism from the perspective of its new features that are promoted by the computer technology. Dahlgren even attributed the advent of digital journalism to the technology and stated that the Internet has a direct impact on the definition of journalism (Dahlgren, 1996). According to Kawamoto's definition, "use digital technologies to research, produce, and deliver news and information to an increasingly computer-literate audience", the digital technology has permeated to both the news producing the news consuming process (Kawamoto et al., 2003). Being applied to the news producing process, the computer technology has affected the features of journalism in the digital age (Kovach & Rosenstiel, 2007). Scholars summarized the features as interactivity, customization of content, hypertextuality, multimediality, and synchronicity (Steensen, 2011; Bardoel & Deuze, 2007). These features indicate that the news story is being composed and presented in a new way which benefits from the evolving technology.

1.1.1 A form of storytelling

"All news stories are stories, but some are more storylike than others." – Schudson (2003: 186)

Journalism has long been explored as a form of storytelling (Bird & Dardenne, 1988). Similar to the traditional storyteller, journalists' work is to compile information with news values and structure them into a coherent narrative that is clearly understood by audiences. Thus, most of the news reports are composed based on the basic storytelling structure, such as narrating a recently happened event with a clear story plot. However, storytelling is not an element of all kinds of news reports. For instance, a knowledge-sharing article with little plot cannot be counted as storytelling. Nonetheless, considering that the narrative structure is followed by most of the news reports, media researchers still explore journalism from the story perspective.

Digital journalism, as a convergence of multiple media formats, has also been an important area of storytelling (Sizemore & Zhu, 2011). The practice of storytelling has been expanded with the emerging of digital media. It has been changed based on the four characteristics of digital media: (1) the media can include all data types, (2) there are no deadlines, (3) all media are dialogical or two-way, (4) everybody can participate in the public debate (Maartmann-Moe, 1991). The first point that the media can include all data types indicates that varieties of new formats of storytelling have come into sight, for example, web-based stories, interactive stories, and hypertexts (Ching & Foley, 2012). Journalism in a digital age, inheriting the form of storytelling, has also benefited from the new storytelling formats that have come into being. Although the storytelling formats that are used in journalism have been enriched by the technology, it can still be decoded into different narrative genre/forms according to the same elements that they share (Roeh, 1989). Therefore, a news story with multiple presentation formats included can be

analyzed based on certain narrative structure, which will be introduced as one of the theoretical frameworks in Chapter 2.

1.2 Visualization

The term visualization is interpreted as "the representation of an object, situation, or set of information as a chart or other image" in the Oxford Dictionary (Visualization [Def.1]). Although it is a general definition, it highlights that it is the representing format that distinguishes visualization from other information manifestations. Scholars tend to comprehend it as a graphical representation of data or visual concepts (Ware, 2012; Ward, Grinstein & Keim, 2015), which points out the target of the visualization. It is also well accepted that applying visualization to present data or visual concepts has a positive impact on human decision-making and also helps to assist in analysis and communication (Ware, 2012; Ward, Grinstein & Keim, 2015). Therefore, visualization has been widely used in many fields like education, science, journalism, and so on.

1.2.1 A brief history of visualization

The earliest visualization can be traced back to approximately 30,000 years ago, in the form of arc cave located in the south of France (Ward, Grinstein & Keim, 2015). It is the first technique for graphically recording and presenting information that was used by early man. With the purpose to facilitate travel, commerce, religion, and communication, visualization in geometric diagrams came out, which has been identified as the origin of maps. The following figure is the famous Hereford map, which presents the world that one can see at the cathedral at Hereford, with religion information provided as well (Ward, et al., 2015).

Figure 1.1. Hereford map, the largest medieval map known still to exist (Wikipedia Commons, n.d., n.p.).

In the 17th century, the volume of data advanced, which spawned new forms of visualization, timelines, bar charts, and line charts, for example. The physical measurement of time, distance, and space were used in map making, navigation and territorial expansion (Friendly, 2008). The following figure is an example of visualization in that age by a Flemish astronomer. It shows all 12 known estimates of the difference in longitude between Toledo and Rome, which was believed to be the first visual representation of statistical data (Tufte, 1997).

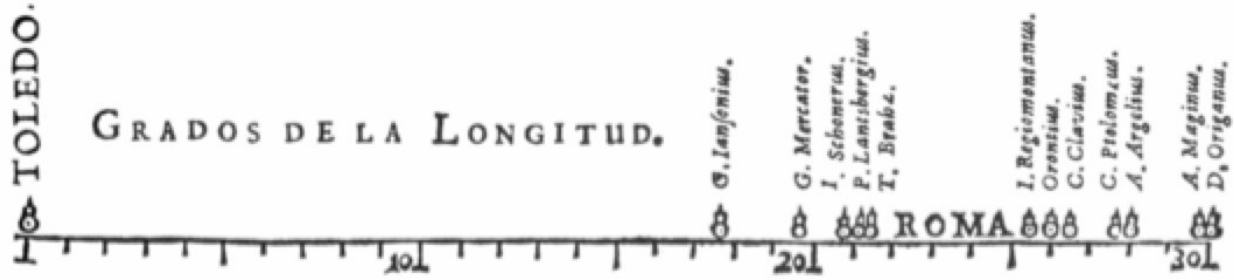

Figure 1.2. Langren's 1644 graph of determinations of the distance in longitude, from Toledo to Rome. Source: Tufte (1997, p. 15)

When it comes to the 18th century, a greater variety of data was visualized to make sense based on the statistic theory initiated by Gauss and Laplace. That time has been recognized as the golden age of data graphics. (Friendly, 2005) The following is an example that shows the national debt of England, by William Playfair. It is also a pioneer of visualization that applies two axis for statistical data presentation and interpretation (Ward, et al., 2015, p13).

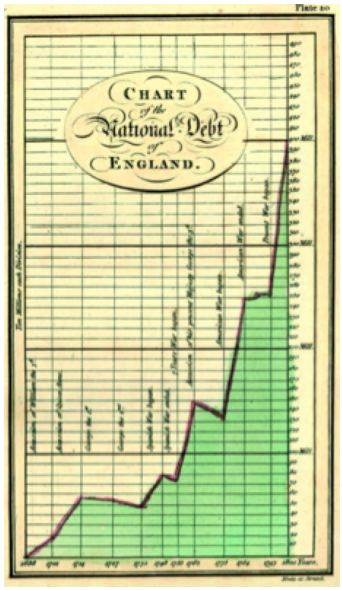

Figure 1.3. National Debt of England by William Playfair (Wikipedia Commons, n.d, n.p).

With the development of software and computer systems, the computer started to show its advantage in visualization since 1975. Varieties of iconic visualization works were produced from that time. Although it is hard to provide a succinct overview of the varied present visualization, it is obvious that high-dimension, interactive and dynamics have become the major feature of the present visualization (Friendly, 2008).

1.2.2 Types of data to be visualized

To apply visualization to facilitate information communication, the first step is to have an idea of the types of data that could be visualized. There are researchers proposing approaches to classify the data to be visualized from different aspects. Usually, the data is classified as ordinal and nominal ones (Ward, 2015). The former one means data taking on numeric values, such as binary, discrete and continuous data. The latter one means data taking on non-numeric values, such as categorical, ranked and arbitrary data. Bertin (1981) proposed a way, which classifies the data that can be visualized in detail. According to Bertin, the data that can be visualized includes the size, shape, value, color, orientation, and texture. Following Bertin's categorization, Ware (2012) identified data as entities and relationships. The former one is the object to be visualized. The data of the object is similar with the categorization proposed by Bertin. The latter one is the association between entities, such as causality. Both entities and relationships have attributes. For example, the size is an attribute of a box. Ware then classified the attributes of entities and relationships into category data, integer data, and real-number data. In addition to Ware, Shneiderman identified seven data types, including one, two, and three-dimensional data, temporal and multi-dimensional data, and tree and network data (Shneiderman, 1996).

Visualization in journalism is different from that of other fields, for example the scientific visualization. The association between entities constitutes a large part of visualization in the journalism field. For instance, journalists often use visualization to demonstrate the causality of a series of events in a straightforward and intuitive way, while the non-numeric data can be an important part of the causality visualization. Take the diagram that used to demonstrate the actor relationship as an example (See Figure 1.5). The thumbnails or names of the actors connected by lines show the complex relationship among actors. The thumbnail or name of actors are the main

elements that constitute the visual diagram. Therefore, in this study, visualization not only means a neat visual presentation of a large amount of complex numeric data. Instead, visualizations that are composed by both numeric and non-numeric data are all considered as the research target.

1.2.3 Infographics and visualization

It is necessary to clarify the two related terms, infographics and visualization, before continuing the study. Infographics is the abbreviation of "information graphic". It has gained popularity since the increasing use of graphics in a variety of areas, such as journalism, medical science, and so on. Cairo (Cairo, 2012) indicated that infographics is a way to present statistical and nonstatistical data, which allows audiences to view the information following the author's setting. Data map and chart, which convert complex data into a visual message, are the two major types of statistical infographics. Fact boxes, tables, non-data maps, and diagrams are the most commonly used types for non-statistical infographics presentation, which are expected to arrange a complex series of numbers or words in a pleasing and easily readable arrangement (Harris & Lester, 2001). Compared to infographics, information visualization emphasizes the exploration by providing an interactive element, which allows audiences to conduct customized analysis of the data. The two news articles *Word According to China* and *Unraveling the Connections Among the Paris Attackers* can be two examples to explain the difference between visualization and infographics (see Figure 1.4 & Figure 1.5). The former one, *Word According to China,* uses interactive maps combined with coloured circles to represent China's enormous overseas spending, which emphasizes the exploration and interaction function of visualization. Audiences are allowed to explore the spending and detailed invest information on different areas by hovering the cursor on different circles. In contrast, the latter one uses a static information diagram as an infographic to present the connection among the suspects, which underlines the

presentation function of visualization. The diagram does not contain complex data and provides little interactive function to allow audiences to explore. Instead, it presents the information by structured images, annotations, and connecting lines.

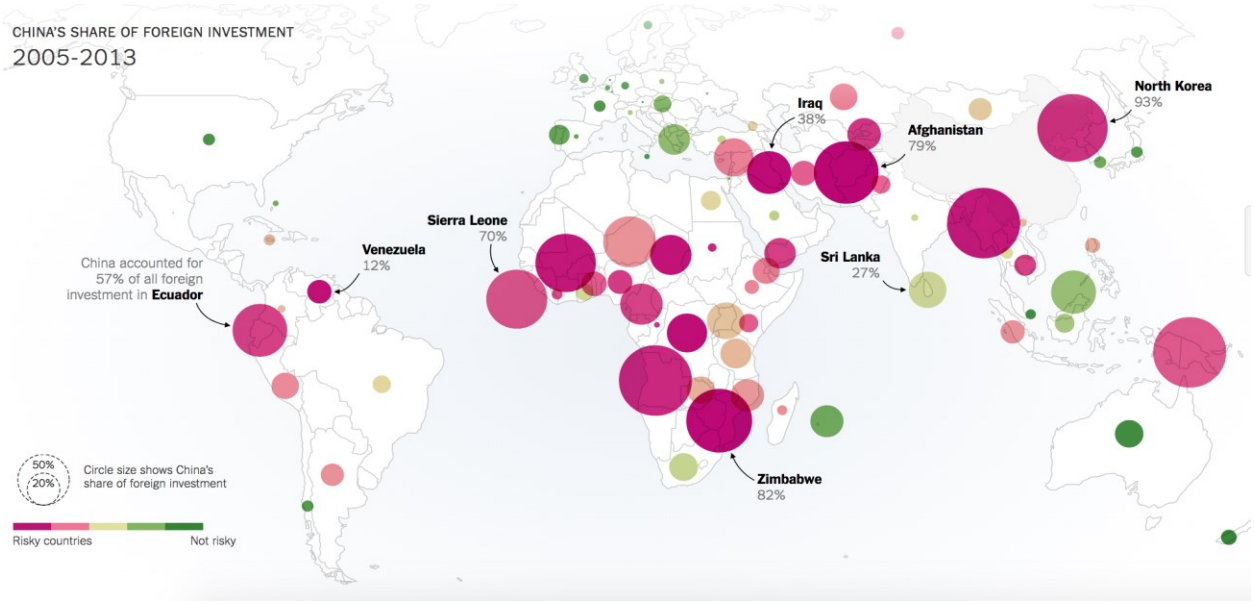

Figure 1.4. Screen capture from *the world according to China* (Gregor Aisch, 2015, n.d.).

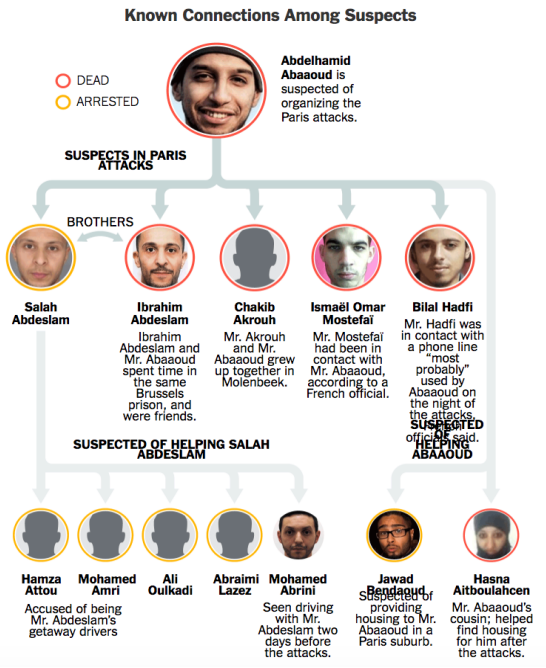

Figure 1.5. Screen capture from *Unraveling the Connections Among the Paris Attackers* (Alicia Parlapiano, 2015, n.d.).

Although the infographics and visualization lay stress on different functions of visualization, both of them include a presentation and an exploration component, which facilitate the analysis and presentation to a different degree (Cairo, 2012). Accordingly, the infographics and data visualizations will be analyzed as a continuum in this study.

1.3 Conclusion

In this chapter, two key concepts, the digital journalism and visualization, are introduced at the beginning of this chapter. Although there is not a widely accepted concept of digital journalism, it is found that most of the definitions highlight the impact caused by computer technology on journalism industry. One of the obvious impacts is the diverse presentation approaches that come out in the digital age. Visualization, which has a long history of being used as an information presentation form, still gains its popularity in many fields. Assisted by the computer technology, an increasing number of media outlets apply visualization as an efficient format in the digital news presentation, in particular, in telling a news story in a convincible way. The information visualized in journalism and the difference between visualization and infographics are discussed in this chapter to clarify the scope of this study.

2. Theoretical Foundation and Literature Review

2.1 Introduction

Having briefly looked at the history and concept of the key terms in Chapter 1, this chapter presents a survey of the academic literature on research in this area. After reviewing literature in visualization design and its application in journalism, it is found that the *Affordance* and *Gestalt* theories, two graphic design theories, are commonly used in the visualization design studies; the news story structure proposed by Bell, which identifies the formula to compose a news story, has been widely used to analyze the news story. Therefore, this study will draw on these widely applied theories to explore the visualization design in journalism and the way that visualization is integrated in the news story. To ease the understanding of the following content, the theories will be introduced first. Next, previous studies are summarized from the perspectives including the computer technology's impact on journalism, the relationship between visualization content and format, the typologies of visualization format, the design of a narrative visualization, and the origin and evolvement of the news story structures.

2.2 Theoretical Foundation

As aforementioned, the theories that commonly used in visualization design and the news story structure will be the main framework of this study. Specifically, Gibson's *Affordance* theory and the *Gestalt* theory, the two popular theories on visualization design, will be the foundation of the analysis of visualization design in the news article. Bell's news story structure will act as the frame to explore the way that visualization is applied to present the news story. The following sections will introduce these theories in detail.

2.2.1 Affordance theory

Perception theorist J. J. Gibson argued that our perception of the environment is designed for operation on it and the perception of the environment leads to the course of action (Gibson 1966; Gibson, 1979). He called the perceivable possibilities as the action affordances. The *Affordance* theory has been adopted by the design community, especially graphical and industrial design for a long time (Norman, 1999). Gibson explained the *Affordance* with a top-down approach, claiming that we do not perceive points of light; rather, we perceive possibilities for action. Ware interpreted Gibson's theory by a series of examples: we perceive surfaces for walking, handles for pulling, space for navigating, tools for manipulating, and so on (Ware, 2012). Ware used the term resonating to describe the way the visual system responds to properties of the environment. When applied in the designing of information visualization, the essence of this theory could be interpreted as we need to build visualization interfaces that can be operated in appropriate and useful ways, making it easy to read and explore. For instance, in the screen-based interface, the user only perceives that clicking a navigation button could lead to somewhere else in the page or another page (Ware, 2012). Following this direction, when applying visualization in a news article, designers need to organize the visual elements from the perspectives of facilitating storytelling and story reading.

2.2.2 Gestalt theory

Gestalt theory is another theory to be used for the analysis on the visualization design. Gestalt theory has been applied to analyze the visual organization from perception perspective (Smith, 2005). It is a family of psychological theories and was founded in 1910 by three German psychologists: Max Wertheimer, Kurt Koffka and Wolfgang Kohler (Behrens, 1998). It has

influenced arts and design since 1923, beginning from the publishing of a paper by Max Wertheimer titled "Theory of Form" (Teuber, 1976). The essence of *Gestalt* theory applied in visual literacy is that "the whole is different from the sum of its parts." It means that individual graphic elements for information presentation have less importance than their total effect (Harris & Lester, 2001). According to Wertheimer, certain gestalts are enhanced by the tendencies to constellate elements that look alike, are close together, or have structure economy (Behrens, 1998). Researchers summarized following five laws or grouping principles, which are commonly used in graphic design in fields like journalism.

The law of *similarity* states that similar elements used in a visualization format tend to be grouped together.

The law of *proximity* says that elements tend to be grouped together according to their nearness.

The law of *connectedness* states that elements connected by visual properties tend to be perceived as a group (Palmer & Rock, 1994).

The law of *continuance* states that our mind follows our eye's instinctive action, which follows a direction derived from the visual field (Fultz, 1999). In other words, continuance means that when readers start looking in a particular direction, they will continue looking in that direction until they see something significant.

The law of common Fate means that elements are likely to be perceived as a group if they move toward a same direction. When applied in graphic design, Common Fate emphasizes not only but also consistency, such as colour scheme consistency and layout consistency across different types of visualization formats. For example, in a visual news report, two different types of

visualization formats might serve to present information regarding one theme, so they need to keep the colour or layout consistent to prevent readers from being distracted.

When applied in the visual journalism field, the following section will explain the embodiment of the five principles in the news article in detail.

Similarity principle means that visual elements which share visual characteristics such as shape, size, colour, texture will be seen as a group. For example, in the following picture from *How the Epidemic of Drug Overdose Deaths Ripples Across America*, twelve maps with a similar color scheme and size are easy to be perceived as a group that shows the continuous trends of the death of the overdose in the United States from the year 2003 to 2014. Harris (2001) used an example to interpret the *Similarity* Principle in Journalism. He said that different elements, like image and text, should be easily differentiated by viewers. But if a designer places text over an image, it may cause confusion when readers try to understand the meaning of the words or the image.

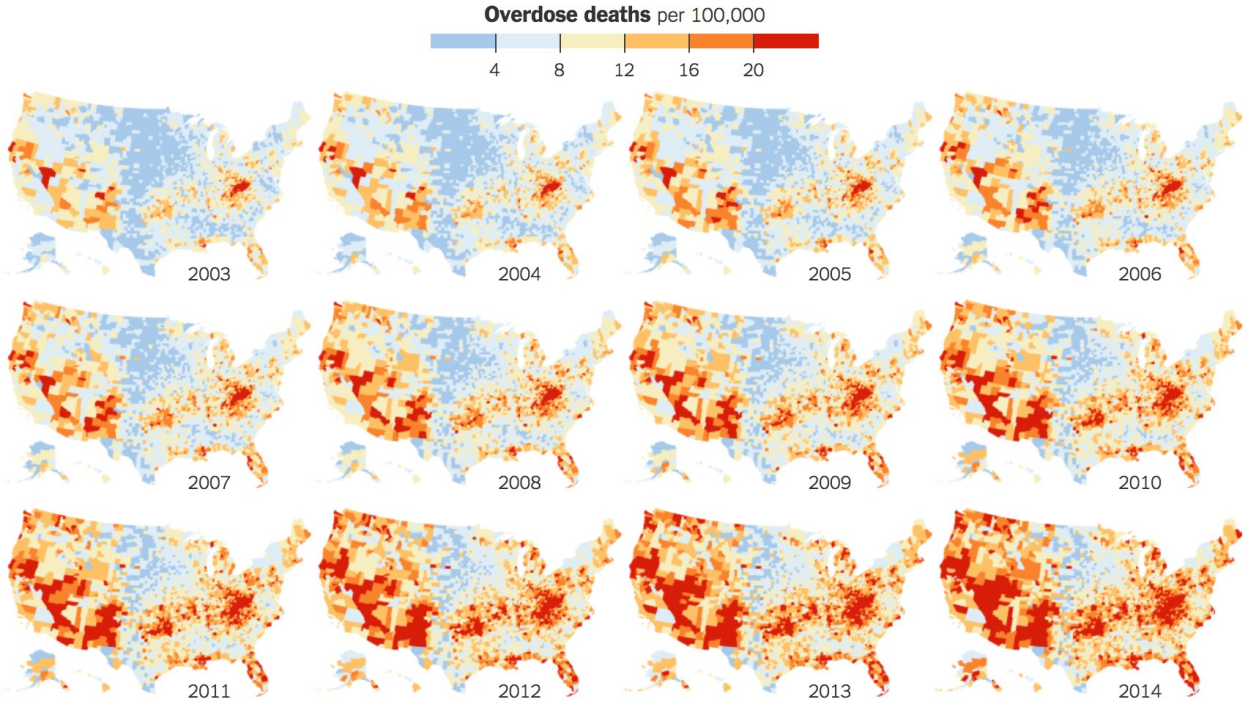

Figure 2.1. Screen capture from *How the Epidemic of Drug Overdose Deaths Ripples Across America* (Haeyoun Park & Matthew Bloch, 2016, n.d.)

The second principle is Proximity, which emphasizes the nearness of the elements. Readers perceive elements that are close to each other by grouping them and recognizing them as part of the same object. For example, in Figure 2.3, the circles placed closely are tend to be perceived

as a group.

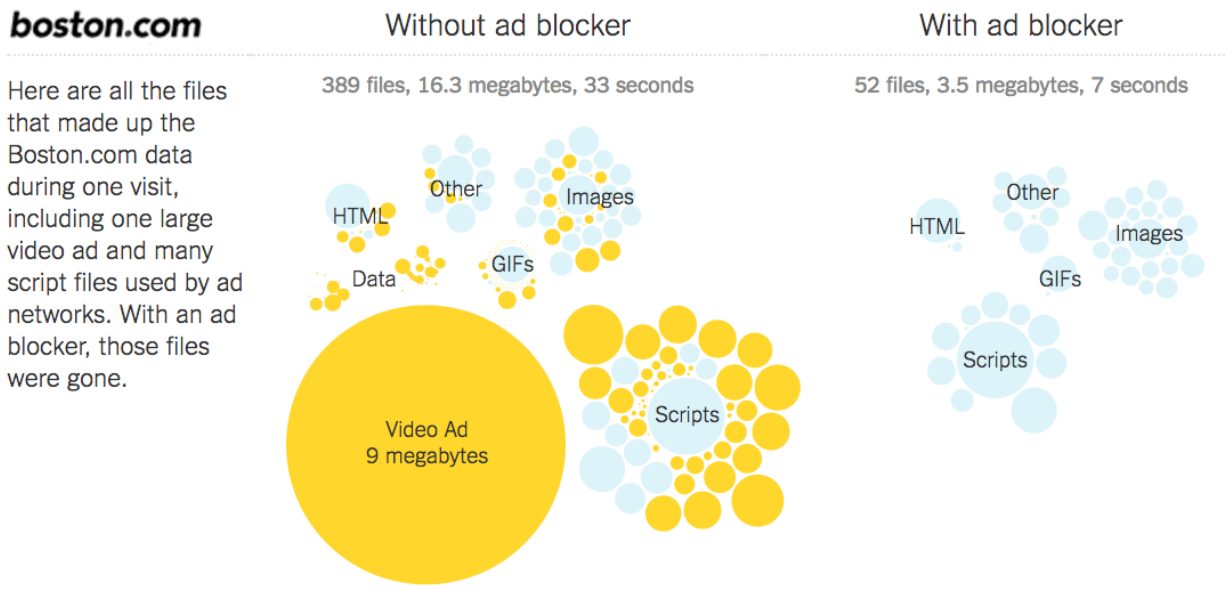

Figure 2.2. Screen capture from *The Cost of Mobile Ads on 50 News Websites* (Aisch, Andews & Keller, 2015, n.d.)

According to the *Connectedness* Principle, elements that connected by visual properties, e.g. lines, will be perceived as a group. Some studies proved that the *Connectedness* has higher priority as compared to the *Similarity* principle. That said, elements that with different shapes and are connected by lines are more likely to be perceived as a group than those with the same shape but are not connected by lines (Han et al., 1999). Take the news *Money, Race and Success: How Your School District Compares*, one of the three cases in Chapter 3, as an example, dots with different colours, which stand for students in difference races but at the same school district, are connected by lines to show the relationship among race, parents' socioeconomic status, and grade of students in the different school districts. These lines show up when readers hover the cursor on the dot connected. In this way, readers are able to quickly identify the relevant dots with the hovered dot.

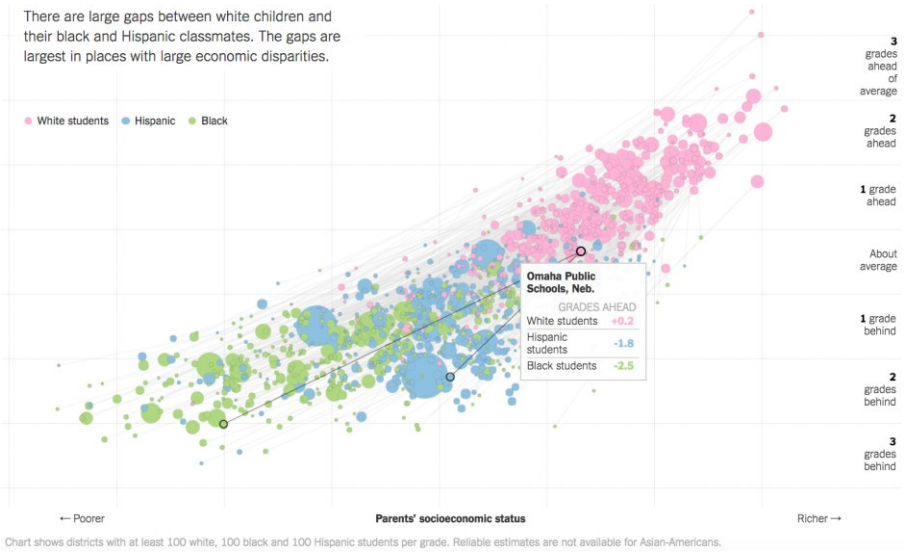

Figure 2.3. Screen capture from *Money, Race and Success: How Your School District Compares* (Rich, Cox & Bloch, 2016, n.d.)

The next principal is *Continuance*, which highlights the continuity of the elements. Designers often use the same color or use lines to link relevant elements. Different from Similarity and Connectedness principles, Continuance principle emphases the arrangement of elements. In visualization design, elements arranged on a line or a curve are perceived to be more related than elements not on the line or a curve. For example, the following report *A Trail of Terror in Nice, Block by Block* uses the yellow lines to indicate the route of the terror attacks. Readers will easily follow the direction indicated by the yellow lines, which are arranged horizontally.

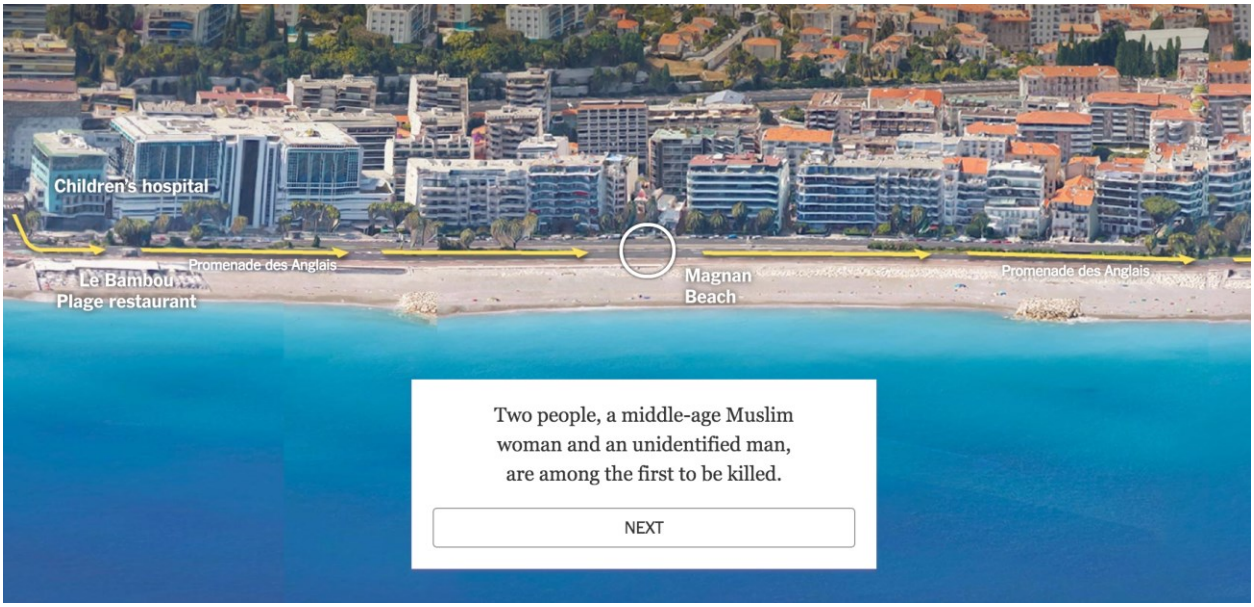

Figure 2.4. Screen capture from *A Trail of Terror in Nice, Block by Block* (Sarah Almukhtar, 2016, n.d.).

The last principle is Common Fate. Harris and Lester extended the definition of Common Fate. They stated that "Common Fate means that graphic elements will be linked if they draw the viewer's eyes in a similar direction", and explain that "an unusually sized picture, a colour rule that does not complement the other colours in the layout, or headlines composed of vastly different typestyles will distract viewers and so message may be lost" (Harris & Lester, 2001, p36). According to Harris and Lester's, when used in a visual report, Common Fate emphasizes the consistency, such as colour scheme consistency and layout consistency, of different types visualization formats used in a news report. Since different visualization formats used in a news report serve to present information of one theme, so they need to be consistent to prevent readers from having their view interrupted and misunderstanding the meanings. Usually, using the same colour scheme and layout is a common way to keep different types of visualization format consistent. In contrast to the Similarity principle introduced above, Common Fate principle

focuses more on the consistency of among different types of visualizations used in a news report, not consistency within a single graphic. For example, in Figure 2.1, the visual elements that follow the Similarity principle are twelve maps with the same visualization format. However, Common Fate principle can be applied to multiple visualization formats, which emphasizes the consistency of an entire visual report. For instance, Figure 2.5 shows two visualizations in The Cost of Mobile Ads on 50 News Websites. Although they are two different types of visualization format, they keep the colour scheme consistent so that, readers will not be distracted by the changing color scheme, which could cause confusion.

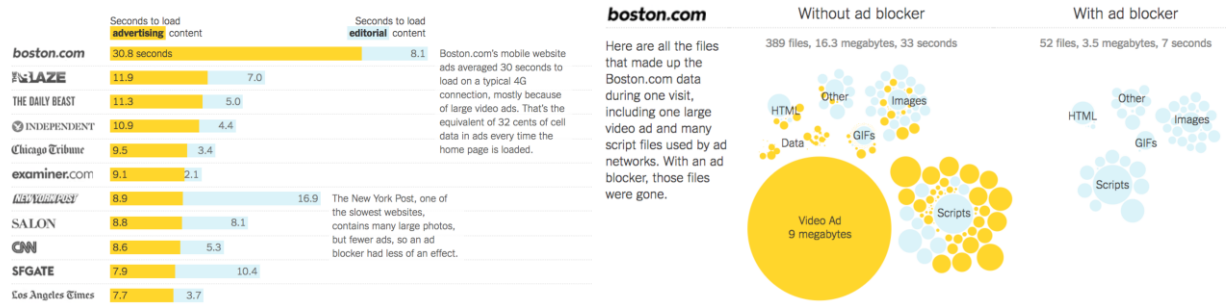

Figure 2.5. Screen captures from *The Cost of Mobile Ads on 50 News Websites* (Aisch, Andrews & Keller, 2015, n.d.)

2.2.3 Structure of the news story

Structure plays the role as the skeleton of a story. As a nature of story, structure can be used to identify whether an article is a story or not. News story, as a subclass of narrative, has its own structure which inherits elements of the structure of general stories and also some unique elements as well. Based on the structure of personal narrative and the news schemata, media researcher Bell proposed the structure of a news story, which consists of abstract, attribution, and a story proper (Bell, 2012). The abstract is the summary part of a story, which contains headline

and lead. The lead often covers the main event in a news story. The attribution contains the source, place, and time information of the piece of news. The story part consists of pieces of episodes, which may include one or many events. An event contains information on attribution, actor, setting, action, follow-up, commentary, and background. The attribution indicate the source of the story; the actor means people relevant to and appear in the event; the setting include the time and place information of a story; the action is the core component of the story plot. The follow-up, commentary and background are three additional categories compared with those elements describing the central action. Follow-up covers action subsequent to the main event, which includes verbal reaction and non-verbal reaction. The commentary covers comment from journalists or news actors. The background contains information on the relevant events that prior to the current action. The following diagram shows the relationship between the components that constitute a news story (Bell, 2005).

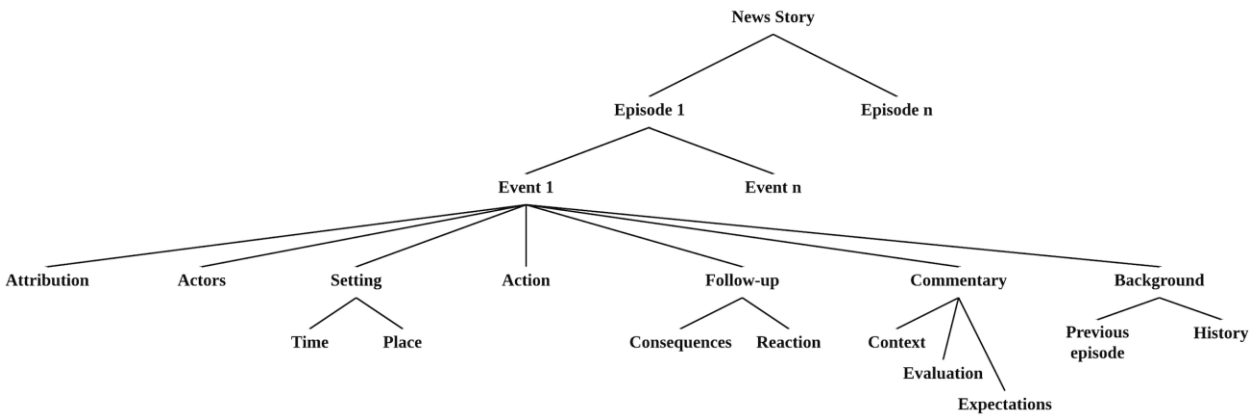

Figure 2.6. News story structure proposed by Bell (Derived from Bell, 2005, p. 174).

This structure “provides an adequate starting point” for the analysis of the news story, as stated by Bell (2005. p. 174). Drawing on Bell’s news structure, this study aims to explore the way that journalists use visualization to represent these news story components.

2.3 Visualization in Journalism

Visualization has a long history, which can be dated back to 30,000 years ago (Ward, Grinstein & Keim, 2015). From the cave drawings to the well-designed interface that used to demonstrate complex information, its evolvement fulfills the growing requirement of mass communication from both technical and social function aspects (Harris & Lester, 2001). When applied in journalism, visualization helps to demonstrate news story intuitively with the assist of computer technology. In the age of computer-assisted reporting (CAR), the computer technology facilitated the news producing by engaging into the workflow of news producing. The integration of computers and social science began from Philip Meyer's use of computer in analyzing the demographics of blacks in Detroit's 1967 riots, which started the practicing and research on CAR (Royal, 2017). In journalism, CAR has been applied in many areas: data collection, data analysis, data presentation, and data archive, and is usually used as a technical support for investigative reporting (Cox, 2000). To some extent, CAR promotes the popularity and development of visualization in journalism in the early age. However, after the spread of the basic technology in newsrooms, research on CAR became less intensive.

Based on the earlier concept of CAR, computational journalism emerges as a new direction that extends the impact of visualization on the journalism industry. From the news process perspective, the computational journalism applies computational thinking to the activities of journalism, from information gathering and organization to information presentation and dissemination. Distinct from the CAR, computational journalism focuses on the processing capabilities of the computer, such as aggregating, relating, correlating, and abstracting (Diakopoulos, 2011). In other words, computational journalism enables the way to access and manipulate large-scale of data in news report.

Data journalism, as another descendant of CAR, has been gaining its popularity since the 2000s. Compared to CAR and computational journalism, data journalism incorporates a variety of forms in the news report, e.g. statistical analysis, computer science visualization and web design, and reporting (Bell, 2012). In addition, data journalism also focuses on exploring the data itself, rather than simply serving as a tool to enhance report (Bounegru, Liliana, et al., 2017). Take The Guardian, a pioneer in data journalism, as an example, it emphasizes the importance of opening data to the public and allows readers to participate in the data exploration through a crowdsourcing way.

2.4 Visualization format

The role that the format plays in visualization is as important as the content it carries. American architect Louis Sullivan once made a statement saying that "form follows function", which emphasizes the importance of content and weaken the form in the meantime (Sullivan, 2012). However, Cairo suspected the unidirectional relationship between form and content stated by Sullivan and preferred to interpret it as a bidirectional relationship. According to Cairo, visualization form impacts the achievable function; in the meantime, the function also constrains form, which means that the form selection must depend on the task it should help with (Cairo, 2012). Therefore, the form can be seen as a reflection of the function it helps to achieve. Grounded on this understanding, the following part will discuss the contextual research regarding the visualization format as a start to explore the relationship between visualization format and news topic.

Scholars have been conducting research on visualization form typologies as an entry of the visualization study field. In the early age, it is common to classify visualization formats as

statistical ones and non-statistical ones (Harris & Lester, 2002). The former one combines numerical data and pictures (including charts and data maps). The latter one is used to arrange a complex series of numbers or words to make the report easy to read. This classification is a rough but reasonable approach for visualization taxonomy. Cairo classified the visualization formats from the perspective of the features to be achieved, based on the Visualization Wheel model he proposed (Cairo, 2013). The visualization wheel's axes correspond to the main features one need to balance when designing an information graphic. The outer layer is divided into two hemispheres. The upper hemisphere's features define graphics that are deeper and more complex. The lower hemisphere's features define graphics that are shallow and more intelligible. For example, a visualization of the scientific topic may have a higher requirement on functionality, density, abstraction, and so on; while, a visualization in arts and design may have higher requirements on figuration, decoration, lightness, and so on.

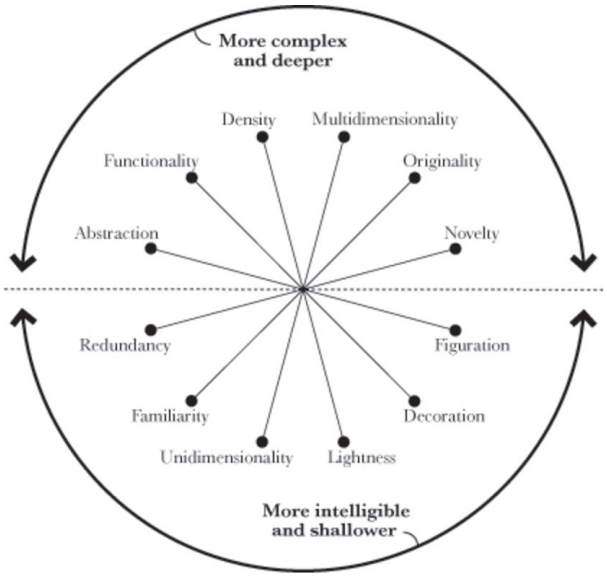

Figure 2.7. The Visualization Wheel model (Cairo, 2012).

Cairo's classification is a start to explore the application of visualization formats based on the topics of content. In addition to Cairo, Kirk's way tries to classify visualization formats according to the purpose of the visualization (Kirk, 2012). Kirk focuses on the functions that different visualization formats aim to achieve when presenting information. These functions include: comparing and assessing hierarchies and part-to-whole relationships, showing changes over time, plotting connections and relationships, and mapping geospatial data. Compared to Cairo, Kirk provided a classification that can build a connection between the designer's purpose and the appropriate visualization format to use. In addition to the above two classifications, visualization formats can also be classified according to the reader's cognition perspective (Wiss & Carr, 1998). Wiss and Carr provided a framework, which consists of three cognitive perspectives: attention, abstraction, and affordance. According to this framework, the visual elements, such as size, movement, location, and metaphor, with the function of attracting human attention are classified into the attention perspective. Segel and Heer (2010), the first ones to explore visualization used in the narrative, gave a more exquisite way to classify the formats and narrowed them down to the narrative visualization formats. They classified visualization formats into seven genres, including Magazine Style, Annotated Graph/Map, Partitioned Poster, Flow Chart, Comic Strip, Slide Show, and Film/Video/Animation. However, as they stated, their classification approach does not consider the cognitive and emotional experience of the readers. A recent study (Figueiras, 2013) developed a new typology for online data visualization aiming to fit the highest number of possible cases of visualization. The new typology consists of ten different types of data visualization, which are not mutually exclusive, including Sequential Graphic, Slideshow, Chart/Diagram, Map, Tag Cloud, Model, Drawing, Video/Animation, Poster, and Game. Figueiras's visualization format typology not only provides a more exhaustive

typology to refer but also identifies possible combinations of elements that can improve certain types of visualization. Considering that visualization in journalism is used to present different kinds of information, both numeric and non-numeric, combining multiple visual elements is necessary to demonstrate information comprehensively, this study will draw on Figueiras's typology and draw on Cairo's direction to examine the relationship between visualization format and news content.

2.5 Design A Narrative Visualization

Although visualization format can be classified based on a variety of criteria, there is no fixed pattern for each visualization format. Thus, visualization can be designed to fulfill different purposes by organizing the basic visual components, such as the line, dot, shape, and so on. Many studies have been conducted to explore the principles for visualization design in a general context based on the human perception perspective. The *Affordance* and *Gestalt* are the two frameworks commonly used to evaluate the visualization design in the these studies. Generally, a good visualization is supposed to follow the principles identified by the two theories.

The *Affordance* theory, which emphasizes the consideration of the possibilities for action to facilitate human perception of the world, was first proposed by Gibson. It has been widely applied in fields like human-computer interaction, ergonomics, visualization, and so on. Providing affordance has been proved to be important in visualization design, especially in the 3D interactive visualization design (Zhao & Vande Moere, 2008; van Schaik, 2010). These studies apply the idea of *Affordance* in a physical environment, which coincidence with the idea it first being proposed. In addition to guiding design in a physical environment, the *Affordance* theory has been extended to the screen-based design. When applied in the screen-based

interaction design, scholars have proposed their own category approaches for classifying *Affordance* and criteria for evaluation in the different contexts (Hartson, 2003; Boy, J. et al, 2016). For example, Hartson's study proposed and explored the use of four types of affordance in interactive design, i.e. cognitive affordance, physical affordance, sensory affordance, and functional affordance. The four types of affordances can be referred to by the practitioners when designing interaction in different context. Kosara and Mackinlay (2013) provided valuable insight into visualization design in a storytelling context with emphasis on the affordance aspect. They stated that a visualization following user's convention and providing clear guidance and feedback is easy to be understood. Same as the conclusion of Kosara and Mackinlay, Cairo (2013) also drew on this theory and emphasized the importance of visualization's easiness for using and providing clues to indicate the possible actions to readers. Therefore, the plain action, explicit feedback, and clear guidance are the most important considerations when applying the affordance theory in a screen-based environment.

Gestalt theory, another framework used to evaluate visualization, has been used to evaluate the design in fields like educational interface (Smith-Gratto & Fisher, 1999), interactive media (Graham, 2008), graphic design (Noble & Bestley, 2011), and so on. It emphasizes that the sum is greater than its individual parts. As stated previously, visualization format is designed to accomplish different function by organizing its basic visual components. *Gestalt* theory provides a series of laws that can be referred to when organizing the visual components. *Gestalt* means "pattern" in German. It was proposed by a group of German psychologists (Ware, 2013). They produced a set of laws to facilitate perception of a certain pattern. Further design guidelines, which were derived from the Gestalt theory, have been proposed by scholars to guide designs in a specific environment (Chang & Nesbitt, 2005). When applied in visualization design, *Gestalt*

laws aim to improve the layout of and to build a pattern for the elements in a visualization to facilitate user's understanding (Nesbitt & Friedrich, 2002; Ware, 2013; Brath, Peters & Senior, 2005; Fekete et al., 2008). In the journalism field, *Gestalt* has also been used as guidance for the news presentation design from the perspective of audience perception. Some of the principles are extracted to frame the analysis of visual design in previous studies (Reinhart, 2009; O'Connor, 2015). By reviewing related research, five commonly used laws, including the *Similarity*, *Proximity*, *Continuance, Connectedness* and *Common Fate*, will be applied to examine the visualization design in the journalism field in this study (Harris & Lester).

2.6 Visualization and The Structure of A News Story

Visualization has been playing an important role in storytelling, as indicated by Shapiro's formula (Shapiro, 2010). *Question + Visual Data + Context = Story,* the formula reveals that after starting with some questions that lead the audiences to the topic and content, the visual data start to take over the storyline, the essence part of a story, to present the topic and the context in an explicit or implicit way. To explore the role that visualization plays in the storytelling, Segel and Heer (2010) brought up a new term in the visualization research field, *narrative visualization*, which combines visualization with storytelling. Through analyzing a large volume of online journalism reports and blogs, Segel and Heer identified three narrative patterns of narrative visualization based on to what extent the readers are allowed to participate in the story developing: 1) the first pattern is called the martini glass structure, which begins with an author-driven approach, and once the author's intended narrative is completed, the visualization enters the reader-driven stage; 2) the second pattern is the interactive slideshow, which allows users to explore the presentation before they move forward to the next stage of the story; and 3) the third one is called the drill-down story, which allows users to decide what stories are told and when.

However, these structures are proposed based on the analysis of the generalized visual story rather than story in a particular field. This study will narrow down to the structure that can be used to frame the news story. Accordingly, visualization's role in the news storytelling will be explored under the news story structure.

News story, as a subclass of narrative, has its own structure, which inherits some elements of the structure of a general story, and some specific elements different as well. Labov summarized a structure for personal narratives after analyzing the personal narratives in a face-to-face conversation, which can be recognized as the origin of the news story structure. This structure identifies six elements in the personal narratives: the abstract, orientation, complicating, evaluation, resolution, and coda (Labov & Waletzky, 1967; Labov, 1972c). Van Dijk proposed the term '*schemata*' as a rule to organize the content of a story in the journalism field. It consists of the headline, lead paragraph, previous events, background, and the main event. Following van Dijk and Labov' s work, Bell (1991) proposed a news story structure in *The Language of News Media*. The structure draws on the personal narrative and van Dijk's structural approach to identify the central concept of a news story. It inherits components of the personal narrative and contains some additional categories that are necessary to characterize the structure of news story. This structure consists of abstract, attribution, and a story proper. The story part consists of pieces of episodes; an episode can include many events; an event contains information on attribution, actor, setting, action, follow-up, commentary, and background.

Bell's structure has been used as a standard news story structure when analyzing news story with different topics and media forms (Iedema, 1997; White, 1998; Knox, 2007; Fetzer et al., 2007; Kautsky & Widholm, 2008). Therefore, it will also be considered in this study, which extends

this structure to identify the components of the online news story, aiming to explore the way to integrate visualization in the news storytelling.

2.7 Conclusion

In this chapter, the three theories, the Affordance theory, Gestalt theory, and News Story Structure theory, applied in this study are introduced at the beginning. Next, previous research on the application of visualization in journalism is summarized from the aspects of visualization format, visualization design principles, and the basic structures of the news with visualization. This study is grounded on the bidirectional relationship between visualization format and content. Following this direction, this study will focus on the journalism field to explore the relationship between news topic and the visualization format. After reviewing the visualization format typologies presented in the previous studies, Figueiras typologies, which is a more exhaustive typology, will be used to classify the visualization formats in the sample news articles. Next, through examining the previous studies on the visualization design, two commonly used design theories, the *Affordance* theory and the *Gestalt* theory, will be adopted as the frameworks to evaluate the visualization design in news story. Moreover, the origin and application of the news story structure is discussed in the last part of this chapter.

3. Research Questions and Methodologies

To explore the way that the NYT applies visualization to news articles, three research questions are posed at the beginning of this chapter. Specifically, the questions discuss the exploration on the relationship between news content and visualization format used, on the design principles that are followed when design a visualization format, and on the news components that most being represented in visualization. The methodologies applied in this study include data collection, data classification, and quantitative analysis. Finally, three NYT news articles are picked out as examples to explain the analysis process and also help to demonstrate the findings in the next chapter.

3.1 Research Questions

The research questions are proposed based on the procedures of incorporating visualization in a news story, from the way to choose and design a visualization format to combine the visualization with the story. The following section will explain the three research questions in detail.

RQ1: How does the NYT choose a visualization format based on the news topic?

This question is proposed based on the hypothesis that there is a relationship between the news topic and visualization format that is used. As is known, each visualization format has its strength in presenting different types of information. For instance, a data map is usually used to present the news that includes geographic information; visual model is an intuitive way that usually used to present complex scientific information. This question aims to explore and analyze the relationship between the news topic and the visualization format to provide a reference for the practicing of visual journalism.

RQ2: What design principles must be followed for designing a visualization news story that is easy to read?

In journalism, a good visualization story should be easy to read by the majority of readers. On one hand, visualization is composed of a series of visual elements, such as dots, lines, and images. The visual elements should be organized in a way that follows the convention of cognitive perception. On the other hand, when applying visualization in a news article it is also necessary to consider how to organize the visualization with the related content, such as organizing the visualization and related text information in a reasonable way. So, two visualization design theories, Affordance and Gestalt, described in Chapter 2, will be the frameworks to analyze the visualization design in journalism.

RQ3: Which news story components are more frequently presented in a visual form?

This question is proposed to reveal how the NYT combines visualization with the main point of the story. According to the news story structure proposed by Bell (Bell, 1991), a complete news story consists of components including the actor, action, setting, background, follow-up, and commentary, which can be visually represented. RQ3 aims to explore the way that journalists apply visualization to represent the news story components.

3.2 Methodologies

To answer the three questions, the methodologies that are applied include data collection, data classification, and quantitative analysis, which will be explained in the following sections.

3.2.1 Sample selection

The samples used in this study are from online news published by the NYT. The NYT has launched collections of visual news stories published every year since 2015. To have the most

current and the broadest sample library and to avoid an unbalanced selection criteria, the two visualization news story collections launched by NYT ("2015: The Year in Visual Stories and Graphics" and "2016: The Year in Visual Stories and Graphics") will be the sample library of this study.

3.2.2 Data collection and classification

Data collection is the first step of this study. To answer the three research questions, the data will be collected according to the three research questions. First of all, the data about the visualization formats that appeared in the sample news articles will be collected, accompanied by the topics of the news articles. Next, the data about the visualization format following the *Affordance* and *Gestalt* principles will be collected based on certain criteria, which will be introduced in detail in the following sections. Finally, the data on news story components represented visually will be gathered. It should be noted that as the third research question explores the way in which the visualizations contribute to how the news story is told, news articles without a plot will be excluded from the data collection.

3.2.2.1 Classification of visualization formats and news topics. This study drew on previous research about the visualization format and news topic categorization for data classification. As stated in Chapter 2, this study will use the typology proposed by Figuerias (2013 & 2014), which is a relatively complete typology of the visualization format. This typology classifies visualization into 10 categories:

a. Sequential Graphic

Sequential Graphic is a format by which graphics are listed in a certain order, usually chronological. Previous researchers defined the order that sequential graphic obeyed is

chronological order, which indicates the timeline in a story, such as graphics in *Gay Marriage State by State: From a Few States to the Whole Nation* (See Figure 3.1). The sequenced data diagrams show the gay marriage trend from the years 2008 to 2015.

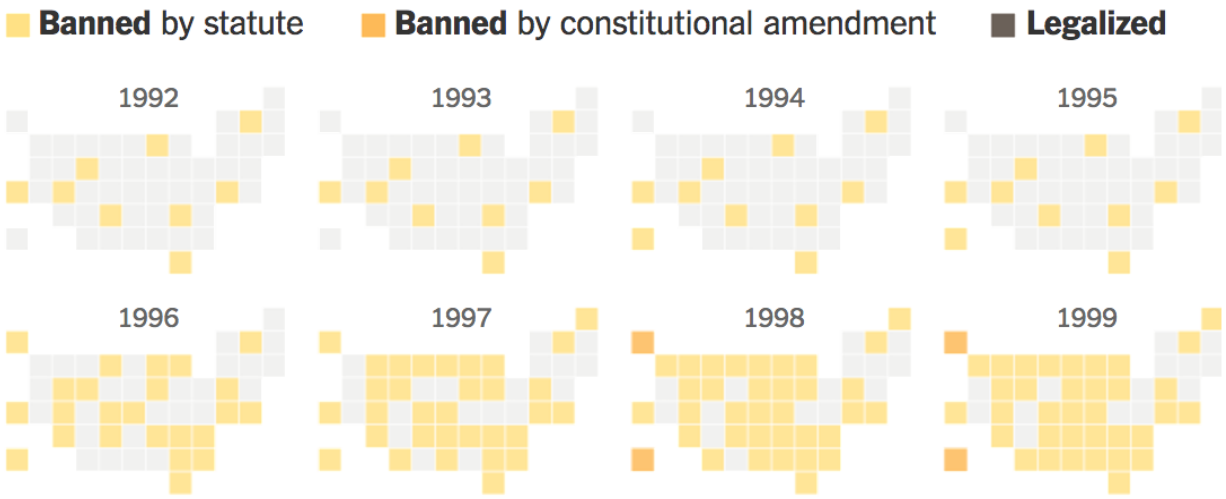

Figure 3.1. Screen capture from *Gay Marriage State by State: From a Few States to the Whole Nation* (Haeyoun Park, 2015, n.d.).

b. Slideshow

A Slideshow is similar to a sequential graphic, and both impose a certain order. However, the difference is that the slideshow does not necessarily obey chronological order. For example, in the article *Foot Soldiers* (See Figure 3.2), readers can click the arrows to navigate through the slides.

Figure 3.2. Screen capture from *The Foot Soldiers* (Christopher Griffith, 2015, n.d.).

c. Annotated Chart/Diagram

Annotated charts and diagrams are frequently used in news reports. These include bar charts, line charts, pie charts. Data presented in the form of a chart or diagram are structured for ease of understanding, especially for large quantities of data and relationships between data. Unlike in professional fields, in journalism, chart and diagram often accompanied by annotation, which provides information for audiences that might have different levels of information about the topic. In this way, information can be presented more effectively (Wadill & McDaniel, 1992; Faraday & Sutcliffe, 1997). For instance, in the graphic, *How Gun Traffickers Get Around State Gun Laws* (See Figure 3.3), a line chart shows the source of guns used in crimes in Missouri. In the line chart, the information regarding the gun control policy, such as the important background of the policy, is provided by the surrounding annotations.

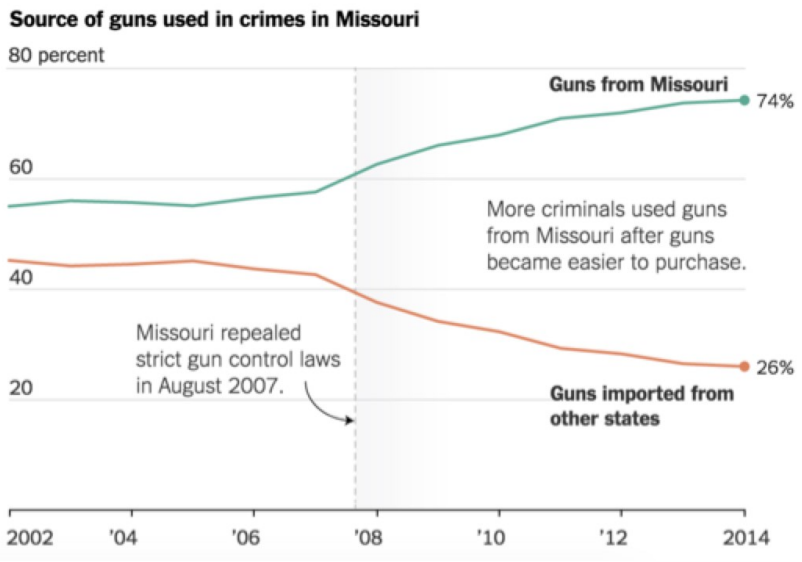

Figure 3.3. Screen capture from *How Gun Traffickers Get Around State Gun Laws* (Aisch & Keller, 2015, n.d.).

To clarify the visualization category and avoid overlap, in this research charts with map elements, such as nautical and aeronautical charts, for example, will be counted as another visualization category: the Maps.

d. Maps

The United States (US) Geographical Survey defines map visualization as a set of points, lines, and areas, which are defined both by position reference to a coordinate system and by their non-spatial attributes (Ward, Grinsten & Keim, 2010). Thus, maps used in visualization do not only present the spatial information but also non-geographical information. For example, the following map from *Iraqi Army Retakes Government Complex in Central Ramadi* (See Figure 3.4) does not only show the location of the airstrikes but also uses the size of the circle to present the number of airstrikes.

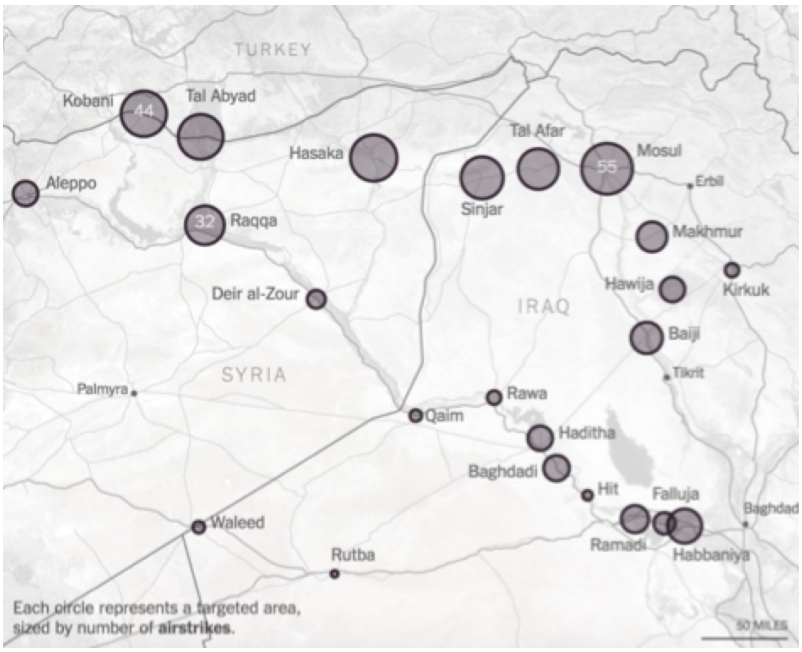

Figure 3.4. Screen capture from *Iraqi Army Retakes Government Complex in Central Ramadi* (Arango et. al, 2014, n.d.).

e. Tag Clouds

Tag Clouds is also an important visualization format. It is often used to visualize text data and generate visualizations based on the frequency of words in the text. In *Inaugural Words: 1789 to the Present*, US Presidential inauguration speeches of from 1789 to 2009 were analyzed and generated a word cloud for each speech according to the word frequency in the speeches. The tag cloud shows the keywords in the speeches intuitively.

(See Figure 3.5)

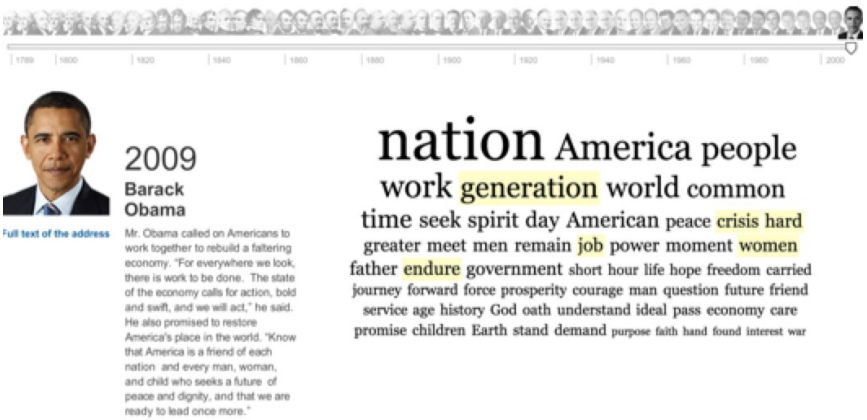

Figure 3.5. Screen capture from *Inaugural Words: 1789 to the Present* (Seelye, 2009, n.d.).

f. Model

A model is often used to present a technical project: for example, using a 3D model to present the complex inner parts of a product, or the inner composition of a building. In *Three Hours of Terror in Paris, Moment by Moment* (See Figure 3.6), the model shows the inner view of the hall in which a shooting happened. Sometimes, the visualized models are interactive, which allows audiences to explore the model.

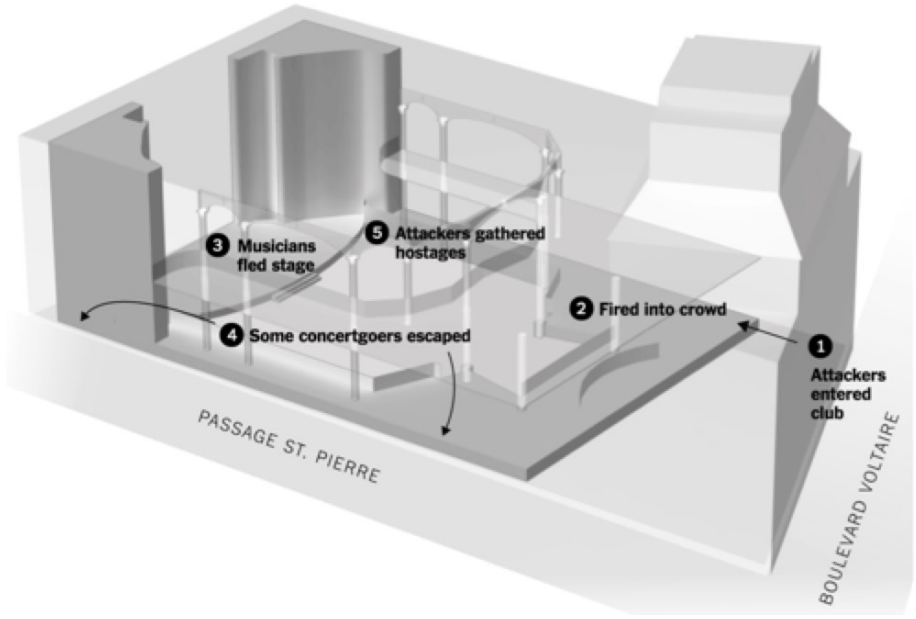

Figure 3.6. Screen capture from *Three Hours of Terror in Paris, Moment by Moment* (Aisch et. al, 2015, n.d.).

g. Drawing

Figueiras defined drawing as a category that combines illustration with other types of visualization, such as a graph or a chart. In *A Gift to New York, in Time for the Pope*, the whole page uses a drawing of St. Patrick's Cathedral as a background. By hovering on the screen as readers scroll down the page, parts of the cathedral will be highlighted. In this case, the drawing,

together with the animated highlighter, makes an interactive visualization interface for audiences to explore.

Figure 3.7. Screen capture from *A gift to New York, in Time for the Pope* (Larry Buchanan et. al, 2015, n.d.).

h. Video/Animation

The video/ animation category presents information in the form of one video or animated video or film or a series of videos or animated videos or films. In the article *This Is Your Life, Brought to You by Private Equity* (See Figure 3.8), an animation is created to tell a story of the influence that the private equity industry has on someone's daily life.

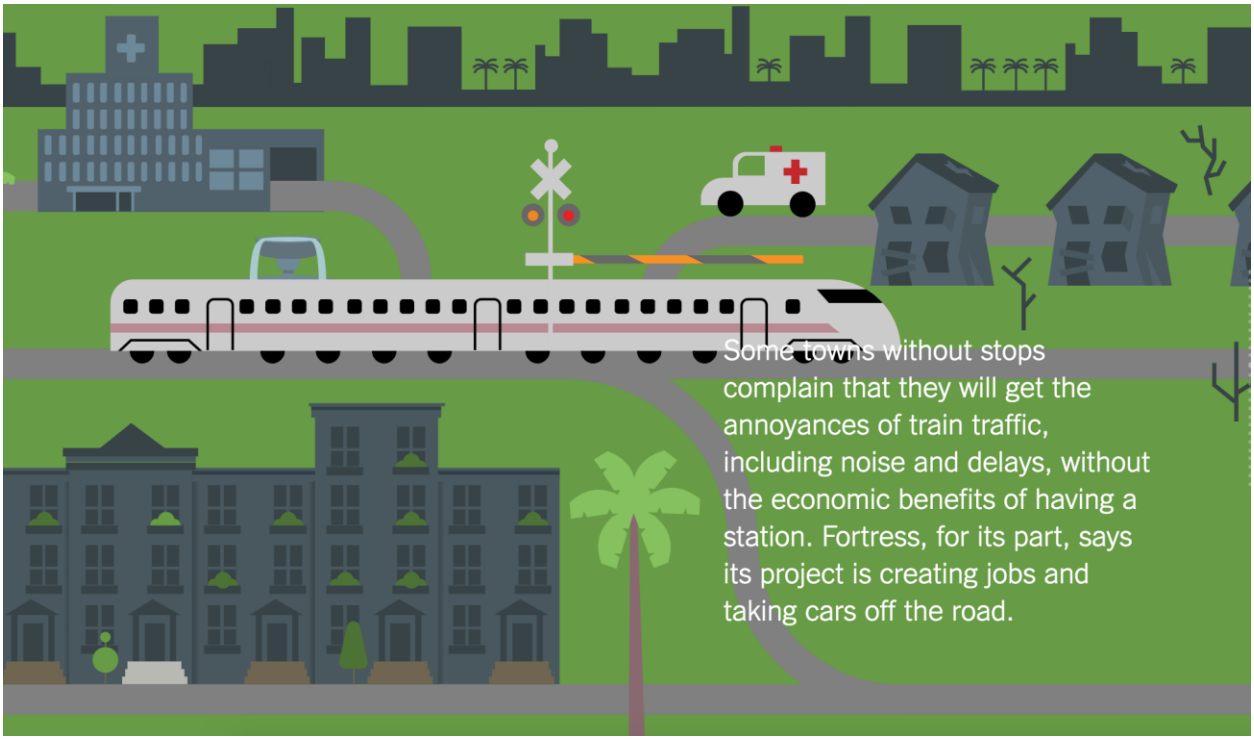

Figure 3.8. Screen capture from *This Is Your Life, Brought to You by Private Equity* (Daniel et. al, 2016, n.d.).

i. Poster

The poster is also listed in Figuerias's categorization. A poster is used to present both textual and graphic elements (Figuerias, 2013), and combines them in a well-designed layout, similar to the presentation of information in an infographic. Figure 3.9 shows an example of a poster that illustrates the diversity gap in the NYT top 10 bestsellers.

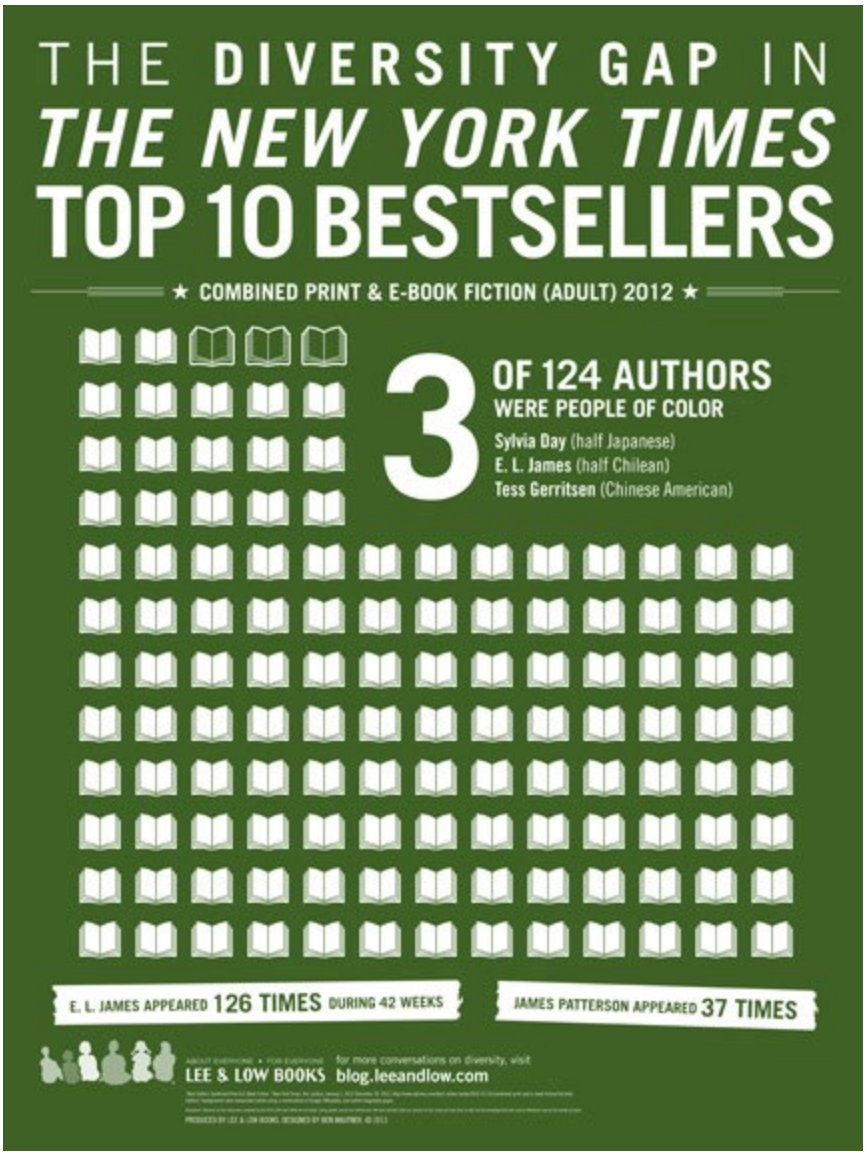

Figure 3.9. The poster from *The Diversity Gap in The New York Times Top 10 Bestsellers* (Jasontlow, 2013, n.d.)

j. Game

The game is not a very popular category in online visual news reports. It integrates game elements into the reports, allowing audiences to explore the story by playing games. Deterding (Deterding, Dixon, Khaled & Nacke, 2011) defined gamification as the use of game elements and game design techniques in non-game contexts to engage people in solving problems.

Existing studies have proven that gamification has a positive effect on engaging audiences, especially young audiences (Van Dijck, 2009). The puzzle form *A Quick Puzzle to Test Your Problem Solving* (See Figure 3.10) is used to demonstrate confirmation bias.

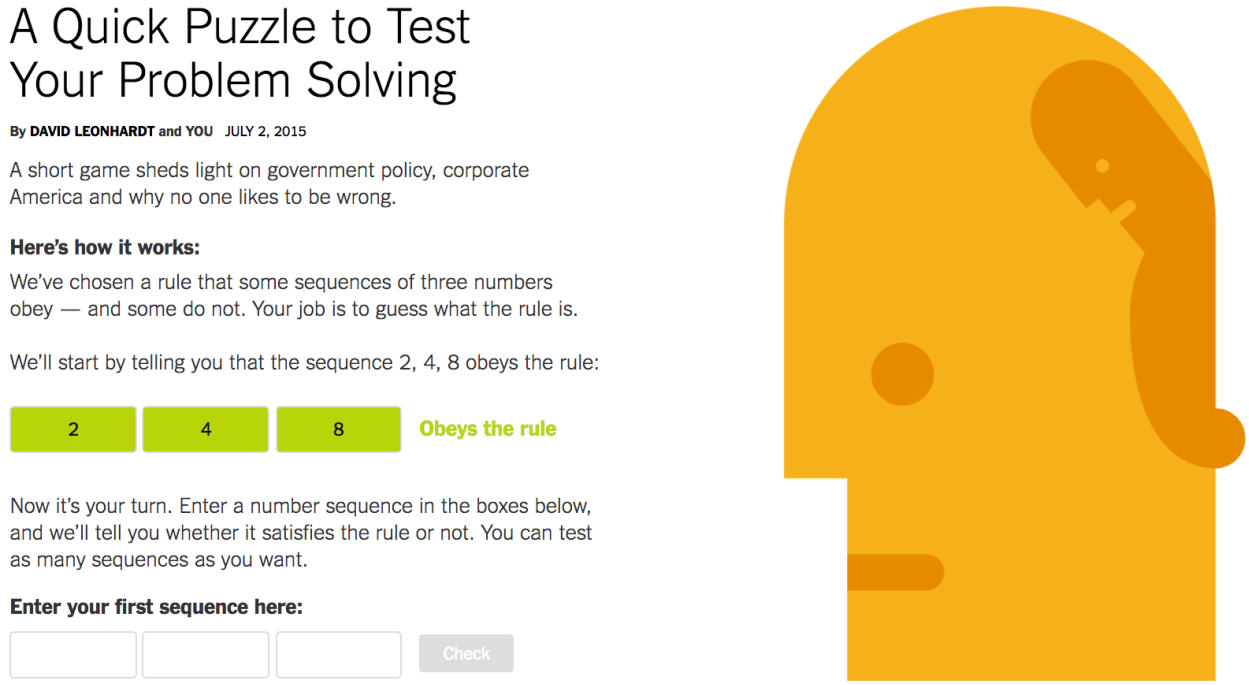

Figure 3.10. Screen capture from *A Quick Puzzle to Test Your Problem Solving* (Leonhardt., 2015, n.d.).

This study refers to the main news sections identified by the NYT for the news topic classification. The NYT provides a classification scheme on their website. News reports are classified into World, US, Politics, NY, Business, Opinion, Tech, Science, Health, Sports, Arts, Style, Food, Travel, Magazine, Real Estate, Fashion & Style, and so on. According to this scheme and the subjects commonly addressed in the sample visualization articles, some categories will be added in this study to classify news topics based on a more detailed scheme. The expanded scheme includes the Arts, Business, Culture, Nature, Politics, Race, Religion, Science, Society, Sports, Travel, and World. The 175 news articles from the NYT will be collected and classified based on the 12 news topics and 10 visualization formats categories.

3.2.2.2 Classification of visualization design principles. With the purpose of designing a visualization that is easy to read by the majority of audiences, the two design theories, Gibson's Affordance theory and the Gestalt theory, which have been demonstrated in Chapter 2 will be used as frames of the analysis in this part. News articles with the visualization formats embodying the two theories will be collected.

Based on Ware (Ware, 2012), this study extends the Gibson's *Affordance* theory in a screen-based environment. Applying the *Affordance* theory in a screen-based environment means designing a visualization with a possibility for action that is plain to the user, giving feedback that is easy to interpret, and guiding the user through the story (Ware, 2012, p356; Kasara & Mackinlay, 2013) (See Table 3.1). The visualization format will be examined according to these criteria under the *Affordance* framework.

Table 3.1. Criteria of Gibson's Affordance theory

Plain action	Follow user's convention on operating the computer-based medium
Explicit feedback	Interaction with clear feedback: for example, hover highlighting, hover details, search, zooming, and so on.
Clear guidance	Providing clear visual guidance for the audience to explore the story, for instance, an arrow to indicate the start point and an indicator of the flow that the audience should follow.

Gestalt theory, the second framework used in this study, has been commonly used as a framework for visual organization analysis as well. The five *Gestalt* principles (see Table 3.2),

which were demonstrated with concrete examples in Chapter 2, will be used to evaluate the visualization format design in the digital news article.

Table 3.2. Criteria of the *Gestalt* theory

Law of *Similarity*	Similarity states that things which share visual characteristics such as shape, size, color, texture, value or orientation will be seen as belonging together.
Law of *Proximity*	Proximity emphasizes the nearness of the elements. Readers perceive elements that are close to each other by grouping them and recognizing them as part of the same object.
Law of *Connectedness*	Elements connected by visual properties, e.g. lines, tend to be perceived as a group
Law of *Continuance*	Continuance principle highlights the continuity of the elements. In visualization design, elements arranged on a line or a curve are perceived to be more related than elements not on the line or a curve.
Law of *Common Fate*	Common Fate emphasizes the consistency, such as colour scheme consistency and layout consistency, of different types visualization formats used in a news report to prevent readers from being distracted.

3.2.2.3 Classification of the news story components.

The third research question is proposed to explore the way that the NYT applies visualization in news storytelling. Examining the visualization used to represent the news story component helps to reveal how the NYT combines visualization with the news story plot. Therefore, Bell's news story structure, which identifies the news story components, will be drawn on for the data collection in this section. The structure includes nodes in three categories: abstract, attribution, and story (Bell, 1991). As the purpose is to analyze the performance of visualization in conveying information in a story, this study focuses on the components that compose a story. These nodes are attribution, actors, setting, action, follow-up, commentary, and background (see Table 3.3).

Table 3.3. Explanation on News story components

Attribution	The source of the news
Actors	People relevant to and appearing in the event
Setting	Time at and place in which the information in the news story occurs
Action	Core components that constitute the event
Follow-up	Action subsequent to the main action
Commentary	Journalist' or news actors' observations about the action
Background	Relevant events prior to the action

3.2.3 Quantitative analysis

The data collected from the preceding procedures will be analyzed using the following step. To conduct analysis regarding the first research question, a cross statistic analysis will be conducted on the news topic and visualization formats. This analysis is expected to reveal the relationship between the visualization format and news topic. Specifically, a 100% Stacked Column Chart, which presents the visualization formats in news articles about different topics from 2015 and 2016, and a combination of the two years, will demonstrate the share of different visualization formats in news article with different topics. The share of the visualization formats in different news topics can indicate the relationship between the visualization format and the news topic.

To explore the way to design a visual story that is easy to read, which is also the objective of second research question, the data on the visualization formats following the principles of Gibson's *Affordance* theory and *Gestalt* theory will be analyzed using the Microsoft Excel. A bar chart will be generated to show the frequency of each design principle followed by the visualization format.

To find the way that the NYT combines visualization with news storytelling, the data on the frequency of the news story components represented in visualization formats will be shown in a bar chart to demonstrate how does the NYT incorporates visualization in the news story presentation.

3.3 Selected Cases

In this section, three cases are selected to give readers a sense of how visualization is applied in news articles. Specifically, three news articles with multiple visualization formats and from different news topics are picked out as concrete examples to demonstrate the way that the news articles apply the *Affordance* and *Gestalt* theories to help the audience to explore the story from

the point of view of visualization design. In addition, the three examples will also help to explain that visualization is used to represent news story components.

3.3.1 Desperate crossing

This report is about a rescue operation of migrants on two fishing boats from Eritrea, heading for the Italian island of Sicily on July 27, 2015. The story reveals the desperate status of the migrants on the two boats, as well as the hopeless status of the refugees.

Figure 3.11. Screen capture from *The Desperate Crossing* (Pellegrin, 2015, n.d.).

Audiences are first presented with a video that shows a boat fully loaded with the refugees floating in the ocean. The text at the bottom of the screen introduces the video briefly, which provides information about the refugees on the boats and the location. When audiences scroll down, the pictures of the refugees appear, with annotation describing the background of the sea crossing, including the number of the dead and rescued migrants.

In general, using the *Affordance*'s perspective, this is an article that is easy for the audience to explore. Reading this article does not require a complex interactive operation. Two arrows at the bottom right of the page serve as a guide for audiences, and indicate the action—scrolling—which is required to read the story.

The *Gestalt* theory is not obvious in this case. According to the *Similarity* principle, audiences tend to group the objects that are similar in appearance as belonging together. When applied in digital journalism, Lester (2001) extends it and states that overlapping different elements, such as text and image, may make it difficult for users to perceive the meaning to be communicated. In this report, however, there is not a clear boundary between the text and visual elements, and sometimes, text content overlaps the image. Another *Gestalt* principle that this news article follows is the *Common Fate* Principle, which can be seen from the consistent colour scheme among the visualizations. As is mentioned in Chapter 2, Common Fate refers to consistency among multiple visualizations formats applied in a news report. In this news article, black and white are used as the main colour schema, which is applied in the multiple visualizations including video, map, and slideshow. The colour scheme is also consistent with the overall depressing theme of the story.

From the news story structure perspective, the visualization contributions are mainly used to present the actor, settings, and action components of this story. The slideshow is used to provide a picture of the desperate status of the people on the boat. Both the close-up view and long-shot are applied to focus on an individual actor and the migrants as a group. In addition to presenting the actor, an annotated map is used to provide information about the settings and the background. This map indicates the geographic information about the migration route and information about the previous accidents, including the place the accidents happened and the number of deaths in

each accident. Moreover, the action of this story is also represented visually. According to Smith (2004, pp. 81), a story is composed of a series of actions, which constitute the main body of the story. In this article, the slideshow, which appears alternatively with the text, serves as an important role in presenting the plot of this story. The follow-up, background, commentary and attribution are the components not communicated by the visualization.

3.3.2 The world according to China

The second case we will explore is about the increasing in China's overseas spending in the developing world, which means that the US and Europe are no longer leading the financial powers in large parts of the developing world (see Figure 3.12). China's large investment in high-risk countries in the Middle East, Africa, and Latin America are shown by individual visual maps. The main focus of this story is China's foreign investments from 2005 to 2013 and the explanations of the investments from political and economic perspectives.

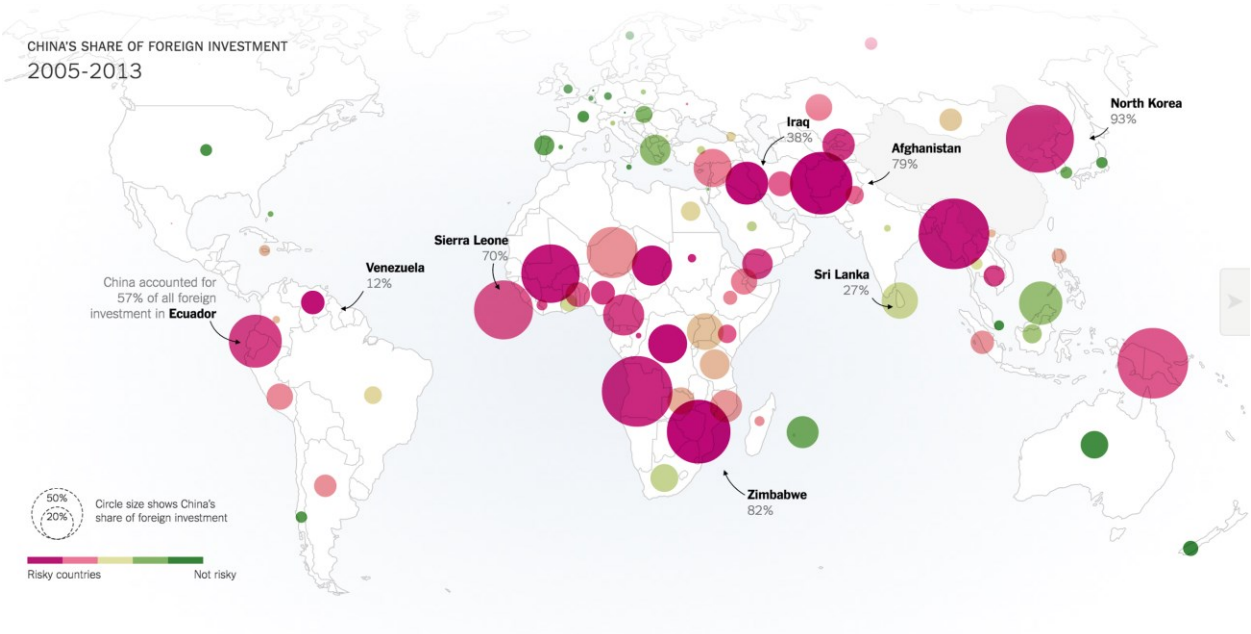

Figure 3.12. Screen capture from *The World According to China* (Aisch, 2015, n.d.).

Similar to the story about the migrants drowning in Italy, this report is easy to read and explore. From the affordance perspective, the operation needed to explore the story is easy, as indicated by the guidance at the beginning of the report: scrolling down to start. The feedback on the visual maps is also clear and easy for audiences to understand. When hovering the mouse over the circle on the map, the explanatory information pops up. Two *Gestalt* principles, the *Proximity* and *Common Fate* are reflected in the visualization design. The text, which is placed close to the map, summarises the core information provided on the map. As stated by Harris and Lester, "the closeness of words and picture makes their connection obvious to the reader" (Harris & Lester, 2001, P 36). The consistent style of the maps, especially the colour scheme, which reflects the *Common Fate* Principle, helps build a connection among the maps and prevents audiences from being distracted by the different visualization designs.

In this story, visualization formats are used to present the story components including the setting and action. In terms of the setting, the eight annotated maps in this story provide geographical and time information about China's foreign investment from 2005 to 2013. In addition, the visual maps also constitute the main focus of the story: the changing of China's foreign investment in different areas from 2005 to 2013. Together with the detailed information provided by the annotation, the reason behind the investment is revealed as well. Thus, the visualization format plays an important role in narrating the story.

3.3.3 Money, race, and success: how your school district compares

This story is about the comparison of students' grades in different schools, from the perspectives of money, race and success (See Figure 3.13). The story is told through three interactive visualizations: the first one shows the educational attainment crossing different school districts and parents' socioeconomic status; the second one shows the educational attainment crossing

students' races and parents' socioeconomic status; the third one shows the academic gaps among students with similar socioeconomic backgrounds but different races.

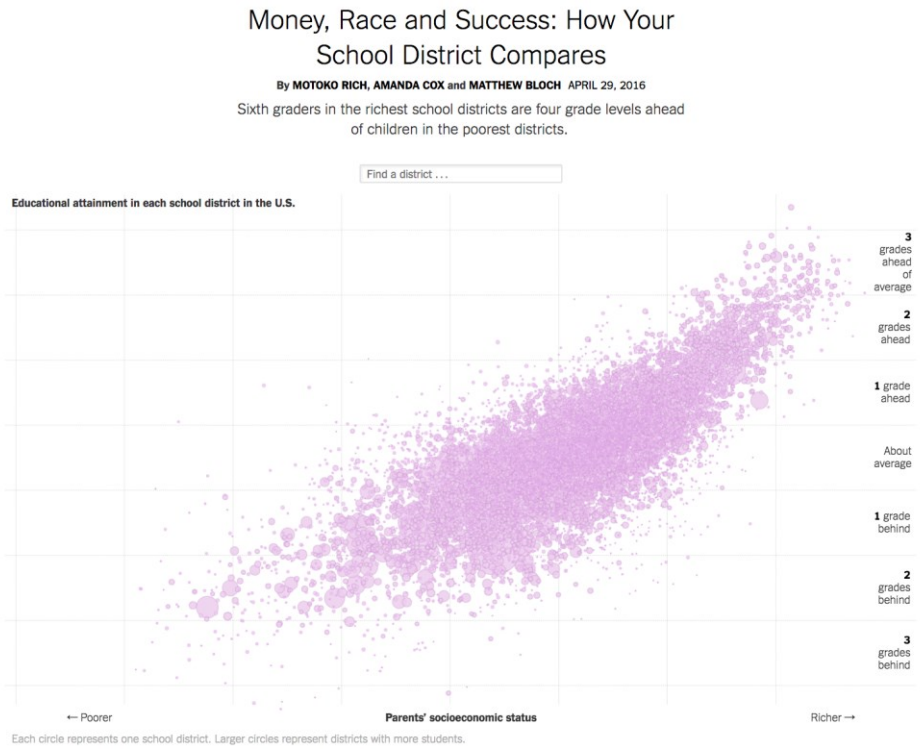

Figure 3.13. Screen capture from *Money, Race and Success: How Your School District Compares* (Rich, 2016, n.d.).

In this story, the three charts constitute an interactive interface for audiences to explore the differences in achievements among students from different school district and different races, and socioeconomic statuses. From the *Affordance* aspect, this interactive story is easy for audiences to go through and also provides audiences with clear feedback and guidance. Generally, the operation required to interact with a story follows the audience's browsing conventions. The annotation at the bottom of each chart, which serves as a guide, provides an explanation for audiences to digest the chart. Hovering for a response is the main way to provide feedback in the visualizations of this report. When hovering with the mouse over the graph, the related circles are highlighted. The size of the highlighted circle provides an idea of the number

of the students. In addition, the detailed information, including the district name, family income, and percentage of different races, will also appear when hovering over a spot. From the *Gestalt* theory aspect, the *Connectedness* and *Common Fate* are the two design principles that the visualization follows in this story. Similar to the first and second cases, the consistency of colour schema in the three visualizations reflects the *Common Fate* Principle. According to Cairo (2012), "the brain is much better at quickly detecting shade variations than shape differences." Using colour is the first choice to distinguish parameters in accordance with the way that our brain detects information. *Connectedness* is another principle reflected in this report. In the second and third interactive visualizations, dots, which represent students in different races but the same school district, are connected with lines. By hovering on a dot, the other related dots and the lines connecting the related dots will be highlighted. According to the *Connectedness* Principle, elements connected by uniform visual properties tend to be perceived as a group. In this report, the lines connecting the related dots help audiences to extract and explore related dots. For example, in the second graph, the length of the line indicates the educational achievement and the socioeconomic status gap between students in the same school district. Without the line highlighted when the mouse is hovering, it is impossible for audiences to extract effective information when exploring the visualization.

From the news structure perspective, the three interactive charts contribute to presenting the main plot of this story, which is also the action component. The three dot charts contribute to demonstrating how the school district, race, and socioecnomic status' impact students' academic achievement. The text following each charts goes deeper to summarize the findings from the three charts. Compared with the first two study cases, audiences for this story have more flexibility to explore the information by interacting with the three visualization charts.

3.3 Conclusion

In conclusion, this chapter discussed the research questions, methodologies, and examples to explain how to use the design theories and news story structure theory in the analysis. Three research questions were raised at the beginning of this chapter. The questions addressed the procedures of designing a visualization used in the digital news article. Next, in the methodology section, the main will be introduced with detailed procedures. These approaches include the data collection, data classification, and quantitative analysis. Finally, three news articles are picked from the samples to explain the way that visualization design principles are reflected and how visualization contributes to news storytelling by representing the news story components.

4. Findings and Discussions

This chapter summarizes the major findings of the study. First of all, the findings show a relationship between the news topic and the visualization format. Next, this study finds that the New York Times (NYT) follows some design principles according to Affordance and Gestalt theories. Some of the news components most often represented in visualization includes action, actor, and setting.

4.1 Relationship Between The News Topic and Visualization Format

After collecting data about the appearance frequency of visualization formats in different news topics from 2015 and 2016, two 100% stacked column charts and two radar charts were generated to show the relationship between the visualization format and news topic. In Figure 4.1, 4.3, and 4.5, the length of the bars shows the percentage of visualization formats used in different topics. The absolute length of the bars in different news topic cannot be compared, because the length represents the percentage of contributions rather than the value of the frequency. The news topics, labeled on the X-axis, are listed in alphabetical order. The visualization formats labeled in the legend are listed according to their total appearance in all the news articles. In Figure 4.2 and 4.4, the two radar charts can be used to compare the distribution of visualization format in each news topic.

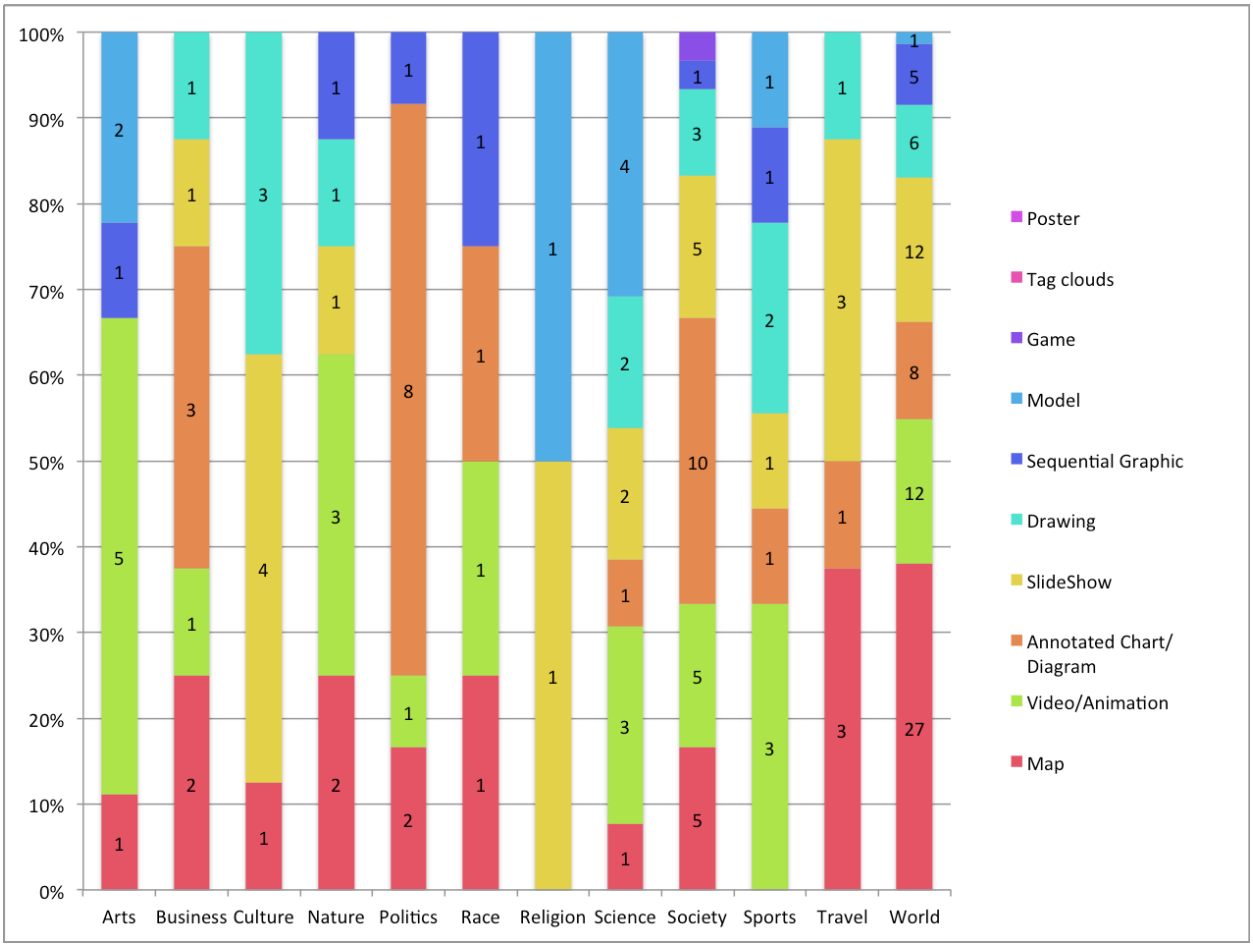

Figure 4.1. The percentage of visualization formats in different news topics in 2015

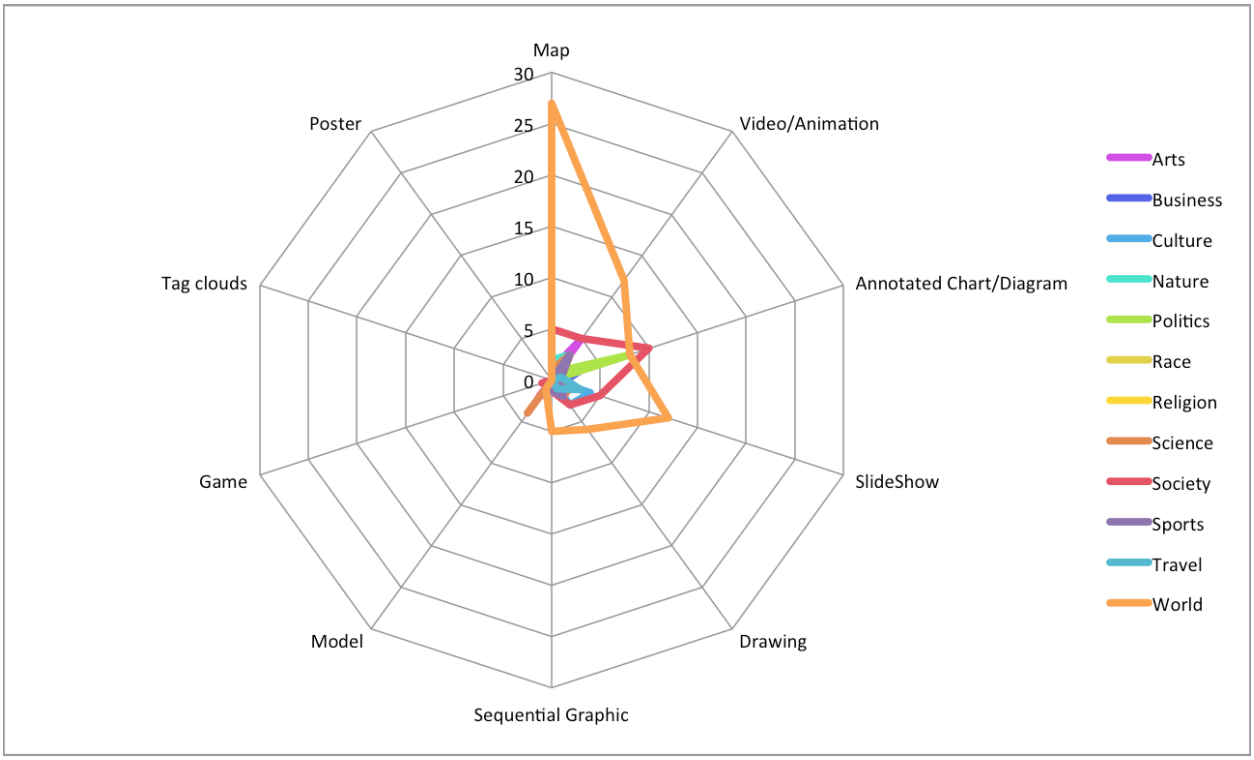

Figure 4.2. The distribution of visualization formats in each news topic in 2015

In Figure 4.1 and Figure 4.2, the data chart shows the visualization formats that appeared in 12 news sections in 2015.

In arts, video/animation is the most commonly used format.

In business, annotated chart and map are the most commonly used formats.

In culture, slideshow and drawing are the most commonly used formats.

In nature, there is no big difference among the share of the visual formats contribution.

In politic, annotated chart is the most commonly used format.

In race, there is no big difference among the share of the visual formats contribution.

In religion, slideshow and model are the most commonly used formats.

In science, model and video/animation are the most commonly used formats.

In society, annotated chart is the most commonly used format.

In sports, video/animation is the most commonly used format.

In travel, maps and slideshow are the most commonly used format.

In world, maps are the most commonly used format.

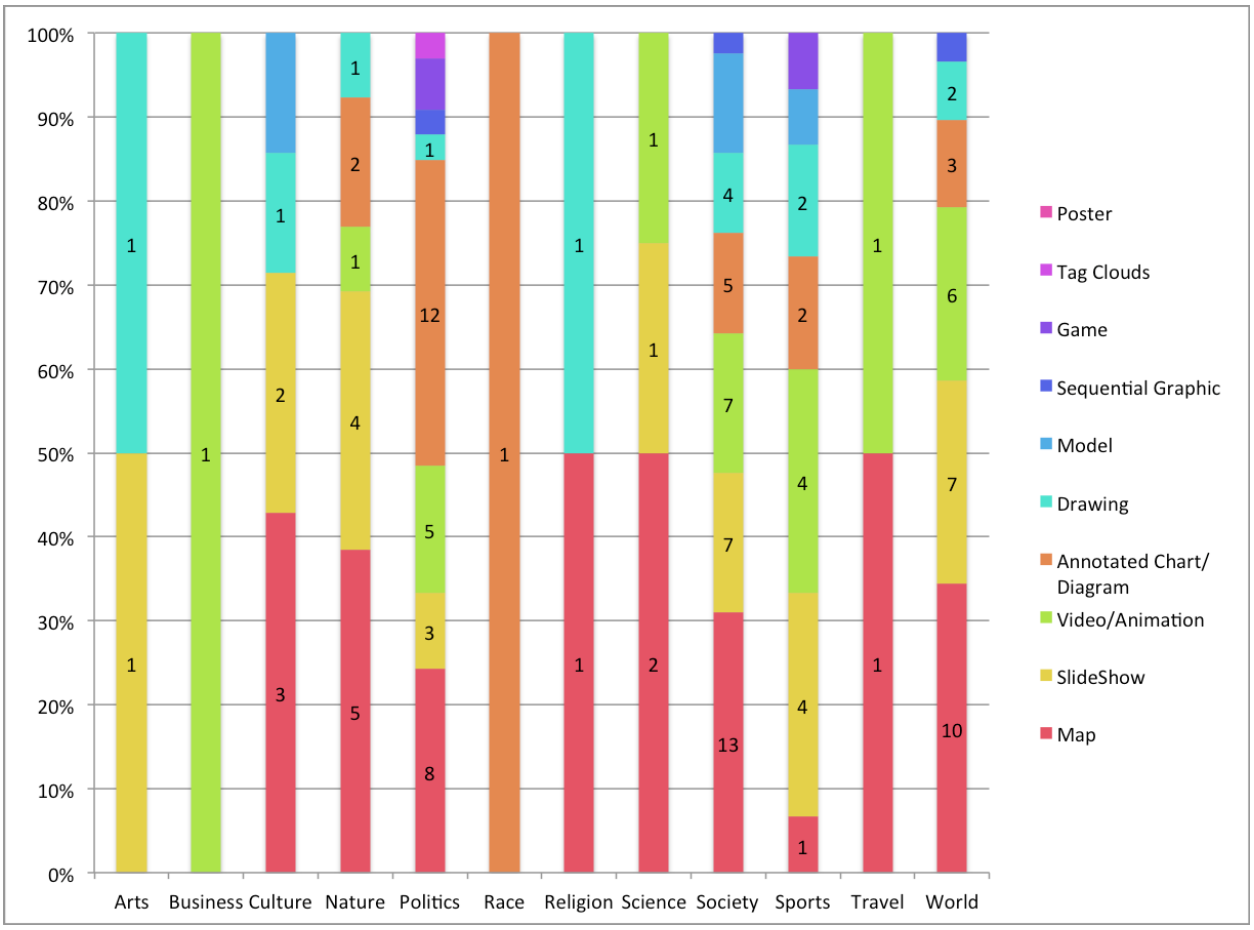

Figure 4.3. The relationship between the visualization format and news topic in 2016

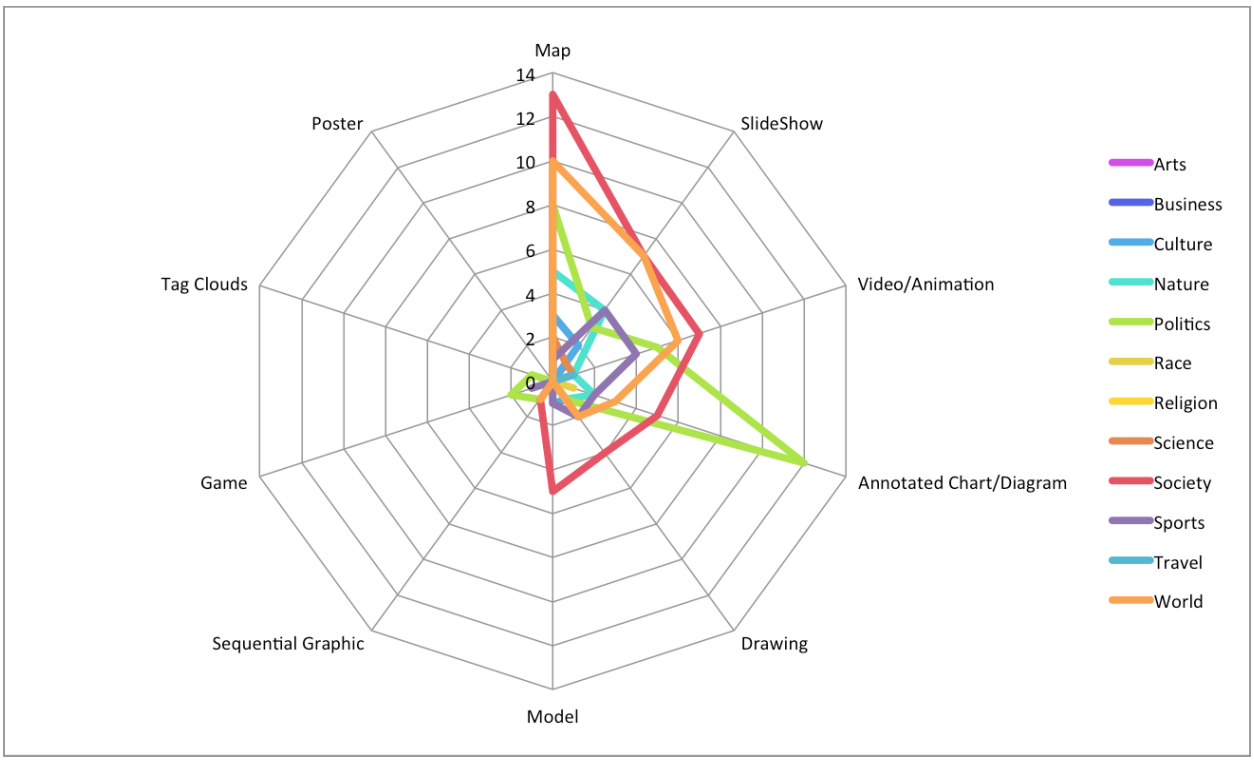

Figure 4.4. The distribution of visualization formats in each news topic in 2016

The charts in Figure 4.3 and Figure 4.4 indicate the visualization formats that appeared in the 12 news sections in 2016.

In arts, slideshow and drawing are the most commonly used format.

In culture, slideshow and maps are the most commonly used format.

In nature, maps and slideshow are the most commonly used format.

In politic, annotated chart and maps are the most commonly used format.

In 2016, we only have one article on the topic of Race, and the annotated chart is the only format used in the report.

In religion, maps and drawing are the most commonly used formats.

In science, maps are the most commonly used format.

In society, maps are the most commonly used format.

In sports, video/animation and slideshow are the most commonly used formats.

In travel, maps and video/animation are the two most commonly used formats.

In world section, maps are the most commonly used format.

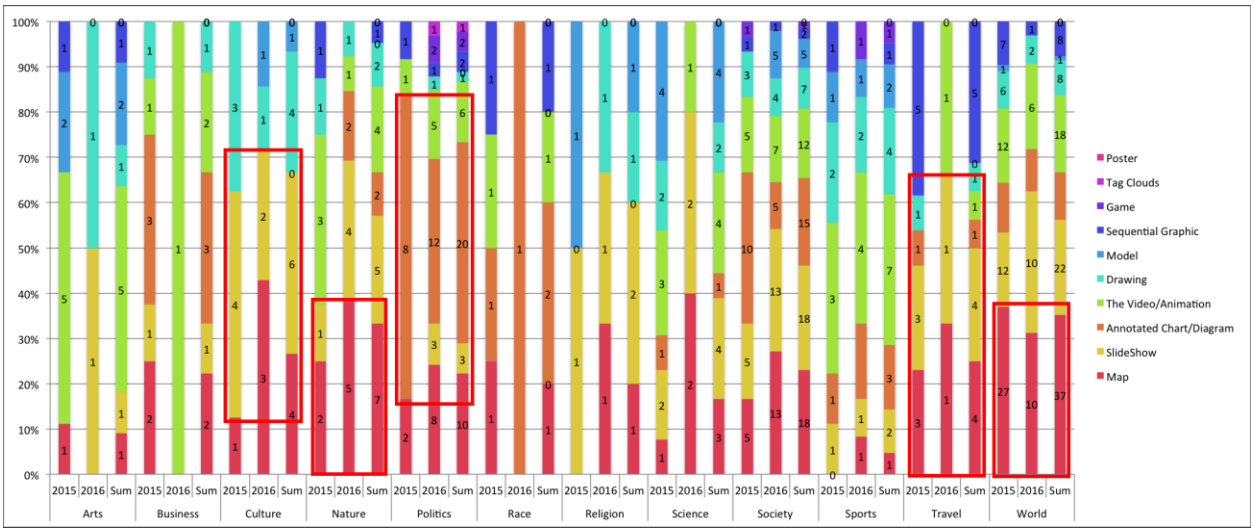

Figure 4.5. The relationship between the visualization format and news topics in 2015 and 2016

To find the underlying regularity in the data, Figure 4.5 provides a comparison between 2015 and 2016, and the combined of the data in the two years. In this figure, each topic has three columns that show the data in 2015, 2016, and the combination of the two years. Similar to the individual data from 2015 and 2016 shown in Figure 4.1 to Figure 4.4, this figure further proves the relationship between the news topic and visualization formats used.

By studying the bar charts and the radar charts, it is found that there are relationships between some of the visualization format and news topics. These topics, including Culture, Nature, Travel, and World, are marked in red in Figure 4.5. Specifically, Culture news usually use slideshow; Travel news commonly use slideshow and map; Politics news usually use annotated chart/diagram; Nature and World news usually use map.

The findings partially support the hypothesis that the visualization format can be chosen based on the news topic. In the above bar chart, the areas marked in red indicate the news topics that have a relatively clear relationship with the visualization format used. These topics include Culture, Nature, Politics, World, and Travel. However, topics like Arts, Business, Race, Religion, Science, and Society do not have a clear relationship with the visualization format. There are two possible to explanations for the relationship. The first is that the visualization is based on the content of news article. The other is that applying visualization can be based on the function of the visualization format.

The content of a news article determines which visualization format is to be used. For example, cultural news is usually about the introduction and presentation of a culturally related phenomenon or theme. As most of the cultural news does not have a clear plot, the role that visualization plays is to illustrate information from the text that has not been presented as part of the story. To support the text information, a slideshow, which consists of a series of pictures, is a commonly used visualization format to attract readers and demonstrate the text by providing relevant photographs. Mostly, these photographs are not required to demonstrate a complete plot. For instance, in the *A Walk Through the Gallery* (Figure 4.6) and *The Voyage* (Figure 4.7), a slideshow is used to show audiences a photograph of the artwork displayed and the portrait and status of people from different cultures. The audience can get a vivid perception of the abstract information through the Slideshow. This cannot be achieved from the descriptive text. The slideshow in the two examples does not take part in the presentation of a story plot. Although slideshow is not a part of the story itself, it provides supportive visual information to ease understanding.

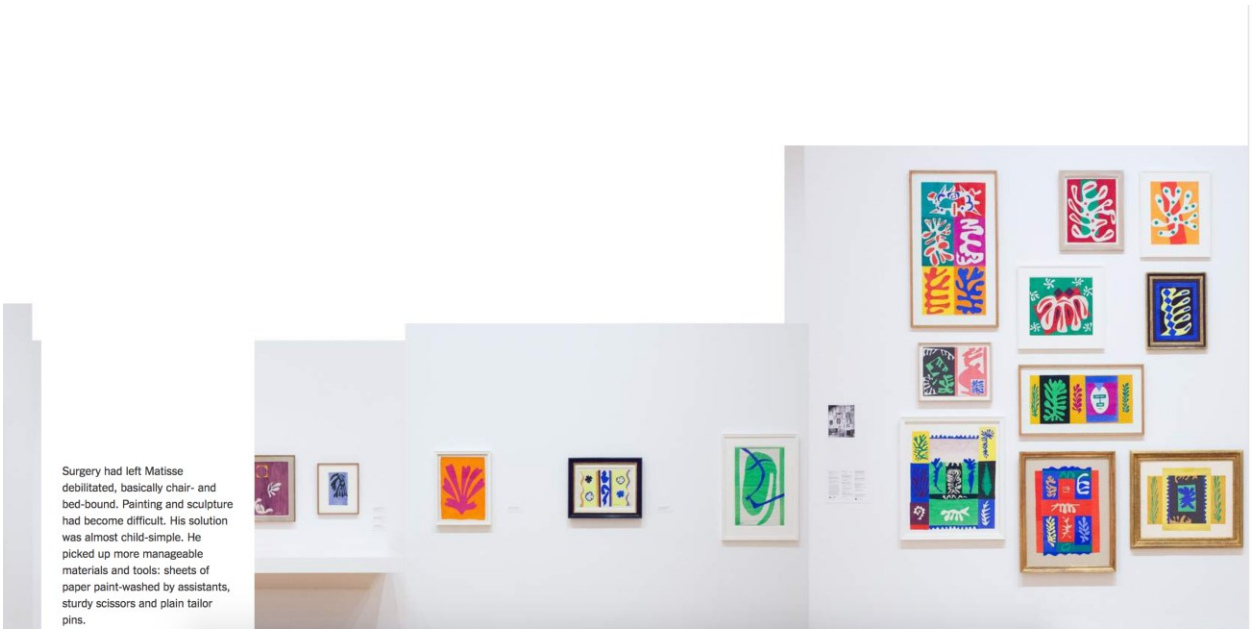

Figure 4.6. Screen capture from *A Walk Through the Gallery* (Buchanan et. al, 2015, n.d.).

Figure 4.7. Screen capture from *The Voyage* (Gordon, 2015, n.d.).

By observing the Political news articles from the samples, the annotated chart/diagram is mainly used to illustrate the relationship between the political actors and explain or analyze political views among the actors. There is research proving that political news which has undergone profound changes in the past decades, has become increasingly focuses on political leaders and personalities (Blumler & Gurevitch, 1995). Therefore, displaying and explaining the complicated relationship among political actors are important parts of political news. The annotated chart/diagram is a visualization format that can illustrate complex relationships by combining textual and visual elements. An annotated chart/diagram organizes information neatly through visual elements such as lines and arrows to indicate connections and relationships. Take the *Array of Conflicts of Interest Facing the Trump Presidency* (Figure 4.8) as an example: a series of diagrams is used to display the complex relationship between US President Donald Trump and the stakeholders. In this diagram, the arrows connect Trump with the related actors. Annotations provide key information for readers to interpret the diagram.

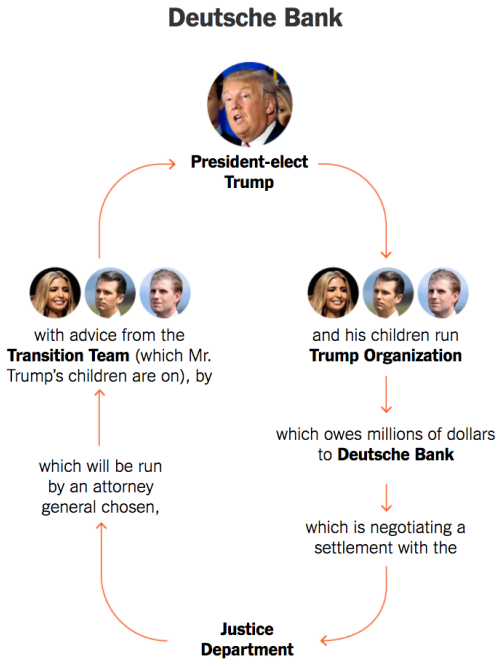

Figure 4.8. Screen capture from *The Array of Conflicts of Interest Facing the Trump Presidency* (Buchanan and Yourish, 2016, n.d.).

Figure 4.3 shows that the map format has a high frequency in news stories about Nature, Travel and World topics. The geographic information is necessary to give audiences a general idea of where the event took place, which is of great importance in these stories. According to the proximity value of news, readers may get confused or lose interest if a news story is told without visual geographic information. Compared to news stories about science, culture, and sports, there is a greater requirement for the geographic information in stories about travel, nature, and world. Travel stories usually provide the audience with information about a target city or destination. Thus, geographic information plays a primary role in introducing a travel destination. World news usually tells a story about something that happened all over world, most of which is happened in a place unfamiliar for the majority of readers. Displaying geographic information helps readers understand the event clearly. Nature is the topic that usually covers the story about natural phenomenon. As with stories about world issues, the geographic factor plays an important role on helping readers to understand the story. Therefore, a map is the visualization format that is most frequently used with these stories. As an element that reflects the objectives and values of journalistic institutions, news maps have become an important part of news stories for people to understand the location and basic geographic information when reading a news story, especially foreign news (Monmonier, 1989. p22). By adding annotation and interactive features, the function of the map is not limited to showing the geographic information about an event. It provides related background information when audiences explore the map. Take the *Battle for Mosul, in One Image* (Figure 4.9) and *Record Flooding in North Carolina Continues Days After Hurricane Matthew* (Figure 4.10) as two examples; the former story uses a map not

only to show the geographic information about the battle but also to tell readers what was happened through the annotations. Audiences can easily understand how the military force was pushed into the city. The dark colour also helps to indicate the main thrust of the battle intuitively. The latter example, *Record Flooding in North Carolina Continues Days After Hurricane Matthew*, uses coloured maps to show the record rainfall in North California, which is an explicit way to explain the reason for the severe conditions after the hurricane.

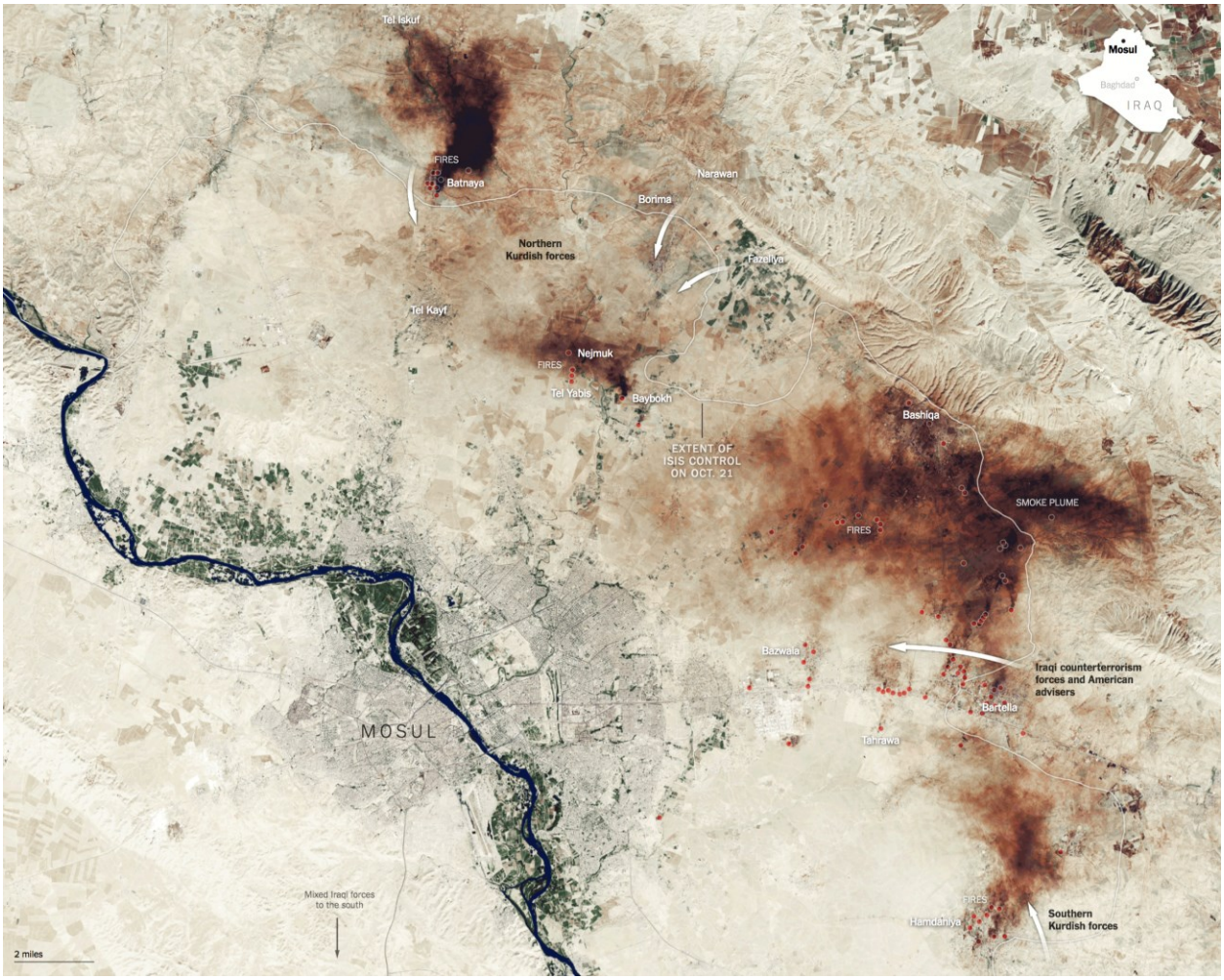

Figure 4.9. Screen capture from *The Battle for Mosul, in One Image* (Almukhtar, Wallace, 2016, n.d.).

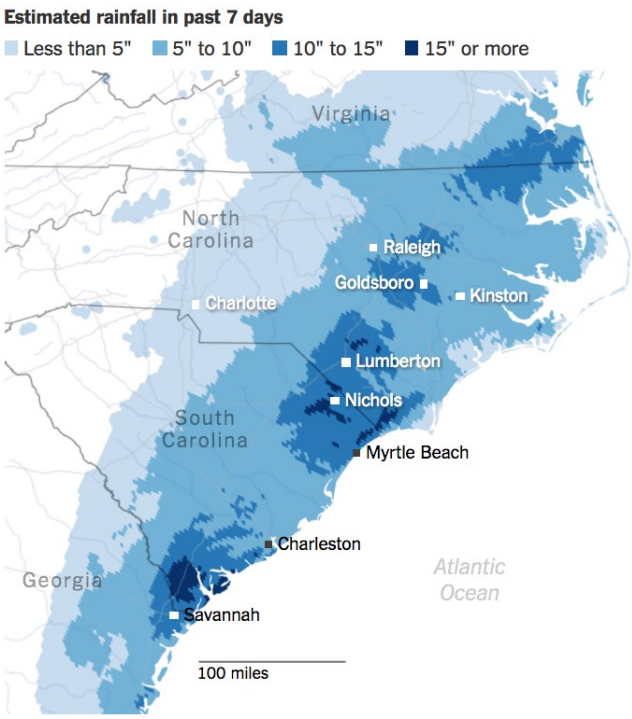

Figure 4.10. Screen capture from *Record Flooding in North Carolina Continues Days After Hurricane Matthew* (Lai, 2016, n.d.).

In addition to explaining the relationship from a news content angle, the function of using a visualization format may affect the application of visualization. According to the Visualization Wheel proposed by Cairo (2012) (see Figure 4.11), as mentioned in Chapter 2, decoration and functionality are the two roles that must be balanced in visualization design. Different visualization formats have emphasized decoration and functionality to different degrees.

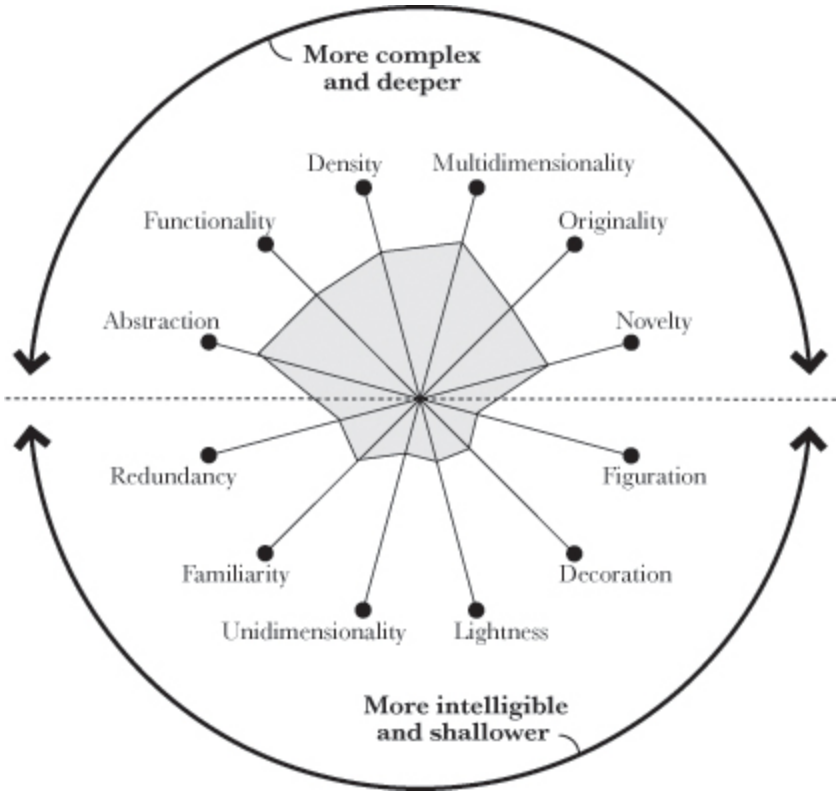

Figure 4.11. The Visualization Wheel model (Cairo, 2012)

The map and annotated chart/diagram are the visualization formats commonly used to transform complex information into a format or interface easy to understand by the majority of audiences. In other words, these visualization formats are aimed more at functionality than decoration. For example, the map format is often used to present geographic information that is closely related to the news story but might be unfamiliar to the majority of audiences. The annotated chart/diagram format is commonly used to explain obscure and abstract relationships, which might be difficult to explain, by text, such as using an annotated chart to show dynamic trends of election results or explain the complex relationship between two candidates. News about politics, nature news, travel news and world events which require the simplification of complex relationships or the demonstration of unfamiliar geographic information tend to use visualization formats that emphasize functionality role.

In contrast, the slideshow format is used to show pictures related to text. Compared to the map, chart, and video, the slideshow format plays a supportive role to the news story text. The information conveyed in a slideshow format is usually non-statistical information, which can be easily perceived by readers. The purpose of using a slideshow is to increase the readability of a story and encourage audiences to stay longer by providing a series of relevant pictures. Thus news stories about cultural topics, which do not have complex information that need to be simplified.

4.2 Designing A Visualization

This study evaluated 132 news articles with plot from the NYT from 2015 and 2016, based on the two visual design theories, Gibson's *Affordance* theory and *Gestalt* theory. As illustrated in Chapter 2, the criteria of *Affordance* include plain action, explicit feedback, and clear guidance. The *Gestalt* principles applied in this study are *Similarity, Proximity, Connectedness, Continuance, and Common Fate*, which are illustrated with concrete examples in Chapter 2. Figure 4.12 shows the design principles followed by the visualization formats in online news articles.

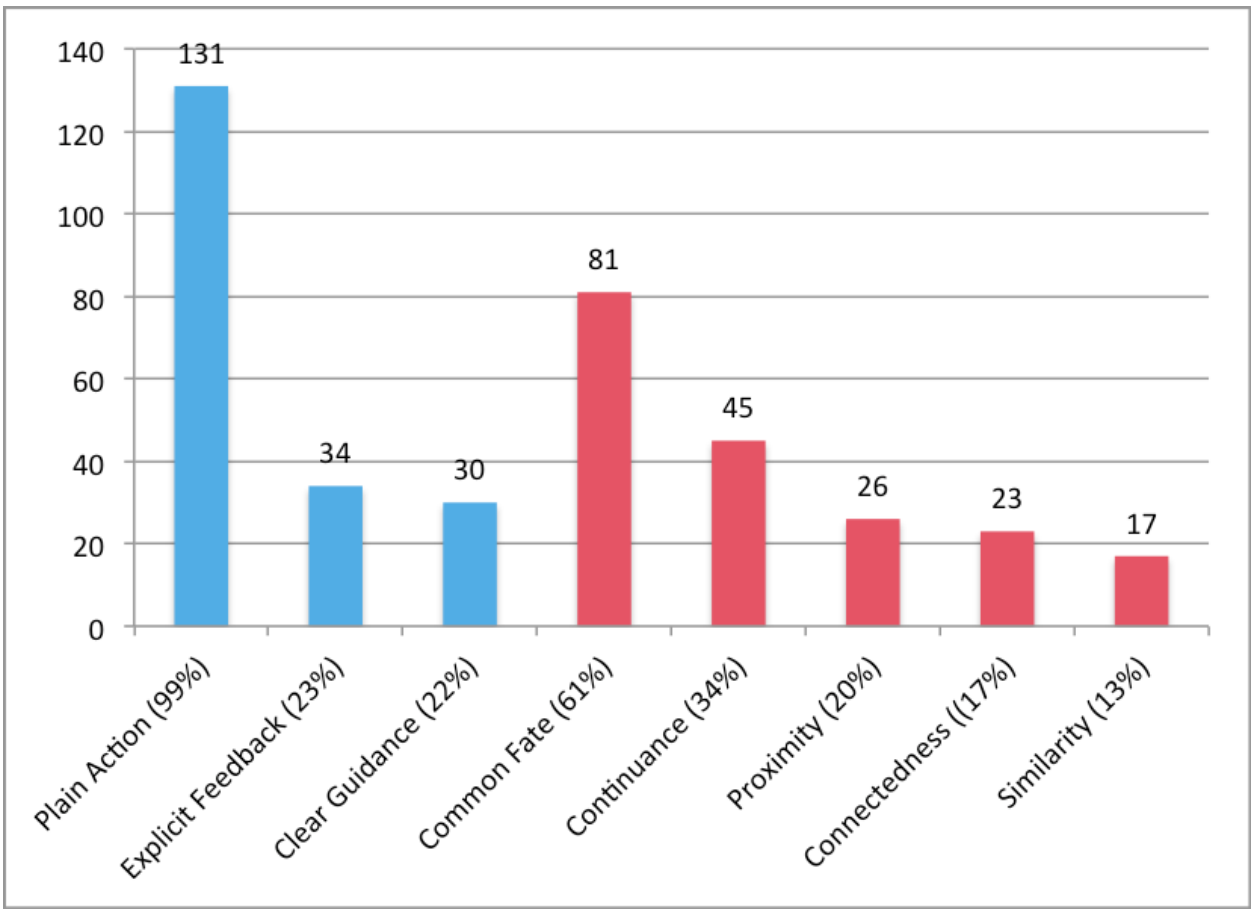

Figure 4.12. Reflection of Affordance and Gestalt principles in the sample news stories

The blue bars in the chart above reflect the application of *Affordance* theory in the online news articles. It is easy to see that almost all the visualizations used in news reports (99%) follows the plain action principle. Rather than requiring the reader to engage in a complex operation to explore a story, the visualization design follows the user's convention in an computer-based environment. Besides, the news articles providing an explicit visualization feedback account for 26% of the whole samples. The feedback here means the interaction design of the visualization, such as hovering for detail or for highlighted information. Moreover, the news articles providing a clear visualization guidance account for 23% of the whole sample articles. As illustrated in

Chapter 3, a clear guidance helps audiences to explore the story: for instance, an arrow to indicate the start point or an indicator of the flow that the audience should follow.

The red bars in Figure 4.12 show the implementation of the Gestalt theory in the sample news articles. It is obvious that the *Common Fate* has a higher frequency compared with the other four principles, and that *Similarity* is the principle that has the lowest frequency. The *Common Fate* principle states that people tend to perceive elements moving in the same direction as being more related than elements that are stationary or that move in different directions. When applied in the visualization design in journalism, it can be extended to emphasize the consistency among the consistency of multiple visualizations that are applied in a news report. Different from *Common Fate*, *Similarity* principle focuses more on the visual elements that constitute a visualization format. Elements that share the same visual characteristics tend to be perceived as a group. Harris and Lester also extended the Similarity to visualization design in the journalism field, and stated that if elements without the same visual characteristics are placed together, readers may not able to get the meaning clearly.

The findings reveal that designing a visual story that is easy to explore is the primary principle for the NYT. When applied in some specific fields, such as science, visualization can be difficult for audiences to explore and understand due to the complex interface. However, since most news story readers do not have a background in information visualization, the basic requirements for design are that the visualization is easy to operate and explore. Thus, it is necessary to provide audiences with an interface that follows the convention of web operation. Besides, visual elements which can be a cue to communicate what action is needed to explore the visualization also help the audience to read the news story. These visual elements prevent

audiences from having to deal with complex presentation formats and ensure that they are able to focus on the content.

The well-known dictum, "the whole is greater than the sum of its parts" is the essence of the *Gestalt* theory. *Common Fate* is the principle with the highest occurrence in the sample news articles. According to Harris et al. (2001), following the *Common Fate* Principle in journalism means making visualization consistent to avoid distracting the audience. When applying visualization formats in a news story, the layout, colour scheme and the integration of elements in different formats impact the perception of the whole story. The *Common Fate*, as the principle being applied in most of the sample news articles, reflects the importance of consistency in the design of the visual story.

Similarity is the principle that occurs least often in sample news articles. Statistical data and observations show that the NYT tends to blur the boundary between textual and visual information to make the elements of different properties connect closely, which contradicts the *Similarity* Principle. One reason could be that the *Similarity* Principle is proposed in the early age, and the technology at that time may not allow designers to place different elements in an interface altogether and at the same time distinguish them clearly. But today, with the assist of the advanced technology, elements with different properties can be well integrated in an interface, and present information clearly. In the digital age, it is common to have textual information closely associated with visual element in the digital news reports. For instance, placing textual information in the background of a visual element, or using fading in/out as a transition between visualization and text content are common ways to integrate visual content and textual content in digital news articles. The first case listed in Chapter 3, *Desperate Crossing* (Figure 4.13) is a good example of how the NYT blurs the boundary between text and

visualization. In this article, there is no clear borderline separating the text from visualization. The text is preceded by fade in/out, with the visual information as the background. In this way, the text is much closely related to the visual background, so that readers can easily perceive the text and relevant visual information as a whole.

Figure 4.13. Screen capture from *Desperate Crossing* (Pellegrin, 2015, n.d.).

However, further study needs to be conducted to see whether this exception to the *Gestalt* principle has a positive impact on readers' perceptions. At this stage, we can see that a simple, consistent interface that follows the audiences' convention is the main principle that the NYT follows to design visualization.

4.3 Applying Visualization To Represent News Story Components

According to the news structure defined by Bell, the components of a complete news story are attribution, actor, setting, action, follow-up, commentary, and background components. The bar chart in Figure 4.14 shows the frequency of the seven news story components represented in visualization, which reveals the way that the NYT incorporates visualization to present a story.

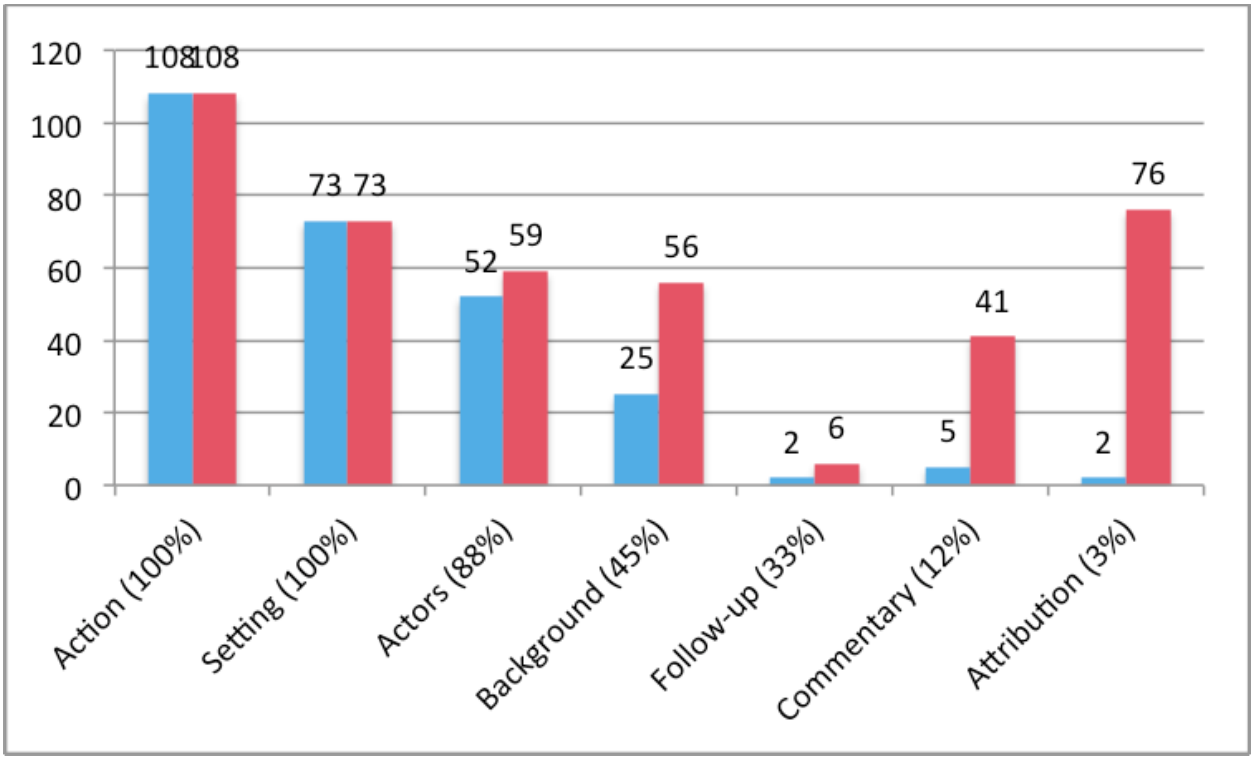

Figure 4.14. News story components represented in visualization

The news story structure proposed by Bell covers the main components in a news story. However, it is not a fixed structure as the occurrence of each component depends on individual news story. For that reason, this study first collected the appearance of each component and then picked out those components represented in visualizations. The incidence of news story components represented in visualization is expected to reveal how the NYT incorporates visualization in a news story plot. In Figure 4.14, the red bars indicate the occurrence of each

story component in the sample news articles. The blue bars show the components being presented in the visualization. Action and settings are the two components represented in every news article. Most news articles (88%) use visualization to present information about actors. However, the background (45%), follow-up (33%), commentary (12%) and attribution (3%) are the less likely to be represented in the visualization format.

There are two reasons that some news story components are more frequently represented in visualization. First, applying visualization into a news story depends on the importance of the components being presented. Second, it depends on the content of each component being presented. In other words, it depends on whether the information carried by the components can be communicated efficiently in the visualization format.

Table 4.1. News Components and the 5W's

Action	Setting	Actor	Attribution
What, why	Where, when	Who	Who

Firstly, applying visualization is to emphasize primary information of a news story. Action, setting, actor and attribution are the core elements constituting a news story. The four components also cover the formula for getting a complete story: who, when, where, what, and why, which is also known as the 5 W's. This study finds that most of the core components are presented in a visualization form. However, the follow-up, background, and commentary, which are not included in the core components, are less likely to use visualization as a presentation format.

The action, as the heart of a story, provides information about the main events of a story, and shows the cause and effect of the event by organizing the related information. The actor and

attribution contribute to telling the audience who says what and who does what, two of the primary questions answered in a news story (Bell, pp. 190). The way that the actor and action of a news story are presented can impact the story's newsworthiness. Most news values, including negativity, consonance, unambiguity, unexpectedness, and eliteness, are presented through the actor and action of the story (Bell, pp.156). The setting component shows audiences when and where the event happened, which are also two of the basic W's. The setting is high on the journalist's list of what to include in a story as it helps to enhance the news value from the proximity and timeliness aspect. Different from the proximity principle in Gestalt theory, the proximity as one of the news values means that "geographic distance between an event and a media organization's newsrooms and its audiences" (Shoemaker, Lee, Han, Cohen, 2007, p231). As stated by Tobler, "Everything is related to everything else, but near things are more related than distant things" (Tobler, 1970). Audiences will be more interested in the event happened close to them. Visualization can be used to emphasize the geographic information in a story in a more compelling and efficient way to convey relevant information. Attribution is an exception; although it is included in the 5W's, it is not frequently represented in visualization. This will be explained in the following paragraph.

Compared to the core components, the follow-up, background and commentary are the supportive components of the main plot in a story. Visualization is less used to present information about these components to avoid distracting audiences from the main story. The follow-up covers the action that is subsequent to the main action of an event. It is usually used to tell the updated events after the main action has been introduced in a story. Similarly, background covers the events prior to the main action. Background can also be called "history". It is used to demonstrate the context of the main action in the story. Commentary is the

journalist's or news actor's observations and comments on the action, which are not a necessity to compose a complete news story. These supportive components, compared with the core components, are less represented in visualization.

Applying visualization to present the core components is a way to lead the audiences to perceive the primary information efficiently and avoid distracting by the subordinate information. In an information-rich scenario, visualization contributes to expanding the bandwidth channel from the computer to the audience (Rodríguez et. al, 2015) (Keller et. al, 2005). Moreover, visualization also offers a more attractive and sophisticated way of storytelling than a traditional form (Figueiras, 2014). Therefore, if use too much visualization to present the background and follow-up information, rather than the main news event, audiences are likely to be distracted from the main story plot and attracted by the supportive content.

Secondly, using visualization is based on the content that each story components conveys. The frequency with which visualization is used depends on the components. Compared to the attribution, background, follow-up, and commentary, the information that constitutes the actor, action, and setting can be communicated in a more efficient way in visualization.

The action, which shows the main plot of a story can be illustrated explicitly using the visualization format. The action component in a news story inherits from the personal narrative. But compared to the action in a personal narrative, readers may encounter story events that happened later first. In this case, readers are able to interact with visualizations in an order they prefer. For example, the interactive news report *Roots of the Recent Violence Between Israelis and Palestinians* (Figure 4.15) provides three portals in the visualization: Dome of the Rock, Western Wall, and Al Aqsa Mosque. Readers can click either of the three to explore the roots of the violence in the Middle East area, rather than follow the order defined by the journalist.

Figure 4.15. Screen capture from *Roots of the Recent Violence Between Israelis and Palestinians* (Huang, White & Yourish, 2016, n.d.).

Besides the action, the actor is also a component that is frequently represented in visualization. To present an actor, the thumbnail face is the format that commonly appears in the visualizations. It has been proven that by using a picture of the actor helps to reinforce the text, make it more concrete, and improve recall of the news story (Prabu, 1998). The thumbnail is also an important format to visualize information about the actor. According to Knox (Knox, 2009), the thumbnail faces used in the online newspaper facilitate making a news story "human" by providing a way for the audience to connect with the news story. For example, in the news article *The Faces of American Power, Nearly as White as the Oscar Nominees* (Figure 4.16), the thumbnails of the actors clearly show the races of the leaders in different fields, which helps to enforce the theme that "*the faces of American power are nearly as white as the Oscar nominees.*" Thus, compared to text alone, the thumbnail visualization describes actors vividly and explicitly.

Figure 4.16. Screen capture from *The Faces of American Power, Nearly as White as the Oscar Nominees* (Park et. al, 2016, n.d.).

The setting component covers the time and space information. It can be demonstrated more intuitively through visualization rather than only in text. Visualization has been long used to present time-oriented and space-oriented data (Friendly, 2007). It is often used to "illustrate stepwise processes visually to an international audience to support the often poorly translated textual instructions" (Aigner, Wolfgang et al., 2011). In addition to the temporal information, the spatial information about a story is usually also represented in the visualization, in particular, the maps. The map has been proven to have the power to allow users to explore, analyze and

visualize spatial datasets to better understand patterns (Crampton, 2001). Because technology is making it possible for the map to provide more and more information, the map's role in the news story has changed from that of a supportive component to an independent element. It is common to use a single data map to convey the geographical information, with or without a few introductory words or sentences. In some news articles, the time and space information can even be illustrated in a single visualization with multiple dimensions. For example, in the story How *Missing Jet's Debris Could Have Floated to Réunion* (Figure 4.17), the temporal and spatial information is shown in an interactive map. The white circles, which represent the debris, move in a direction according to the ocean current. The dynamic time information on top of the map indicates the time of the movement of the debris. The combination of the temporal and spatial information in a map shows explicitly how the debris floated.

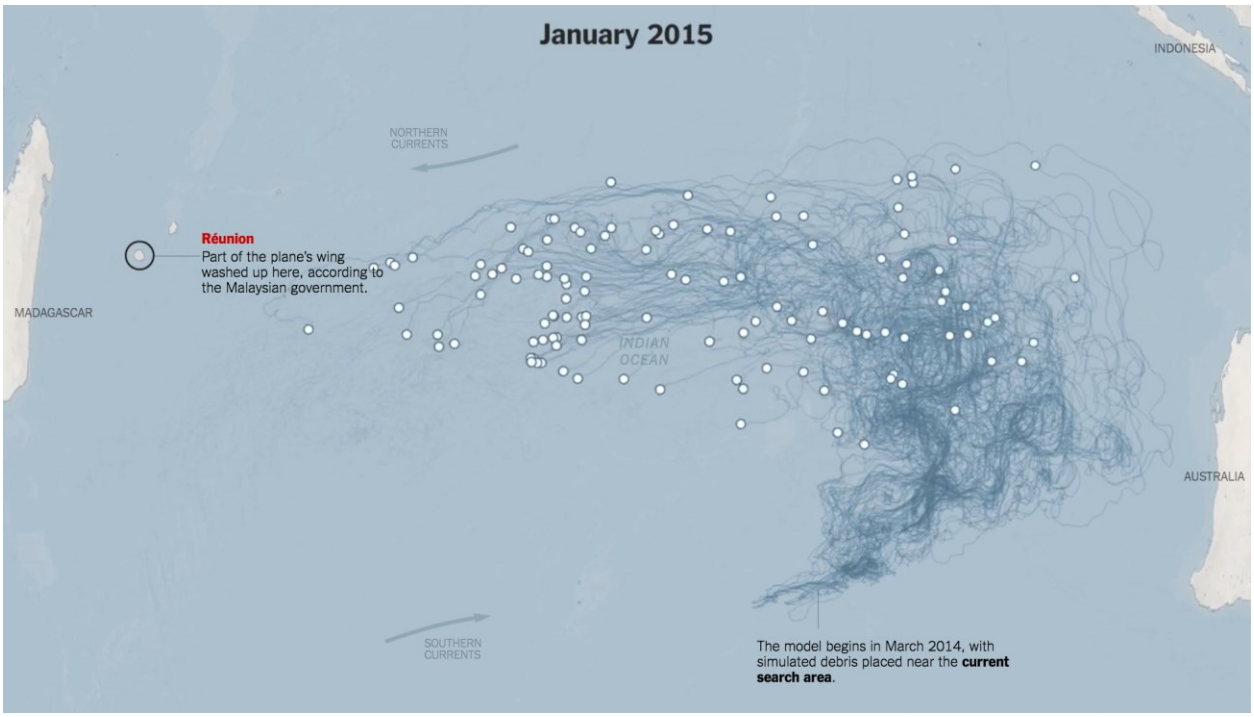

Figure 4.17. Screen capture from *How Missing Jet's Debris Could Have Floated to Réunion* (Innis et. al, 2014, n.d.).

Commentary and attribution are the components that are least represented in visualization formats. In part, this is because of the kind of information that these two components convey. Commentary is the term used to describe observation made by the journalist or actor. It usually appears as a quotation of the news actor. Rather than stating a fact, commentary is the subjective opinion. Usually, the subjective opinion constitutes a very small part of the story. For instance, in the *Greenland Is Melting Away* story, the commentary is presented in the text in the form of a quote from the actor about Greenland melting.

It's hard to make the choice to come on projects like this, but everything in my life has prepared me to come out here," Mr. Overstreet said. "We go from battling the river to working with it, and then we learn so much from it.

- *Greenland Is Melting Away* (Davenport, Haner, Buchanan & Watkins, 2015, n.d.)

Obviously, using text can express the subjective attitude explicitly. The visualization format, which is usually used to transform complex information in a simple way, would be much less effective in this situation. Attribution usually contains a person's name and affiliation or an institution name. Text is an easy and straightforward way to show attribution because attribution requires only limited information to be visualized.

Background and follow-up are also less likely to be represented in visualization. Although visualization is used to illustrate the comparison between the previous or follow-up event and the main event in some sample news stories, it is used infrequently to represent these two components to prevent readers being distracted from the main event as discussed in the preceding section.

4.4 Conclusion

This chapter summarized the major findings corresponding to the three research questions. The news sections, such as the culture, nature, politics, travel and world, have a preference on choosing events are the topics that have strong correlations with applicable visualization formats. This chapter also revealed the visualization design principles that the NYT follows. By using the *Affordance* and *Gestalt* theories, we can see that using a simple, consistent interface and following audiences' convention are the main principles that the NYT follows to design a visualization format. It is also found that among the seven news story components, the action, actor, and setting are the three that are most represented in visualization. The NYT applies visualization to emphasize the news components that convey the primary information. Applying visualization to represent news story component also depends on the content conveyed by components.

Conclusion

Visualization has been widely used in journalism to enrich the presentation format in news articles. However, there is little research that focuses on the way that visualization is incorporated in digital news articles. To fill this gap, this study was conducted to explore the experience of a successful media outlet, the NYT, and is expected to provide a good reference for media practitioners using the visualization format in a news article. Based on the main topic, three research questions were identified. These questions were used to examine how the visualization format is selected, designed, and incorporated in the body of news story, and addressed the process of designing a visualization and implementing it in a digital news article.

Through analyzing 175 news articles gathered from the NYT, this study reveals 1) the relationship between news topics and the visualization formats chosen to accompany them; 2) the design principles that the NYT follows when designing a visualization; and 3) the way that the NYT uses visualization to represent news story components.

Specifically, the findings show that culture, nature, politics, travel and world events are the topics that have a clear relationship with the visualization format. The slideshow, which usually plays a supportive role to the text information, is often used in the culture and travel stories. The annotated chart/diagram, which is commonly used to illustrate complex relationships between entities, appears more often in political stories. Maps, with can present temporal and spatial information, are frequently used in the news sections (Nature, Travel, and World). According to the visualization design model proposed by Cairo (2012), maps, and annotated chart/diagrams focus more on functionality, while the slideshow usually serves as a decoration in a news article. This suggests that news topics such as politics, world event, and nature, which need to demonstrate complex information, usually use visualization formats that focus on functionality

and not the decoration, while topics such as culture, which do not need to simplify complex information, tend to use visualization as a decoration to accompany articles.

This study explores the design principles that the NYT follows, under the framework of the *Affordance* and the *Gestalt* theories. From the *Affordance* perspective, most of the visualizations in the news articles are designed to guarantees that users will not be interrupted by needing to perform an unfamiliar operation to explore the news article. From the *Gestalt* perspective, most of the visualizations are designed in a consistent scheme, which follows the Common Fate principle. This helps to prevent readers from being distracted by inconsistently organized visual elements. Moreover, from observation, it is common to see that in most of the news articles, the NYT tends to blur the boundary between textual and visual information to more closely connect the elements of different properties. However, further study needs to be conducted to see whether or not this exception has a positive impact on the perception. At this point, we can see that simplicity and consistency are the main principles that the NYT follows when designing a visualization format.

Last but not least, the findings reveal that among the seven news story components, action, actor, and setting are the three that are most represented in the visualization format. There are two possible reasons for this phenomenon: visualization is applied to emphasize the news components that convey the primary information; these frequently visualized components can be presented and communicated visually more efficiently than other components.

To sum up, this study shed the light on the intersection of two closely related fields— the journalism and visualization—by exploring the way that the NYT, a successful media outlet, applies visualization in digital news articles. One major significance of this study is that the results will help media practitioners and researchers to develop strategies to apply visualization

to better present news stories. However, some limitations still exist. One limitation of this study is the lack of diverse sample articles. Only the NYT was considered in this study. Although it is one of the pioneers in digital journalism, and also has invested heavily in the practice of visualized reports, the experience of a single media organization is insufficient to provide a comprehensive view of the entire industry. Expanding the research target and having multiple media organizations included in the research, such as The Guardian, would result in a more widely applicable conclusion. Thus, future research is expected to have a larger sample library, which contains online news stories from multiple news organizations. A comparative study can be conducted to explore how different media organizations use the visualization format in news stories. The second limitation of this study is the inevitable subjectivity of data classification. In this study, the sample news reports were classified according to visualization format categories and news topic categories proposed by scholars who have already studies this topic. This classification process is unavoidably affected by the author's perception of the visualization format and news topic, which may make the data classification inaccurate. Therefore, in future research, the data classification is expected to be conducted by three to five trained researchers to minimize the impact of subjectivity and guarantee accuracy and objectivity. Despite the above limitations, this thesis lays out a complete analysis methodology, on which, future studies can be easily based.

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