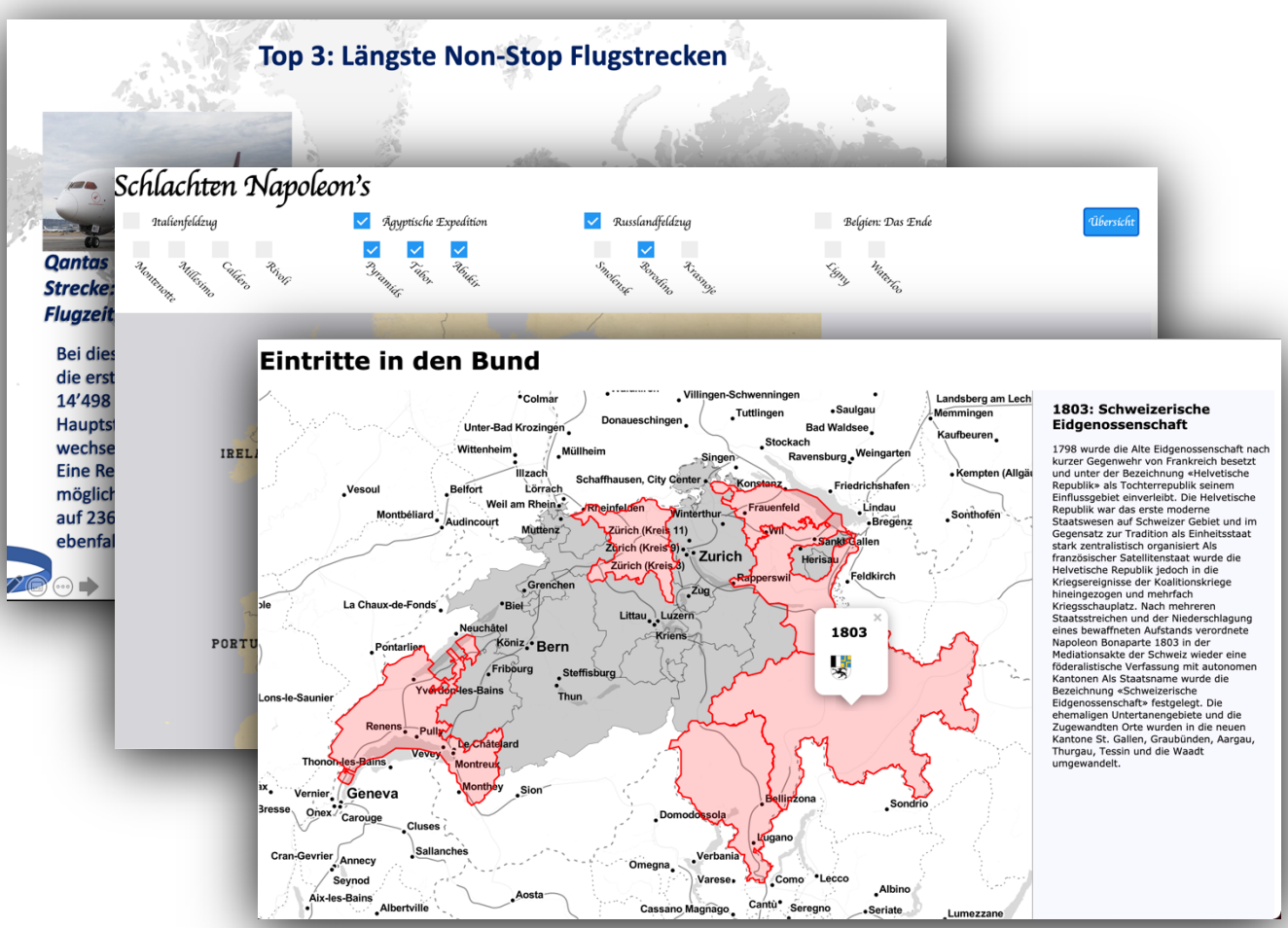
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

IKG
Institute of Cartography
and Geoinformation

STORYTELLING IN INTERACTIVE ATLASES

CHALLENGES AND SOLUTIONS



MASTER THESIS

GEOMATIC ENGINEERING AND PLANNING

AUTHOR:
STEFAN SCHALCHER
SCHALSTE@STUDENT.ETHZ.CH

SUPERVISOR:
PROF. DR. LORENZ HURNI

ADVISORS:
DR. RENÉ SIEBER
NINA BONASSI

AUTUMN SEMESTER 2020
SUBMITTED 25 JANUARY 2021

PREFACE

I was confronted with interactive maps and storytelling in maps for the first time during the lecture "Multimedia Cartography" at ETH Zurich. The goal was to create a literary atlas in a project, where all project members chose a fictional book and tried to map the events of the story in a map. I was fascinated by the nearly endless possibilities and the different ways how to transfer the different stories onto a map. So when I saw the announcement with the different topics for the master thesis, it became quickly clear that I would choose the topic "Story telling in Interactive Atlases" for my master thesis. For me, this work was a chance to expand my knowledge in interactive cartography as well as to take further steps in the broad storytelling area.

Firstly, I would like to thank the Institute of Cartography and Geoinformation (IKG) at the Swiss Federal Institute of Technology in Zurich (ETH) for giving me the opportunity to write this master thesis.

Furthermore, I would like to express my sincere gratitude to my supervisors Dr. René Sieber and Nina Bonassi for their competent support and valuable inputs for my work – mostly done virtually via *Zoom Meetings* due to the ongoing COVID-19 situation.

Last but not least, I would like to thank as well my whole family for their support and in particular my "better half" Stephanie Konrad for her support during this time and for reading through this thesis.

Effretikon, January 2021

Stefan Schalcher

ABSTRACT

This master thesis deals with storytelling in interactive atlases. In the first part, this thesis provides a clear overview over today's existing techniques and concepts of storytelling implementation in cartography. Current challenges, solutions and important concepts to group different storytelling approaches are highlighted. With the most important findings from that profound literature analysis, a *Storytelling Toolbox* is derived which consists of important concepts and techniques for a successful implementation of storytelling. Using a proof-of-concept implementation, the elaborated *Storytelling Toolbox* is verified: selected techniques are thereby used to create prototypes of maps with storytelling implementation. The prototypes are implemented as web map applications using the open-source *JavaScript* library *Leaflet* and also as a simple storyboard. The results of the implementations show that the techniques and methods from the elaborated *Storytelling Toolbox* can be applied to implement successfully storytelling in a cartographic environment. Moreover, two external storytelling examples are examined and same or similar recurring techniques can be found there as well. The findings of this work are furthermore used to give recommendations for an implementation of storytelling in the Atlas Cartography Environment. The presented thesis succeeds in consolidating important concepts and techniques into a clear structured toolbox.

Keywords: storytelling, cartography, interactive atlases, storyboard, web map application, interactive maps, leaflet

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1. INTRODUCTION AND PROBLEM STATEMENT

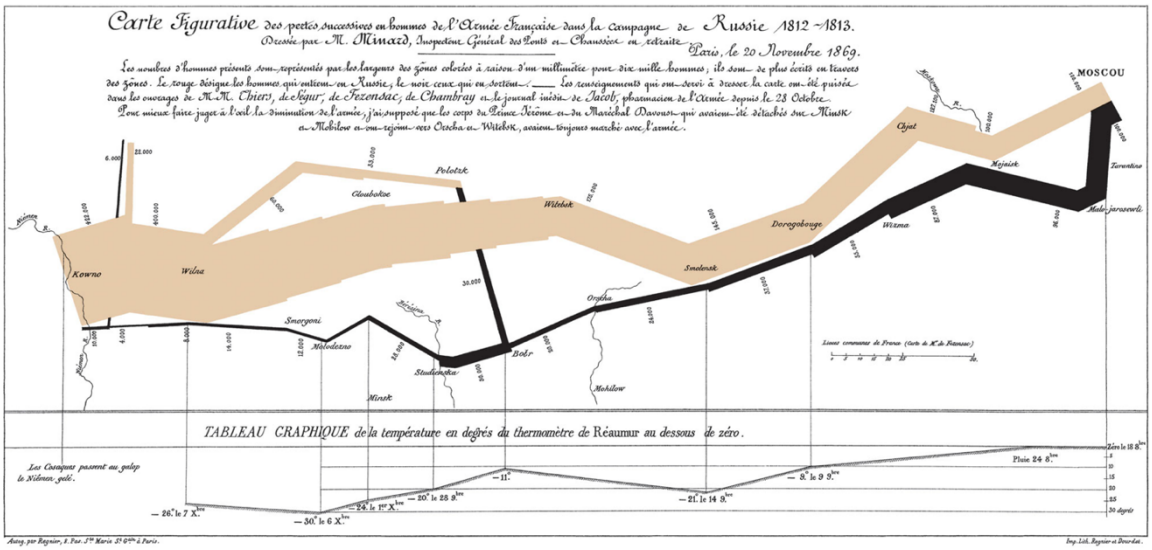


Figure 1: Charles-Joseph Minard's map of Napoleon's flawed Russian campaign (https://de.wikipedia.org)

Called by many as the "best statistical drawings ever created", Figure 1 shows Charles-Joseph Minard's map of Napoleon's flawed Russian campaign. This map tells the true story of Napoleon's army departing the Polish-Russian border. The thick line across the map illustrates the size of his army at specific locations during their advance and retreat. In particular, it displays many different types of data at the same time: the number of Napoleon's troops, the distance and direction travelled, and the temperature. Minard's interest lays especially in the sacrifices of the soldiers.

Particularly, Minard's map can be seen as an successful implementation of storytelling in cartography. In fact, storytelling has become increasingly important in the field of printed and digital mass media, but also in cartography:

"Visual storytelling gives cartography multiple ways to unite technology with praxis, product with process, and design with critique."

[Robert E. Roth (2020): Cartographic Design as Visual Storytelling:
Synthesis and Review of Map-Based Narratives, Genres, and Tropes,
The Cartographic Journal]

Additionally, more and more terms such as "spatial narratives", "story maps" or "visual storytelling" emerged in the field of cartography. Particularly, all these arising trends show that

storytelling can be an important tool with a strong impact on the cartographer's design decision and push cartographic conventions in new ways (Roth, 2020). So it is more than appropriate to examine these trends and the implementation of storytelling in the field of cartography. Especially in the Atlas Cartography Environment, the tool of storytelling based on narratives can be a promising solution. Atlas Cartography can thereby be described as a collection or bundle of maps. Traditionally, they have been bound into book forms, but nowadays many atlases are in multimedia formats – The Atlas of Switzerland being a well-known example. Storytelling based on narratives is proposed to be a very promising solution in order to make digital maps more interesting and catchy, or even to reveal more complex or hidden facts in maps.

1.2. GOALS

1. PROVIDE CLEAR OVERVIEW OVER EXISTING TECHNIQUES AND CONCEPTS OF STORYTELLING IN THE FIELD OF CARTOGRAPHY.
1.1.1. DEFINE SCOPE AND DIFFERENT LEVELS OF STORYTELLING.
1.1.2. HIGHLIGHT CURRENT CHALLENGES OF IMPLEMENTING STORYTELLING IN CARTOGRAPHY.
1.1.3. PROVIDE OVERVIEW OVER CURRENT SOLUTIONS OF IMPLEMENTING STORYTELLING IN CARTOGRAPHY.
1.1.4. DEVELOP A "TOOLBOX", WHICH CONSISTS IMPORTANT CONCEPTS AND TECHNIQUES TO IMPLEMENT STORYTELLING IN CARTOGRAPHY.
2. IMPLEMENT 2-3 USE CASES OF STORYTELLING IN THE ATLAS CARTOGRAPHY ENVIRONMENT.
2.1.1. DEFINE APPROPRIATE USE CASES FOR THE ATLAS CARTOGRAPHY ENVIRONMENT.
2.1.2. CHOOSE AN APPROPRIATE OUTPUT FORMAT FOR THE USE CASES (MOCKUPS OF MAPS, STORYBOARDS, VIDEO SNIPPETS OR SMALL APPLICATION).
2.1.3. DEMONSTRATE APPLICATION OF STORYTELLING IN ATLAS CARTOGRAPHY ENVIRONMENT.
2.1.4. PROOF APPLICATION OF STORYTELLING IN ATLAS CARTOGRAPHY ENVIRONMENT.
2.1.5. EVALUATE APPLICATION OF STORYTELLING IN ATLAS CARTOGRAPHY ENVIRONMENT.

Table 1: The defined two main goals and their sub-goals

With this master thesis "Storytelling in Interactive Atlases", two main goals are pursued. On the one hand, a clear overview over existing techniques and concepts of storytelling in the field of cartography should be given. Current challenges and solutions should be highlighted and in the end a toolbox with important concepts and techniques developed. On

the other hand, the goal is also to implement *Use Cases* of storytelling in the Atlas Cartography Environment. In particular, selected techniques from the previously elaborated *Storytelling Toolbox* are used for the implementations. This should demonstrate, proof and evaluate the application of storytelling in the Atlas Cartography Environment. The full list with defined goals and sub-goals can be seen in the following.

1.3. STRUCTURE OF REPORT

The current situation, the problem statement and the goals of this thesis are emphasized in the **Introduction (1)**. Chapter two deals with the **Methodology (2)**, where all the work steps from the literature analysis to the implementation are explained.

Afterwards, the **Literature Analysis (3)** contains some definitions of storytelling, challenges and potential when implementing storytelling and provides an overview over existing concepts and techniques.

Chapter four deals with the development of the **Storytelling Toolbox (4)**. It emphasizes how the most important findings from the literature analysis are used to develop a toolbox which incorporates techniques and concepts to implement storytelling in a cartographic environment.

Thereafter, the chapter **Implementation (5)** outlines how the prototypes of maps with storytelling implementation have been created using techniques from the *Storytelling Toolbox*.

The capabilities of the *Storytelling Toolbox* are further examined in **Discussion (6)**. The implementations and their used techniques are reviewed with respect to the defined challenges and *Storytelling Toolbox* is evaluated with regard to external implementations. With the most important findings, recommendations for an implementation of storytelling in the Atlas Cartography Environment are given.

Concluding chapter seven focuses on the **Conclusions and Outlook (7)** of the master thesis as a whole and discusses some possible future work.

2. METHODOLOGY

2.1. METHOD

This thesis is divided into two main parts. The first part is dedicated to a profound literature analysis. Based on existing literature and previous work in the subject, an overview of existing concepts and used techniques with regard to the realization of storytelling in maps will be given. As a result of this first part, a *Storytelling Toolbox* is created, which incorporates the most important concepts and techniques to implement storytelling. In the second part, based on the elaborated *Storytelling Toolbox*, three *Use Cases* of storytelling are defined and implemented. The focus relies on the use in the Atlas Cartography Environment.

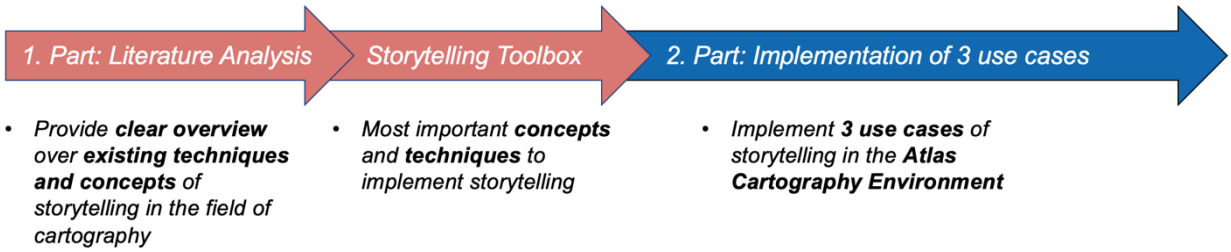


Figure 2: An overview over the work steps of this thesis

2.1.1. LITERATURE ANALYSIS

The main purpose of the first part is to get an overview of today's existing concepts and techniques in the realization of storytelling in maps. Particularly, the literature analysis looks into existing writings and provides some fundamental definitions of storytelling. It addresses challenges and potentials of the implementation of storytelling in today's cartography and provides an overview of existing concepts and techniques. Questions such as "What types of storytelling do exist?" or "How do map creators use storytelling in their maps?" are addressed. A full list of considered literature for this part can be found in the bibliography.

Subsequently, the most important findings from the literature analysis serve as a requirement for the development of a *Storytelling Toolbox*. The *Storytelling Toolbox* incorporates important concepts and techniques to implement storytelling in cartographic representations. Especially, it provides a quick overview over existing techniques and furthermore, it is designed to be expandable in future works and user-friendly when working with it.

2.1.2. IMPLEMENTATION

The second part of the thesis comprises three *Use Cases* of storytelling. Particularly, techniques and concepts from the previously elaborated *Storytelling Toolbox* are being used. The implementation part is therefore a derivation of the Literature Analysis part.

To verify this model of the *Storytelling Toolbox* and the entire workflow we test the operability of that model with a proof-of-concept implementation. With the proof-of-concept implementation, selected techniques of the *Storytelling Toolbox* are used for the creation of prototypes of maps. The types of maps are thereby chosen in a way that they differ from each other and that various techniques from the *Storytelling Toolbox* can be applied to them. For each *Use Case*, two version are implemented: one with a more *Author-Driven* and another one with a more *Reader-Driven Approach* of storytelling. As a result, in total six prototypes of maps with storytelling implementation are created. Each of the prototypes covering either temporal, spatial or thematic aspects of map content. More details about the definition and implementation of the maps can be seen in Chapter 5.

The purpose of the implementation is therefore further to test the feasibility of that model and should as well investigate its capabilities in terms of current technologies for the implementation of storytelling in cartography. Especially, the focus of the implementations rely on the use in the Atlas Cartography Environment.

2.1.3. DISCUSSION

Results from the literature analysis and the experience derived from working with the elaborated *Storytelling Toolbox* will be discussed and used to give some recommendations for an implementation of storytelling in the Atlas Cartography Environment. Additionally, a more objective comparison between techniques from the *Storytelling Toolbox* and techniques used in two external examples from the web will be given. In conclusion, the achievements of the defined goals in this thesis will be briefly reviewed as well.

2.2. DATA

The implemented *Use Cases* partly use the free downloadable *swissBOUNDARIES3D* geodata from *swisstopo (Bundsesamt für Landestopografie)*. The use of these data is regulated by the terms of use available at https://www.swisstopo.admin.ch/de/home/meta/conditions.html.

Besides the geodata, there are various online sources used for the pictures and content of the individual implementations.

A full list of all considered sources for the implementation can be seen in Appendix iii.

2.3. INFRASTRUCTURE

All the work of this thesis has been performed on my personal computer (MacBook, Retina, 12-inch, early 2015).

Two *Use Cases* have been implemented using the open-source *JavaScript* library *Leaflet*. The *JavaScript* programming part has been realized in *Atom 1.53.0*, an open-source desktop text editor and the interactive maps tested in *Google Chrome*. For the data preparation of the interactive maps, tools from *QuantumGIS 2.18* have been utilized. The third *Use Case* has been implemented as a simple storyboard using *Microsoft PowerPoint* for Mac.

The *Storytelling Toolbox* has been elaborated using *Microsoft Excel for Mac* and the report has been written with *Microsoft Word for Mac*.

3. LITERATURE ANALYSIS

The literature analysis is divided into three subsections. Section 3.1. explains a couple of common definitions in terms of storytelling and provides a basis for the upcoming chapters. Today's challenges and potentials of storytelling in cartography are presented afterwards in section 3.2 and 3.3. In the end, important concepts of storytelling implementation in visualizations are briefly outlined in section 3.4.

Since storytelling is a particularly large domain and has been studied intensively by various literature in the past, it is too broad to be covered in its entirety in this thesis. For that reason only the most important findings are presented in the next chapters. However, a full list of considered literature can be found in the Appendix ii.

3.1. STORYTELLING – DEFINITIONS

Nowadays, there exist many different types and genres of storytelling. However, Caquard and Cartwright outline in their research (Caquard & Cartwright, 2014) the following three main storytelling forms that can generally be distinguished:

ORAL STORIES	*based on spoken word*
WRITTEN STORIES	*based on written word, linguistics and literature*
AUDIO-VISUAL STORIES	*integrating art, music, film or multimedia*

Table 2: The three main distinguishable storytelling forms (Caquard & Cartwright, 2014)

ORAL STORIES

Being one of the earliest forms of storytelling, oral stories are completely based on the spoken word. Almost as ancient as humankind and as languages came around, members of ancient societies began talking to each other, sharing and spreading stories. This oral traditions would be passed on through many generations and is still very much used widely today. In terms of mapping oral stories, cartographers have historically used oral stories from travelers and explorers to fill in the blanks on their maps and to develop first base maps (Caquard & Cartwright, 2014).

WRITTEN STORIES

When languages were developed, mankind began to write and oral stories were transcribed into written stories. Nevertheless, it was not an ideal form of storytelling, as it was very time consuming and only one person could read the story at a time. However, the invention of the printing press changed everything, as multiple copies of books could be made and different more forms of written story types emerged – from newspapers to novels. There is a long tradition in literary studies to map settings of novels. Undoubtedly, one of the most famous is the publication of Franco Moretti's Atlas of the European Novel 1800-1900 (Moretti, 1999). In a series of 100 maps, Franco Moretti exposes the fascinating connections between literature and space by mapping often unexpected relations between literature and geography.

35. Social classes in London according to Charles Booth (1889)

Booth's color-coding, inscribed at the bottom of the map, runs as follows: '*Black*: Lowest class. Vicious, semi-criminal. *Dark blue*: Very poor, casual. Chronic want. *Light blue*: Poor. 18s. to 21s. a week for a moderate family. *Gray*: Mixed. Some comfortable, others poor. *Pink*: Fairly comfortable. Good ordinary earnings. *Red*: Middle class. Well-to-do. *Gold*: Upper-middle and Upper classes. Wealthy.'

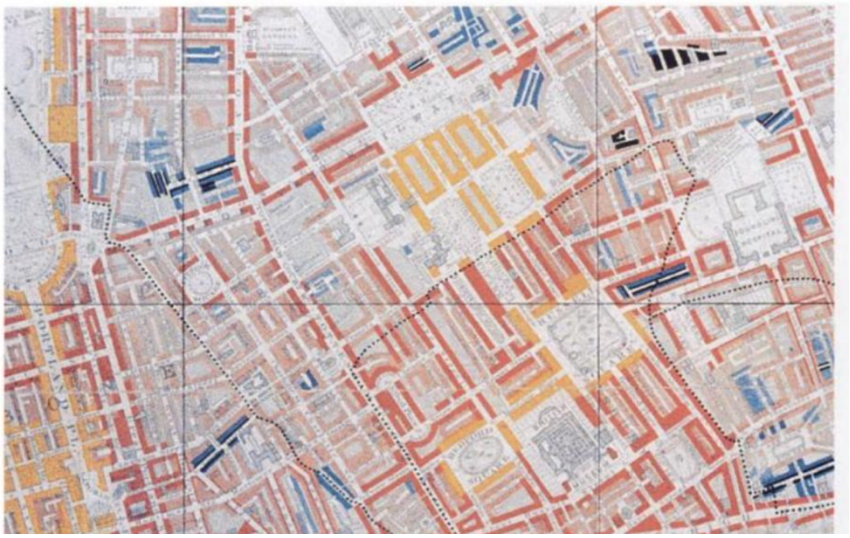


Figure 3: Extract from Franco Moretti's Atlas of the European Novel (https://books.google.ch/books/about/Atlas_of_the_European_Novel_1800_1900.html?id=ja2MUXS_YQUC&redir_esc=y)

AUDIO-VISUAL STORIES

The rise of new technologies such as television, film and music has given new possibilities in the domain of storytelling. Particularly, audio-visual storytelling can range from simple video recordings to complex cinematographic productions. Nowadays, the internet allows us to have access to a nearly endless library of compelling stories from around the world. Furthermore, with social media, everyone can take part in that storytelling process and share

their own personal stories across the entire world. Highlighted by (Caquard & Cartwright, 2014), one of the major challenges in cartography is the representation of emotions since conventional maps have rather a dehumanizing character and cannot transmit emotions. Therefore, there is a growing interest to include into mapping other types of multimedia such as audio or visual elements in order to transmit stronger emotional messages.

When digging a bit more into the area of storytelling, various more specific terms do come up. Consecutively, some more definitions are given which are based on the definitions made by (Roth, 2020):

STORY	*An account of specific events, places and people*
NARRATIVE	*The presentation of a story in a particular way, having a beginning, middle and an end*
PLOTLINE	*Connected series of events which form the story*
STORY MAP	*Any cartographic representation that exhibits narrative elements where user get additional context-based, narrative information*
VISUAL STORY	*Stories communicated through illustrations, graphics, imagery and video instead of or in addition to oral, written or audio formats, with a map potentially just one scene in the overall story*

Table 3: Further definitions of terms used in storytelling (Roth, 2020)

In today's cartography storytelling is mainly achieved with the help of story maps (Thöny, et al., 2018). As mentioned in the table above, a story map can be described as any cartographic representation that exhibits narrative elements where users get additional context-based, narrative information. The results of story maps are mostly interactive maps consisting of independent thematic features or spatial referenced individual stories, but hardly of map-centered, consistent stories.

A typical example of story maps are applications created with the Esri Story Map Journal App. As can be seen in the example of Figure 4, (Cartwright, 2015) tells a story about a soldier's journey during World War I. The map component is thereby enhanced with appropriate additional media such as photographs, videos, sketches or historical artifacts. Users are able to navigate the narrative via the timeline (at left of the screen in Figure 4) or the map itself.

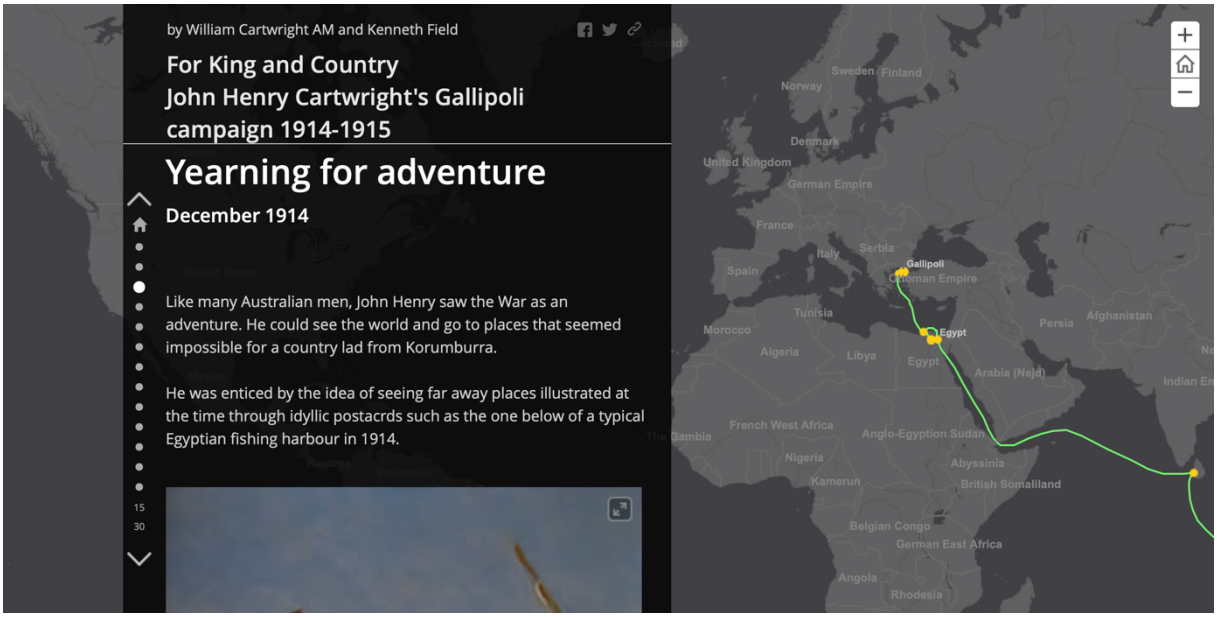


Figure 4: An example of a story map using the Esri Story Map Journal App (Cartwright, 2015)

Usually, story maps are implemented using a top-down approach to focus on a specific theme or issue (Thöny, et al., 2018). However, this approach often leads to interactive maps consisting of independent thematic features or spatial referenced individual stories, but hardly of map-centered, consistent stories. Since those story maps remain highly motivated by specific topics, this approach can be classified as extrinsic storytelling. As a contrary approach, intrinsic storytelling has been introduced by (Sieber & Bonassi, 2017).

EXTRINSIC STORYTELLING	• *Highly motivated by a specific topic* • *Communicated through different medias* • *Map only a part of communicated story*
INTRINSIC STORYTELLING	• *Story is integral part of map* • *Map is focus of communicated story* • *Other media formats can be included*

Table 4: Difference between extrinsic and intrinsic storytelling approach (Sieber & Bonassi, 2017)

The main differences between extrinsic and intrinsic storytelling is briefly summarized in Table 4. In extrinsic storytelling, the story is highly motivated by a specific topic and the story is communicated through different medias such as illustrations, graphic, imagery and video instead of or in addition to oral, written or audio formats. The map component is here only a part of the communicated story, with potentially just one scene in the entire story. Contrarily in intrinsic storytelling, the story is an integral part of the map and the story is further

built upon a map. The map component is the focus of the communicated story and the narrative structure becomes visible on the map. Other media formats such as graphics, text, video or audio might be included to support this intrinsic approach.

One more important term needs to be mentioned: the narrative structure. The narrative structure is often described as a sequence or ordering of scenes. In film, journalism and literature it is typically defined by the temporal order of events (Phillips, 2012). Particularly, narrative structure describes a framework that defines the order and manner in which the narrative is presented to the user.

NARRATIVE STRUCTURE	*Order and manner in which the narrative is presented to the user*

Table 5: Definition of narrative structure

The narrative structure or the ordered sequence of steps is a key feature of storytelling. Stories always have a beginning, middle, and end: an introduction to the situation, a series of events often involving tension or conflict, and a resolution. Traditionally, narrative structure roughly corresponds with time and is based on a linear three-act structure (see). According to (Roth, 2020), the three acts of a traditional linear three-act structure are defined in Table 6.

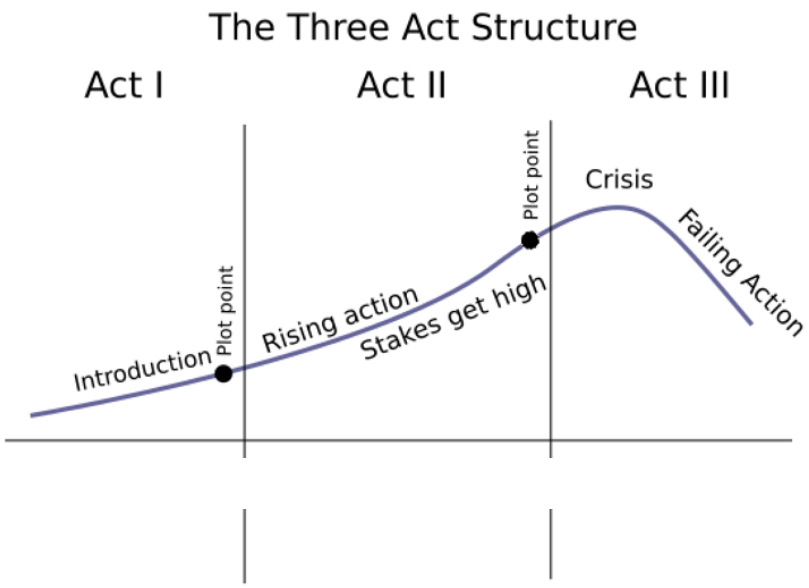


Figure 5: Traditional three-act structure (https://www.arcstudiopro.com/blog/three-act-structure-in-screenwriting/)

ACT I	*Introducing the setting, characters and problem context*
ACT II	*Progression into conflict, introducing problem, building tension and incrementally advancing the narrative*
ACT III	*Presenting concluding resolutions to the problem*

Table 6: Description of acts in a typical linear three-act structure (Roth, 2020)

Not all visual stories follow or implement all elements of the three-act narrative, as for many visual storytelling contexts, the three-act narrative is either to too idealized or an overly-formulaic structure. Furthermore, there are many more narrative sequences not mentioned here, such as alternative non-linear, parallel or interactive (see Table 7).

NON-LINEAR	*A nonlinear structure tells the story out of chronological order, jumping disjointedly through the timeline.*
PARALLEL	*In parallel structure, the story follows multiple storylines, which are tied together through an event, character, or theme.*
INTERACTIVE	*The reader makes choices throughout the interactive narrative, leading to new options and alternate endings.*

Table 7: Some examples of other narrative structures

Besides the narrative structure, good stories have plotlines that develop over time in a tension curve, based on cause, intervention and effect. According (Thöny, et al., 2018), this tension is achieved by stepping through different phases of Freytag's triangle. Also often referenced as Freytag's pyramid (see Figure 6), novelist Gustav Freytag developed this narrative pyramid in the 19th century as a description of narrative structure. It describes five key stages in successful storytelling and its method maps the progression of conflict from inception to resolution. In particular, tension is reached by stepping through the phases of exposition, inciting incident and rising action to a climax. Afterwards, the action falls and the resolution takes place with the plotline endling up in a relaxing phase.

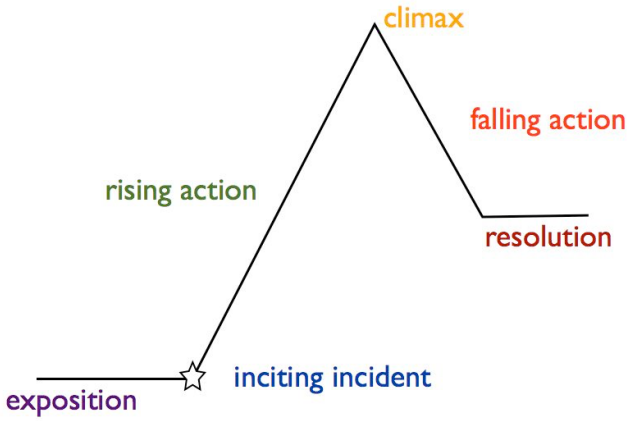


Figure 6: Freytag's triangle (https://writers.com/freytags-pyramd)

(Thöny, et al., 2018) further point out some key aspects for a good and interesting story. Crucial is thereby the starting incident since it serves as an attractor. Without a trigger event to look at the story, it remains unnoticed. Furthermore, the evolvement of the story is important as well. If events are presented in the same order as the user expects, the user's emotional engagement will be low. Particularly, when events in the story are presented in a different order than expected, a higher emotional response by the user can be created. Three kinds of tension are here presented: suspense, surprise and curiosity.

Suspense is created when a cause is presented, but the effect is shown delayed (Tan, 1996). On the other hand, surprise arises when an effect is shown that later turns out to be unexpected or even incorrect. In conclusion, curiosity is evoked when an effect is presented without information about the cause.

3.2. CHALLENGES

The implementation of storytelling in cartography offers many challenges and limitations. This subsection provides an overview and brief summary of the most essential findings of the literature analysis and are listed below:

CHALLENGE 1: GUIDANCE FOR READER

This challenge can be considered as the biggest issue. As maps and other visualizations using a spatial reference are inherently two-dimensional, they often lack a temporal sequence or relevant linear axis to inform a plotline (Roth, 2020). Without these elements it is difficult for the viewer to detect a plotline or to follow a story. Therefore, the big challenge for the cartographer is how to provide some guidance for the viewer through the content and the story. In other words, how to arrange the path viewers take through the map.

CHALLENGE 2: BALANCE BETWEEN AUTHOR-DRIVEN AND READER-DRIVEN ELEMENTS

(Segel & Heer, 2010) propose a concept, where visual stories can be placed along a spectrum of *Author-Driven* and *Reader-Driven Approaches* (see Table 8).

AUTHOR-DRIVEN	***READER-DRIVEN***
• *Linear ordering of scenes* • *Heavy messaging* • *No interactivity*	• *No prescribed ordering of scenes* • *No messaging* • *Free interactivity*

Table 8: Differences between Author-Driven and Reader-Driven Approach (Segel & Heer, 2010)

Choosing a purely Author-Driven Approach, the visual story has a linear ordering of scenes, relies on heavy messaging and includes no interactivity. On the contrary, a purely Reader-Driven-Approach has no prescribed ordering of scenes, no messaging and a high degree of interactivity. A major challenge for visual stories is therefore to find the right balance or the flexibility in balancing elements from both approaches. Is the goal of the visual story to deliver a clear message (Author-Driven) or to let the user have a high degree of interactivity (Reader-Driven)? A more detailed look into the concept of Author- and Reader-Driven Approach is given in chapter 3.4.

CHALLENGE 3: EXPRESSION/DELIVERY OF EMOTIONS

Traditional cartographic maps in their conventional form have rather a dehumanizing character (Caquard & Cartwright, 2014). The expression or the delivery of emotions with such media is therefore another challenge. It might be interesting to check how storytelling can be used to overcome this issue. Storytelling, together with the mobilization of other media, can offer greater opportunities to transmit these emotions that cannot be done with traditional cartography.

CHALLENGE 4: HANDLING DIFFERENT SCALES

Handling different scales in cartography is another essential concern. As stories often navigate from the very local (e.g. a neighborhood, house) to the very global (e.g. journeys across countries), this is a major issue in cartography (Caquard & Cartwright, 2014). How is it possible to display in an map multiple scales of different spatial settings embedded in a story? Figure 7 shows an Example from the Gallery of Washington State Department of Natural Resources. Multiple map scales are here handled by displaying different map extents when scrolling through this visual story.

Figure 7: An example of storytelling from the Gallery of Washington State Department of Natural Resources (https://wadnr.maps.arcgis.com/apps/Cascade/index.html?appid=84ea4016ce124bd9a546c5cbc58f9e29)

CHALLENGE 5: REDUCE AND PRIORITIZE INFORMATION

Visual stories often prioritize only on essential information needed to follow the narration of the story. They often emphasize a small set of key characters, places and events and reduce all other information in order to focus only on the essential information and to avoid a visual and narrative overflow of information. The main challenge here is to find and focus only on the essential information needed to follow the story without compromising the narration or main message.

CHALLENGE 6: TECHNICAL INCORPORATION OF GRAPHICAL ELEMENTS AND INTERACTION METHODS

Another challenge is finding the right graphical elements and interaction methods. Which graphical elements and interaction methods should the map designer choose to implement storytelling in cartography? Are there graphical elements or interaction methods which are more adequate than others from both the view of a map designer or map user? Does a right balance exist between them to unfold the full potential of the storytelling implementation in cartography?

3.3. POTENTIAL

Besides the mentioned challenges and limitations in section 3.2, the implementation of storytelling in cartography offers many exciting possibilities and chances. An overview of possible potentials can be seen in the following.

DESIGN

In terms of design, the cartographer can make intentional decisions about the composition of the map. Furthermore, in addition to the wide range of cartographic design decisions for traditional maps, the cartographer can also typically enforce an order and pacing to the reading of the accompanying visual elements, choosing creatively this sequence to advance the narrative (Ormeling, 1995).

PRIORITIZATION

With storytelling, it is possible to prioritize only on the most essential information needed to properly follow the narrative of the story. Moreover, visual stories privilege brevity over completeness, with story maps often containing cropped geographic extents, interior holes or inconsistent cartographic scales (Pearce, 2009).

INTERACTION

Storytelling can offer new and exciting ways for intuitive interaction and can make a map more interesting for the user. Users are able to interact with the visualized data to get more insight. Especially when using interactivity, the immersion into the story and the visualized data is facilitated (Thöny, et al., 2018).

APPEAL

Storytelling is also considered a more meaningful or appealing way to communicate a message. Visual stories often capture our attention with integration of vivid graphics, images or other multimedia. When combining all the media with maps, visual stories can develop a richer sense of place than vector linework alone (Roth, 2020).

RELATION

Stories promote empathy and can make maps more relatable. The audience puts themselves into the story setting, assuming the roles of the characters and drawing from personal experience to add context (Gershon & Page, 2001). In this way, it can humanize maps and evoke emotions from the audience. (Roth, 2020) even proposed that visual stories should perhaps be judged less on how efficiently or effectively they are read or understood, but instead how they make the audience feel about and connect to other people and places.

SIMPLIFICATION

Storytelling can help simplify and illustrate complex circumstances. Moreover as visual stories are partial abstractions and often simplifications of the reality, it generally makes them easier to understand due to reduces information complexity (Roth, 2020). For example in a geological map, it can help explain complex and hidden relationships of geospatial data. Figure 8 tries to display the rather complex geological relationship of kelp forests in Washington state in a simpler and more appealing way.

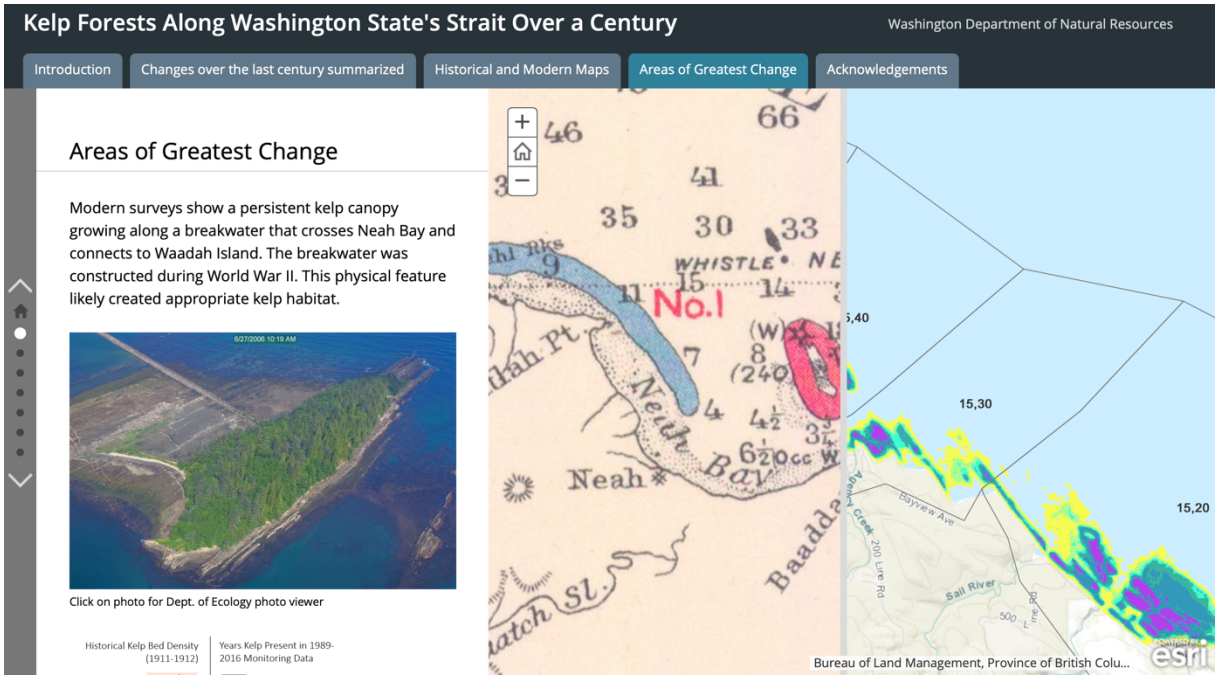


Figure 8: Another example from the Gallery of Washington State Department of Natural Resources (https://wadnr.maps.arcgis.com/apps/MapSeries/index.html?appid=6b32b37740a443cb8e8848a8614879a2)

MEMORABILITY

Visual stories – through their intuitive, appealing and relatable design - can consolidate information in a logical or exciting way in order to make them more memorable (Roth, 2020). Moreover, users can memorize stories much better than hard numbers or facts.

PERSUASION

As maps with storytelling elements not only "explain" but "argue" from their situated position (Harley, 1989), maps with storytelling can also be more persuasive in delivering information or a key message.

CURIOSITY

Curiosity is evoked when an effect is presented without any information about the cause (Tan, 1996). Through storytelling, users can be motivated and encouraged to explore the geographic space and the thematic data by curiosity. For example with an interesting and captivating story, the user's attention can be kept after story completion in order to let him curiously discover more hidden insights and facts about the told story.

3.4. OVERVIEW OF EXISTING CONCEPTS

The following chapter gives an overview over encountered concepts in the literature analysis. In total four concepts are presented which show how to divide or group different types of storytelling implementations in visual stories nowadays.

CONCEPT 1: STORYTELLING SCENARIOS

(Kosara & Mackinlay, 2013) define storytelling scenarios with different settings and with many different audiences. Each of these scenarios has different requirements for the techniques used, the way the presentation is structured and the amount of interaction anticipated (see Table 9).

1 SELF-RUNNING PRESENTATION TO A LARGE AUDIENCE	• *Entirely self-running* • *Large audience* • *No interaction*
2 LIVE PRESENTATION BY A SPEAKER IN FRONT OF AN AUDIENCE	• *Presented by presenter* • *Large audience* • *Some interaction*
3 INDIVIDUAL (OR SMALL-GROUP) PRESENTATION OF RESULTS	• *Presented by presenter* • *Small audience* • *A lot of interaction*

Table 9: Storytelling scenarios according (Kosara & Mackinlay, 2013)

The first storytelling scenario is typical for news media presentations. The presentation is thereby created once and then viewed by a large audience independently and without the ability to interaction with the author or ask questions. These stories are often entirely self-running (like a movie) or require the user to click through (like a slide show).

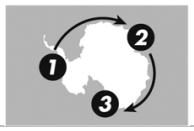
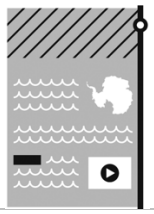
The second storytelling scenario is similar to the way many business presentations are given nowadays. The story is presented by a presenter in front of a large audience. The presentation is based on a live visualization which allows the presenter to pause the story anytime and interact to questions from the audience.

The third storytelling scenario might not seem different from the second one. However, here it involves much more interaction between the presenter and the audience since the audience comprise only a small group or even an individual. Furthermore, this requires the

presentation tool to be more flexible than just a simple slide show, as excursive discussions might happen. For example, in a discussion of quarterly results, questions about specific sales or marketing measures might come up that were not part of the story, but are of interest to people in the audience.

CONCEPT 2: VISUAL STORYTELLING GENRES

Three ways to organize the design space for map-based visual storytelling are presented by (Roth, 2020). One of them being visual storytelling genres, which is a revision based on a concept introduced by (Segel & Heer, 2010) where the genres are defined only by the visual or interactive techniques used to enforce a linearity in the narrative structure. Table 10 gives an overview of all visual storytelling genres and summarize their linear enforcing technique.

STATIC VISUAL STORIES 	*Linearity is enforced through partitioning of the layout into frames and clarifying reading with annotation*
LONGFORM INFOGRAPHICS 	*Linearity is enforced through vertical reading and browser scrolling*
DYNAMIC SLIDESHOWS 	*Linearity is enforced by advancement through a series of slides, which may include horizontal swiping or 'next' and 'back' buttons*
NARRATED ANIMATIONS 	*Linearity is enforced by the progression of digital display time, with the animation starting either on page load or through a play control*
MULTIMEDIA VISUAL EXPERIENCES 	*Linearity is enforced by anchor tags and hyperlinking, with content often activated dynamically while scrolling*

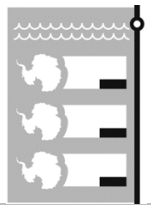
PERSONALIZED STORY MAPS 	*Linearity is enforced by the order that an individual contributes content to the map, with the story often presented from older to newer updates*
COMPILATIONS 	*Linearity is enforced unfolding events in near real-time or major updates to the design, with maps often organized in a stack from newer to older with links to the full story*

Table 10: Overview over the visual storytelling genres (Roth, 2020)

CONCEPT 3: GENRES OF NARRATIVE VISUALIZATIONS

VISUAL NARRATIVE TACTICS	***VISUAL STRUCTURING***	*Mechanisms that communicate overall structure of narrative to the viewer*	*Establishing Shot / Splash Screen*
			Consistent Visual Platform
			Progress Bar / Timeline Slider
			"Checklist" Progress Tracker
	HIGHLIGHTING	*Visual mechanisms that help direct the viewer's attention to a particular element in the display*	*Close-Ups*
			Feature Distinction
			Character Direction
			Motion
			Audio
			Zooming
	TRANSITION GUIDANCE	*Techniques for moving within or between visual scenes without disorienting the viewer*	*Familiar Objects (but still cuts)*
			Viewing Angle
			Viewer (Camera) Motion
			Continuity Editing
			Object Continuity
			Animated Transitions
NARRATIVE STRUCTURE TACTICS	***ORDERING***	*Ways of arranging the path viewers take through the visualization*	*Random Access*
			User Directed Path
			Linear
	INTERACTIVITY	*Mechanisms that manipulate the visualization*	*Hover Highlighting / Details*
			Filtering / Selection / Search
			Navigation Buttons
			Very Limited Interactivity
			Explicit Instruction
			Tacit Tutorial
			Stimulating Default Views
	MESSAGING	*Ways a visualization communicates observations and commentary to the viewer*	*Captions / Headlines*
			Annotations
			Accompanying Article
			Multi-Messaging
			Comment Repetition
			Introductory Text
			Summary / Synthesis

Table 11: The two divisions visual narrative tactics and narrative structure tactics (Segel & Heer, 2010)

Drawing on case studies from news media, (Segel & Heer, 2010) outline an organization of design space with the following three divisions:

- **SEVEN BASIC GENRES** where all the examined examples can be assigned to (see Figure 9)
- **VISUAL NARRATIVE TACTICS**
- **NARRATIVE STRUCTURE TACTICS**

Visual narrative tactics (see Table 11) describe visual mechanisms that assist and facilitate the narrative. It is furthermore subdivided into three sections: *visual structuring*, *highlighting* and *transition guidance*.

Visual structuring specify mechanisms that communicate the overall structure of the narrative. Particularly, theses mechanisms allow the user to identify his position within the visualization, help orient him early on (e.g. with an establishing shot or a consistent visual platform) and moreover track his progress through the narrative (e.g. with progress bar or timeline slider). *Highlighting* consists of visual mechanisms that help direct the user's attention to a particular element in the visualization. This can be done through the use of close-ups, motion, color or zooming. *Transition guidance* involve techniques for moving within or between visual scenes without disorienting the viewer (e.g. camera motion and animated transitions).

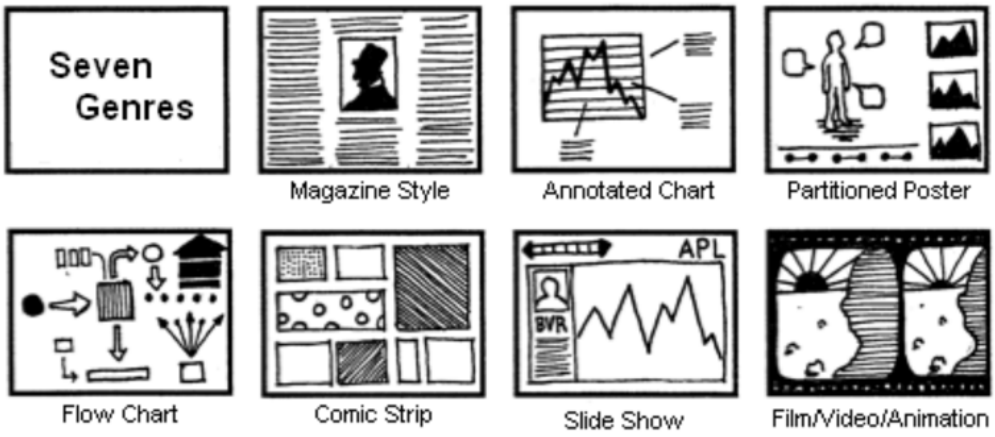


Figure 9: The first division with the seven basic genres of narrative visualizations (Segel & Heer, 2010)

Narrative structure tactics (see Table 11) specify all non-visual mechanisms that assist and facilitate the narrative. This division is further subdivided into: *ordering*, *interactivity* and *messaging*. *Ordering* describes ways of arranging the path a user takes through the visualization. This path can be prescribed strictly by the author (linear), sometimes there is no path prescribed at all (random access) or sometimes the user must select a path among multiple alternatives (user-directed). *Interactivity* refers to mechanisms that manipulate the visualization (e.g. through filtering, selecting or navigation). *Messaging* consists of ways how a visualization communicates observations and commentary to the user. This can be achieved through short text fields (e.g. labels or captions) or through more substantial descriptions (e.g. introductory text or summaries).

CONCEPT 4: AUTHOR-DRIVEN VERSUS READER-DRIVEN

As already briefly mentioned in chapter 3.2, (Segel & Heer, 2010) place their examined examples from news media within the spectrum of *Author-Driven* or *Reader-Driven Approaches*.

A purely *Author-Driven Approach* has a strict linear path through the visualization, relies heavily on messaging, and includes no interactivity. When the main goal is storytelling or efficient communication, this *Author-Driven Approach* works best. For this reason, this approach is mainly used in films, commercials or educational videos. On the other hand, a purely *Reader-Driven Approach* has no prescribed ordering of images, no messaging, and a high degree of interactivity. In particular, reader-driven approaches support tasks such as data diagnostics or pattern discovery. Table 8 shows summarily the main differences between these two approaches.

However, throughout their case studies from news media (Segel & Heer, 2010) found out that most narrative visualizations fall somewhere in-between the two approaches, using mostly a mix of *Author-Driven* and *Reader-Driven Approaches*. Deriving from their analysis, they point out the three most common hybrid models. An overview over these three hybrid models can be seen below in Table 12.

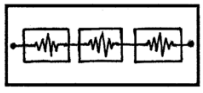
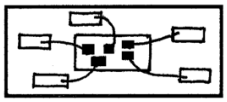
MARTINI GLASS STRUCTURE 	• *Begins with Author-Driven Approach, using questions, observations or written articles to introduce to the visualization.* • *Once the author's intended narrative is completed, the visualization opens up to a reader-driven stage, where the user is free to interactively explore the data.* • *The structure resembles a martini glass, with the stem representing the single-path Author-Driven narrative and the widening mouth of the glass representing the available paths made possible through Reader-Driven interactivity and exploration.*
INTERACTIVE SLIDE SHOW 	• *Follows a typical slideshow format, but incorporates interaction within the slides.* • *Allows user to further explore particular points of the data before moving ahead to the next stage of the story.* • *Offers a more balanced mix of Author-Driven and Reader-Driven Approaches.* • *Works well with complex datasets and complex narratives.*
DRILL-DOWN STORY 	• *Presents a general theme and then allows the user to choose among particular instances of that theme to reveal additional details and backstories.* • *For instance, the theme might be "North Korean Prison Camps", where the map allows the user to learn more about individual camps by clicking on a specific location on the map.* • *More emphasis on reader-driven approach, as user can dictate what stories are told and when.*

Table 12: Three common hybrid models using a mix of Author-Driven and Reader-Driven Approaches (Segel & Heer, 2010)

In conclusion, after a general overview of all encountered concepts in the literature analysis has been presented, the decision is to stick to concept 3 and 4 from (Segel & Heer, 2010). Concept 1 from (Kosara & Mackinlay, 2013) defines typical storytelling scenarios which outline the basic setting and surroundings where storytelling can take place. However, these storytelling scenarios cannot entirely form a basis for the development of the *Storytelling Toolbox*. As concept 2 from (Roth, 2020) is a revision of an already existing concept, the derived storytelling genres might not form an ideal basis for the development of further techniques.

Although having been mainly drawn on case studies from news media, both concepts from (Segel & Heer, 2010) present underlying techniques which form a good fundamental basis for storytelling techniques in cartographic environments. Furthermore, the techniques of concept 3 are presented and assigned to a framework with different divisions which helps a lot to keep the overview over the entire topic. Specifically, this basis provides an open and wide range of techniques at present which can be complemented effectively in this thesis or even in follow-up projects in the future.

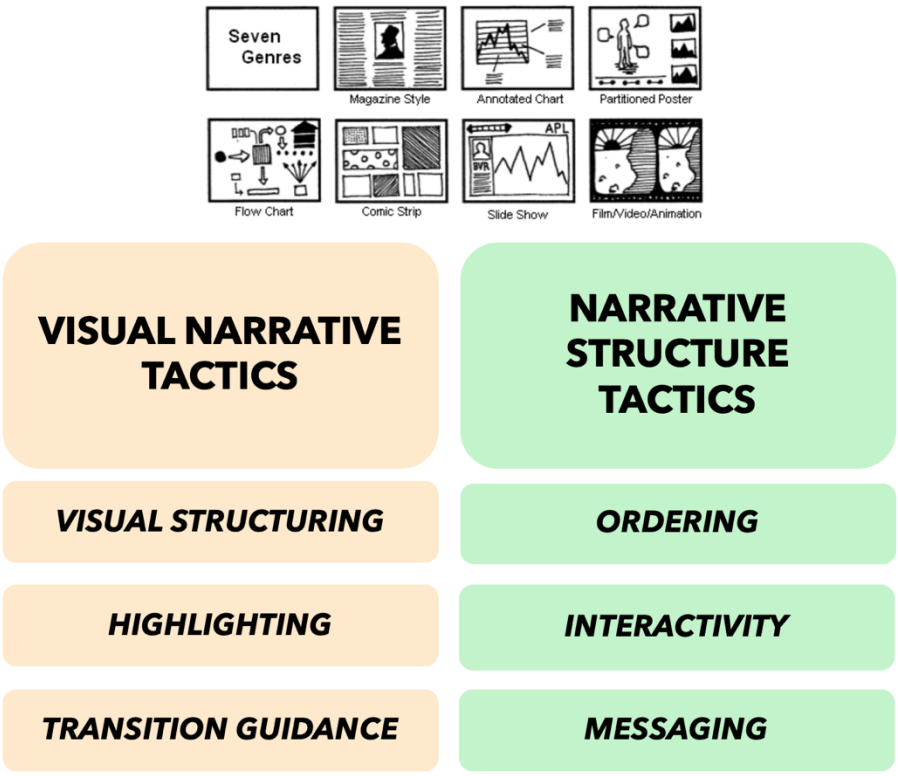


Figure 10: The three divisions according (Segel & Heer, 2010)

4. STORYTELLING TOOLBOX

As a result of the literature analysis, the *Storytelling Toolbox* is developed using concept 3 from (Segel & Heer, 2010) as a basis. However, accounting that the entire concept relies heavily on case studies from news media, some changes are being applied to the three main divisions.

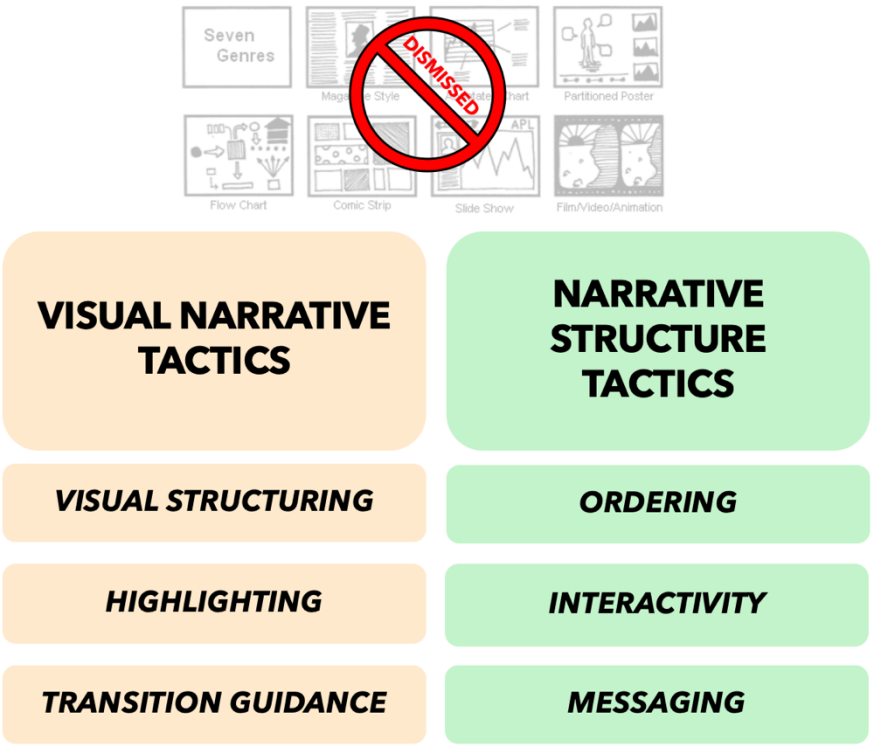


Figure 11: The two divisions of (Segel & Heer, 2010) form the basis for the Storytelling Toolbox

On the one hand, since being excessively influenced by articles from news media, the first division with the seven basic genres of narrative visualizations is dismissed. This leads to a more simplified version where the focus relies more on the other two divisions: Visual narrative tactics and narrative structure tactics (see Figure 11). As described in section 3.4, while visual narrative tactics describe visual mechanisms, narrative structure tactics specify all non-visual mechanisms that assist and facilitate the narrative. Going through all the subdivisions, the existing techniques are examined, simplified and adapted to particularly fit the specific use in the cartographic environment. Additionally, a few techniques encountered in literature are added to enrichen the individual subdivisions. All the subdivisions including a brief description of their techniques can be seen in the following passage.

VISUAL STRUCTURING

ESTABLISHING SHOT	*Sets up context for the scenes ahead. Informs audience where the story will take place.*
CONSISTENT VISUAL PLATFORM	*Maintenance of a general layout with consistent visual elements.*
CHECKLIST STRUCTURE	*Provides overview of content and serves as reminder what each section contains.*
PROGRESS BAR	*Indicating length of the narrative and providing a mechanism to navigate between segments of the content.*
TIMELINE BAR	*Indicating temporal range of narrative and chronological sequence of the content.*

HIGHLIGHTING

COLOR	*Visually separate objects of interest from their context using a different color.*
MOTION	*Using motion to highlight objects of interest.*
CLOSE-UP / FRAMING	*A type of shot that tightly frames an object of interest.*
SIZE	*Visually separate objects of interest from their context using a different (mostly larger) size.*
AUDIO	*Using audio to highlight objects of interest.*
STYLE REDUCTION	*Eliminating all but, but most-basic representational form of non-highlighted objects.*
HOVERING	*Highlighting through moving a pointer over a trigger area, usually done with a mouse.*
TRANSPARENCY	*Dissolve context around object of interest.*
CONTOURING	*Uses multiple outlines around object of interest to create an effect that highlighted object is "higher" than non-highlighted object.*
DEPTH OF FIELD	*Creates areas of contrasting sharpness to visually separate object of interest from context.*

TRANSITION GUIDANCE

CONTINUITY EDITING (FILM)	*Combining shots or different scenes into a sequence enabling the viewer to perceive a causal cohesion across the sequence.*
ANIMATED TRANSITIONS	*Gives appearance of motion or change within or between different scenes.*
OBJECT CONTINUITY	*Consistency of objects within or across different scenes.*
CAMERA MOTION	*Alters relationship between the camera frame and the objects in the frame enabling to shape the viewer's perspective of space and time in the visualization.*

ORDERING

LINEAR	*Path is strictly prescribed by author.*
USER-DIRECTED	*Viewer must select a path among multiple alternatives.*
RANDOM ACCESS	*There is no path suggested at all.*

INTERACTIVITY

FILTERING	*Remove unwanted information or objects in visualization.*
SELECTING	*Choose wanted information or objects of interest in visualization.*
SEARCHING	*Looking for wanted information or objects of interest in visualization (e.g. in a search field).*
NAVIGATING	*Using navigation buttons or direct touch inputs to change extent of visualization (or map).*

MESSAGING

LABELS	*Short text field attached to an object giving information about it.*
CAPTIONS	*Short piece of text that describes or explains a visualization.*
HEADLINES	*A title or short text at the top of the visualization.*
ANNOTATIONS	*Short explanation or note added to a text or an image.*
INTRODUCTORY TEXT	*Text in the beginning which sets up the context or purpose of the visualization.*
ARTICLE	*More substantial text in addition or alongside the visualization.*
SUMMARY	*Text in the end which sums up the context or purpose of the visualization.*
VIDEO	*Video within or alongside the visualization. Might also be used as an introduction or as a summary in the end of the visualization.*
AUDIO	*Used to deliver observations and commentary within the visualization.*
DETAILS ON DEMAND	*Displaying additional information on user demand (e.g. hovering)*

Besides drawing on the framework for the structure of the *Storytelling Toolbox*, the different techniques are classified in respect of concept 4 from (Segel & Heer, 2010). The classification is carried out on the basis of the experience working with the techniques in implementing the prototypes (see section 5). The techniques from the *Storytelling Toolbox* are thereby assigned as good as possible to the *Author-Driven* or *Reader-Driven Approach* according the classification in Table 13. Techniques which work best to tell an *Author-Driven* story, are therefore classified to class "pA". On the other hand, techniques which support a *Reader-Driven* story are classified to class "pR". As often techniques cannot be assigned completely to either one of the approaches, most of them are classified somewhere in the middle with class "AR" representing techniques which are suitable for both approaches.

AUTHOR-DRIVEN APPROACH vs ***READER-DRIVEN APPROACH***	***pA***	*Best for purely Author-Driven Approach*
	rA	*Rather Author-Driven Approach*
	AR	*Suitable for both Approaches*
	rR	*Rather Reader-Driven Approach*
	pR	*Best for purely Reader-Driven Approach*

Table 13: Classification for Storytelling Toolbox according fit for telling an Author-Driven or Reader-Driven story

In particular, this classification should provide an overview which techniques can be used to implement a more *Author-Driven* or a more *Reader-Driven Approach* of storytelling in a cartographic environment. The entire *Storytelling Toolbox* is displayed in the following pages.

DIVISION		SUBDIVISION		TECHNIQUES		*AUTHOR-DRIVEN* versus *READER-DRIVEN*				
VISUAL NARRATIVE TACTICS	*Visual mechanisms that assist and facilitate the narrative.*	**VISUAL STRUCTURING**	*Mechanisms that communicate overall structure of narrative to the viewer.*	***ESTABLISHING SHOT***	*Sets up context for the scenes ahead. Informs audience where the story will take place.*			X		
				CONSISTENT VISUAL PLATFORM	*Maintenance of a general layout with consistent visual elements.*			X		
				CHECKLIST STRUCTURE	*Provides overview of content and serves as reminder what each section contains.*		X			
				PROGRESS BAR	*Indicating length of the narrative and providing a mechanism to navigate between segments of the content.*	X				
				TIMELINE BAR	*Indicating temporal range of narrative and chronological sequence of the content.*	X				
		HIGHLIGHTING	*Visual mechanisms that help direct the viewer's attention to a particular element in the display.*	***COLOR***	*Visually separate objects of interest from their context using a different color.*			X		
				MOTION	*Using motion to highlight objects of interest.*			X		
				CLOSE-UP / FRAMING	*A type of shot that tightly frames an object of interest.*			X		
				SIZE	*Visually separate objects of interest from their context using a different (mostly larger) size.*			X		
				AUDIO	*Using audio to highlight objects of interest.*		X			
				STYLE REDUCTION	*Eliminating all but, but most-basic representational form of non-highlighted objects.*			X		
				HOVERING	*Highlighting through moving a pointer over a trigger area, usually done with a mouse.*			X		
				TRANSPARENCY	*Dissolve context around object of interest.*			X		
				CONTOURING	*Uses multiple outlines around object of interest to create an effect that highlighted object is "higher" than non-highlighted object.*			X		
				DEPTH OF FIELD	*Creates areas of contrasting sharpness to visually separate object of interest from context.*		X			
		TRANSITION GUIDANCE	*Techniques for moving within or between visual scenes without disorienting the viewer.*	***CONTINUITY EDITING (FILM)***	*Combining shots or different scenes into a sequence enabling the viewer to perceive a causal cohesion across the sequence.*	X				
				ANIMATED TRANSITIONS	*Gives appearance of motion or change within or between different scenes.*	X				
				OBJECT CONTINUITY	*Consistency of objects within or across different scenes.*			X		
				CAMERA MOTION	*Alters relationship between the camera frame and the objects in the frame enabling to shape the viewer's perspective of space and time in the visualization.*		X			

Table 14: The first division Visual Narrative Tactics with its subdivisions and techniques

DIVISION		SUBDIVISION		TECHNIQUES		*AUTHOR-DRIVEN* versus *READER-DRIVEN*				
NARRATIVE STRUCTURE TACTICS	*Non-visual mechanisms that assist and facilitate the narrative.*	**ORDERING**	*Ways of arranging the path viewers take through the visualization.*	***LINEAR***	*Path is strictly prescribed by author.*	X				
				USER-DIRECTED	*Viewer must select a path among multiple alternatives.*			X		
				RANDOM ACCESS	*There is no path suggested at all.*					X
		INTERACTIVITY	*Mechanisms that manipulate the visualization.*	***FILTERING***	*Remove unwanted information or objects in visualization.*					X
				SELECTING	*Choose wanted information or objects of interest in visualization.*					X
				SEARCHING	*Looking for wanted information or objects of interest in visualization (e.g. in a search field).*					X
				NAVIGATING	*Using navigation buttons or direct touch inputs to change extent of visualization (or map).*				X	
		MESSAGING	*Ways a visualization communicates observations and commentary to the viewer.*	***LABELS***	*Short text field attached to an object giving information about it.*			X		
				CAPTIONS	*Short piece of text that describes or explains a visualization.*			X		
				HEADLINES	*A title or short text at the top of the visualization.*			X		
				ANNOTATIONS	*Short explanation or note added to a text or an image.*			X		
				INTRODUCTORY TEXT	*Text in the beginning which sets up the context or purpose of the visualization.*	X				
				ARTICLE	*More substantial text in addition or alongside the visualization.*	X				
				SUMMARY	*Text in the end which sums up the context or purpose of the visualization.*	X				
				VIDEO	*Video within or alongside the visualization. Might also be used as an introduction or as a summary in the end of the visualization.*		X			
				AUDIO	*Used to deliver observations and commentary within the visualization.*		X			
				DETAILS ON DEMAND	*Displaying additional information on user demand (e.g. hovering or clicking)*				X	

Table 15: The second division Narrative Structure Tactics with its subdivisions and techniques

5. IMPLEMENTATION

The second part of the thesis comprises *Use Cases* of storytelling in a cartographic environment. As the purpose of the *Use Cases* is to use a wide range of techniques from the previously elaborated *Storytelling Toolbox*, different types of maps are defined. Therefore, each of the *Use Cases* are covering either temporal, spatial or thematic aspects of map content (see Table 16).

Furthermore, considering concept 4 from (Segel & Heer, 2010), the goal is to implement storytelling using either of the two presented approaches there. In particular, two versions are implemented for each *Use Case*: one with a more *Author-Driven* and another one with a more *Reader-Driven Approach* of storytelling. In conclusion, three *Use Cases* à two versions are implemented. So in total, we have six prototypes of storytelling implementations.

USE CASE	TYPE	GERMAN TITLE	ENGLISH TITLE	TECHNICAL ENVIRONMENT
1	*Temporal*	*«Eintritte in den Bund»*	*Entry into Swiss Confederation*	*Web map application (Leaflet)*
2	*Spatial*	*«Schlachten Napoleon's»*	*Napoleon's Battles*	*Web map application (Leaflet)*
3	*Thematic*	*«Zeitreise: Luftfahrt»*	*Journey through time: Aviation*	*Storyboard*

Table 16: The three Use Cases of storytelling implementation

The first two *Use Cases* are implemented as a web map application using the open-source *JavaScript* library *Leaflet*. The third *Use Case* is implemented as a simple storyboard using *Microsoft PowerPoint*. All the prototypes, their source codes and data can be found in the submission dataset of this thesis.

In the following subsections, the focus relies on the decision and applied techniques of the elaborated *Storytelling Toolbox* in order to realize the storytelling implementation in the prototypes.

5.1. TEMPORAL USE CASE 1: *«EINTRITTE IN DEN BUND»*

The first *Use Case* shows the accession of the cantons to the Swiss Confederation at specific time steps. In particular, it displays the temporal change before the year 1291 until 1979. The purpose of this web map application is to see when and which Swiss canton has joined the Swiss Federation and what the reasons were behind accession.

5.1.1. PROTOTYPE 1-1: AUTHOR-DRIVEN APPROACH

The web map application starts with an ESTABLISHING SHOT, where the user gets an overview of the situation before the year 1291 (see Figure 12). The *INTRODUCTORY TEXT* on the right side supports this first scene. As the user steps through the different time steps, the application maintains a *CONSISTENT VISUAL PLATFORM,* with the map showing the extent of the Swiss Federation in the center, a *TIMELINE BAR* at the bottom and text in form of *HEADLINES* and an *ARTICLE* in the panel on the right. The *Author-Driven Approach* is enforced through the *TIMELINE BAR* where the user can step through the story in a *LINEAR* order. In particular, at each time step it is visible which Swiss canton joins the Swiss Confederation.

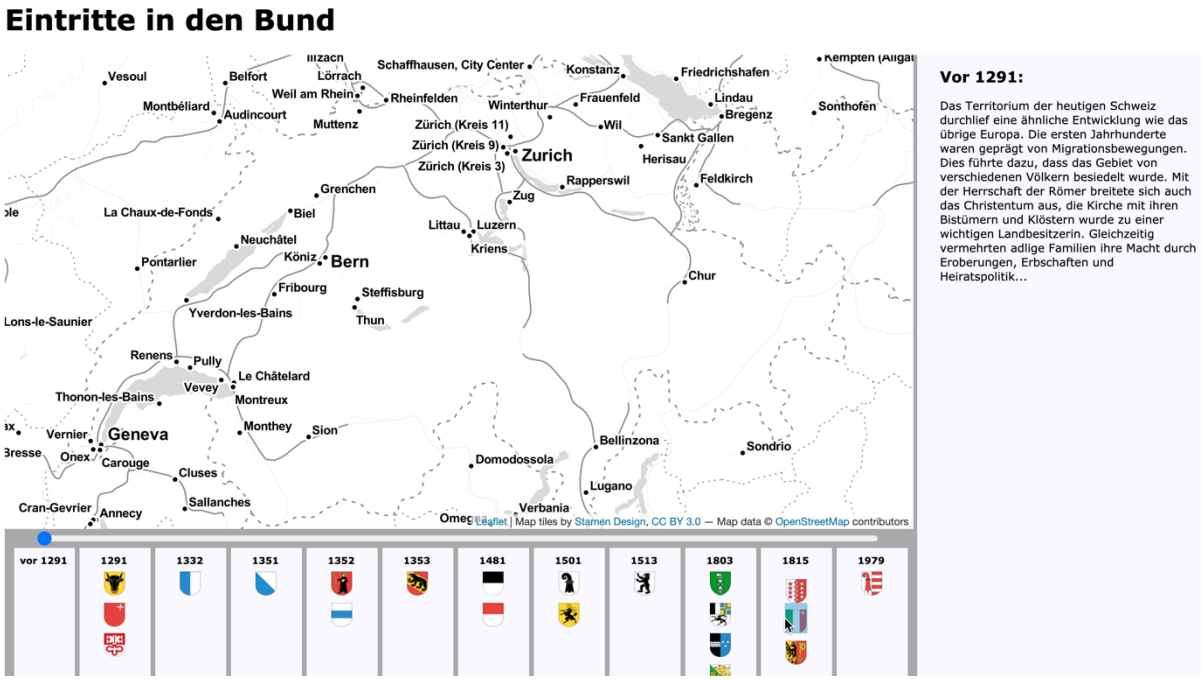


Figure 12: The establishing shot sets up the context for the scenes ahead.

The joining Swiss cantons are highlighted in the map using *COLOR, TRANSPARENCY* and *CONTOURING* (see Figure 13*)*. While joining cantons at the current time step are displayed

in red color, previously joined cantons are in grey color. Moreover, this effect accomplishes to display the current extent of the Swiss Confederation at any given time. *CAMERA MOTION* and *ANIMATED TRANSITIONS* are deployed when the user clicks on a canton's emblem which takes him directly to the canton of interest (e.g. clicking on Bern in Figure 13). Besides that, it is also possible to explore the map *NAVIGATING*.

VISUAL NARRATIVE TACTICS		
VISUAL STRUCTURING	***HIGHLIGHTING***	***TRANSITION GUIDANCE***
ESTABLISHING SHOT	*COLOR*	*ANIMATED TRANSITIONS*
CONSISTENT VISUAL PLATFORM	*TRANSPARENCY*	*CAMERA MOTION*
TIMELINE BAR	*CONTOURING*	

NARRATIVE STRUCTURE TACTICS		
ORDERING	***INTERACTIVITY***	***MESSAGING***
LINEAR	*NAVIGATING*	*INTRODUCTORY TEXT*
		HEADLINES
		ARTICLE
		LABELS

Table 17: Applied techniques for the Author-Driven Approach of Use Case 1.

Messaging is achieved mainly through the *INTRODUCTORY TEXT* in the beginning, *HEADLINES* and *ARTICLE* like text during the story. Particularly, at each time step in the panel on the right the text is adapting to give background information about the current situation and providing reasons why a canton has joined the Swiss Confederation. Additionally, *LABELS* are used in the map to identify the cantons.

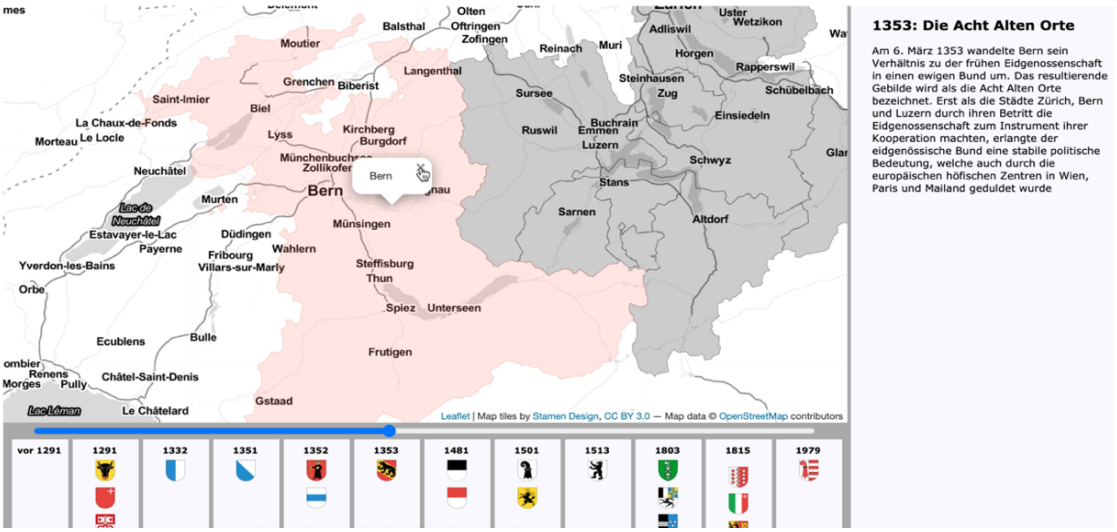


Figure 13: With the help of coloring, newly joined cantons can be highlighted.

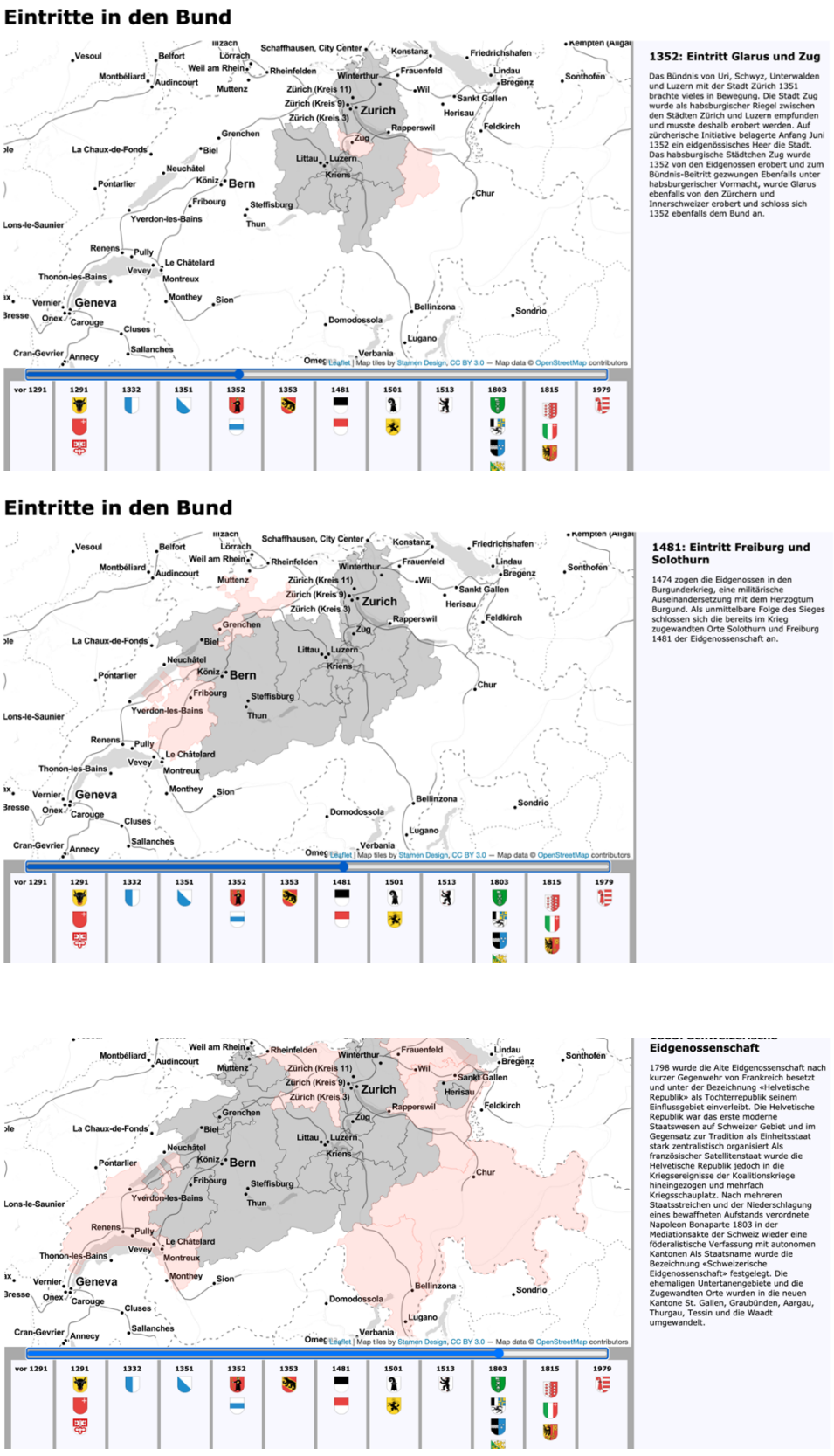


Figure 14: Different time steps showing a different extent of the Swiss Federation

5.1.2. PROTOTYPE 1-2: READER-DRIVEN APPROACH

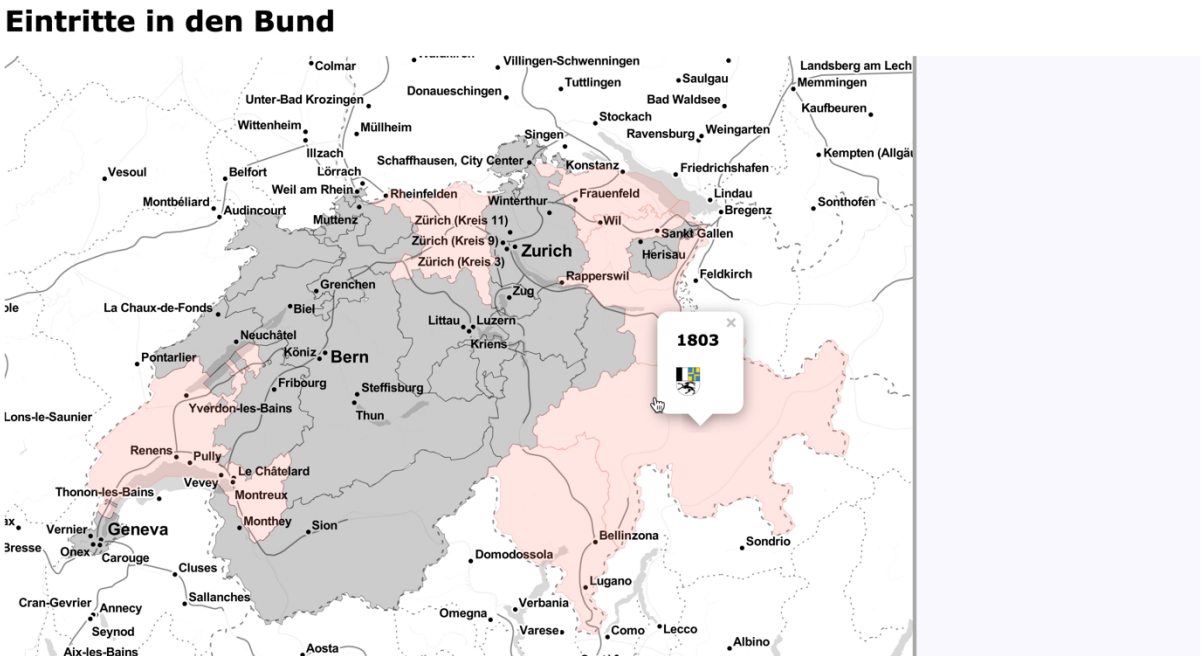


Figure 15: Cantons which joined the Swiss Confederation together are highlighted simultaneously.

In contrast to *Prototype 1-1*, no establishing shot is setting up the context of the story. However, a *CONSISTENT VISUAL PLATFORM* is given with the map in the center and a panel for messaging on the right. As there is no timeline bar, there is no linear ordering of the scenes. Through *RANDOM ACCESS*, the user can choose directly the canton of interest.

VISUAL NARRATIVE TACTICS		
VISUAL STRUCTURING	***HIGHLIGHTING***	***TRANSITION GUIDANCE***
CONSISTENT VISUAL PLATFORM	*COLOR*	
	TRANSPARENCY	
	CONTOURING	
	STYLE REDUCTION	
	HOVERING	

NARRATIVE STRUCTURE TACTICS		
ORDERING	***INTERACTIVITY***	***MESSAGING***
RANDOM ACCESS	*NAVIGATING*	*HEADLINES*
		ARTICLE
		DETAILS ON DEMAND
		LABELS

Table 18: Applied techniques for the Reader-Driven Approach of Use Case 1.

When *HOVERING* over the map, cantons which joined the Swiss Confederation at the same time step are highlighted simultaneously through *COLOR*, *TRANSPARENCY* and *CONTOURING*. Furthermore, *DETAILS ON DEMAND* occur in form of a *LABEL* when the user hovers over a canton showing its emblem and its entry year.

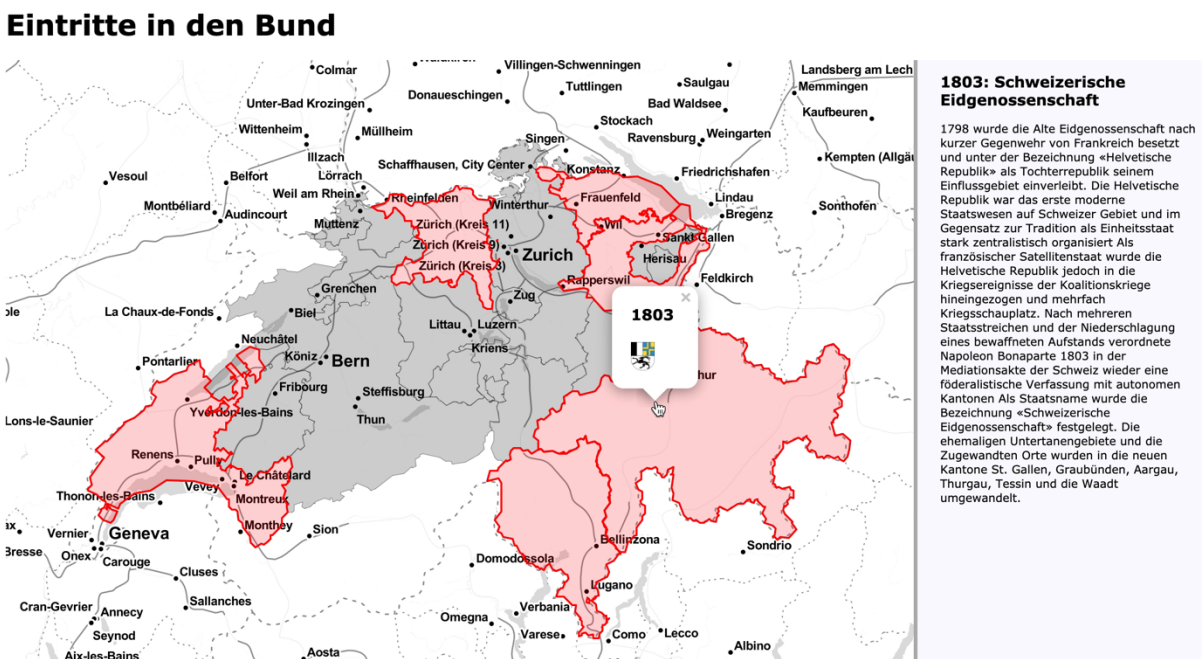


Figure 16: Clicking on a canton, the current extent of the Swiss Confederation is displayed together with an updated descriptive text of the situation on the right.

When clicking on a canton of interest, the current extent is displayed with a *STYLE REDUCTION* where only already joined cantons are displayed. Alongside, the current situation is described through messaging on the right in form of updated *HEADLINES* and an updated text in *ARTICLE* form.

5.2. SPATIAL USE CASE 2: *«SCHLACHTEN NAPOLEON'S»*

The second *Use Case* highlights some important battles of Napoleon Bonaparte during his different executed campaigns. Showing the locations of important battlegrounds, the focus relies here mostly on the spatial aspect. The purpose of this web map application is to get an understanding where those battlegrounds took place and also to get more background information about them.

5.2.1. PROTOTYPE 2-1: AUTHOR-DRIVEN APPROACH

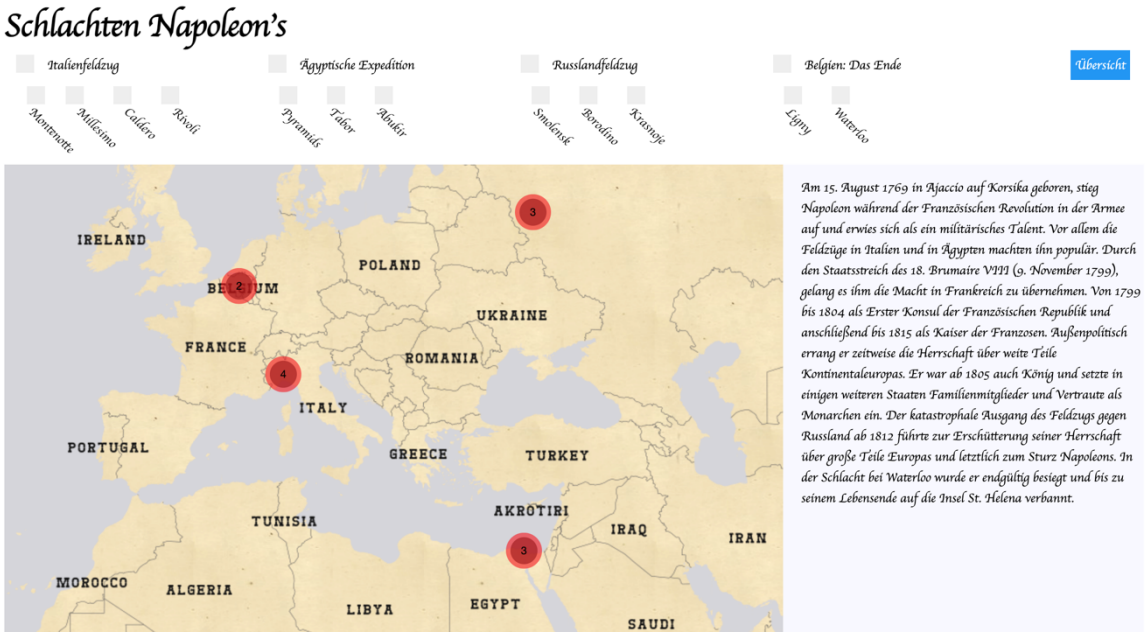


Figure 17: Establishing shot of Napoleon's battlegrounds

Starting with an *ESTABLISHING SHOT,* the user gets an overview over all locations of Napoleon's most important battlegrounds. Providing an *INTRODUCTORY TEXT* on the right side the context of the story is set up. The *Author-Driven Approach* is enforced through a *CHECK-LIST STRUCTURE* at the top of the map where the battlegrounds are assigned to the different campaigns in a LINEAR order corresponding their chronological order. Furthermore, this *CONSISTENT VISUAL PLATFORM together with OBJECT CONTINUITY* provides an easy transition between the different scenes of the battlegrounds.

When clicking on one of the campaigns in the checklist, *CAMERA MOTIONS* and *ANIMATED TRANSITIONS are applied to a CLOSE-UP / FRAMING of the* chosen campaigns' location (see Figure 18). The battlegrounds are thereby highlighted in different *COLORS*. While the red color symbolizes a defeat, the green color stands for a victory of Napoleon's army.

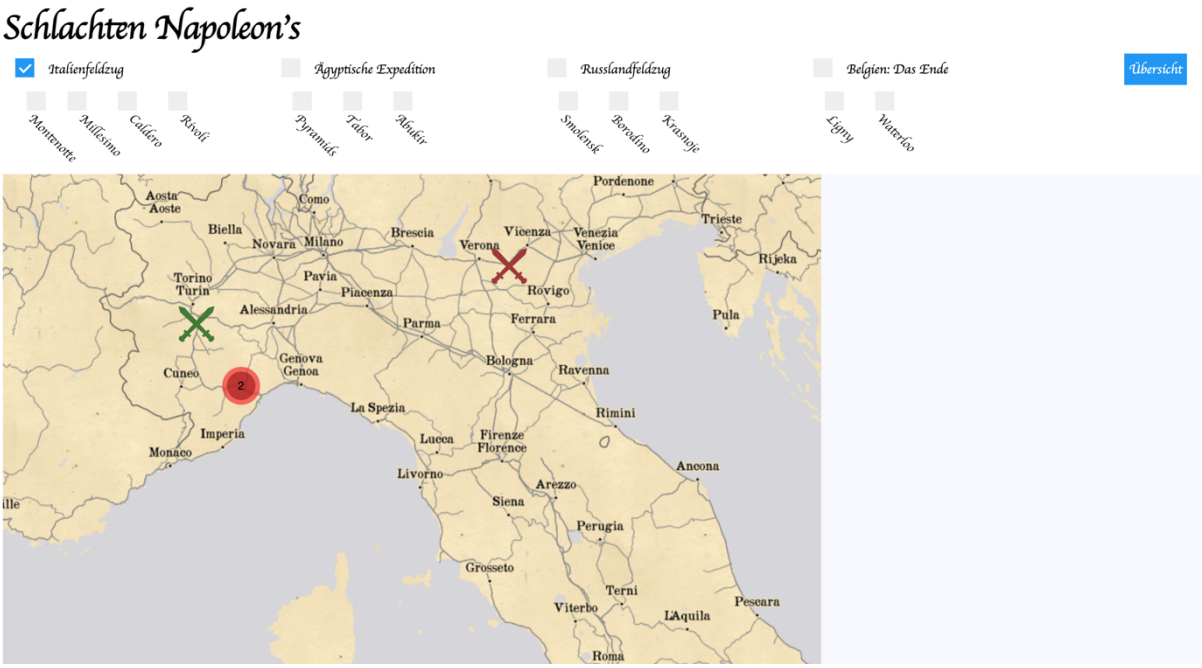


Figure 18: A close-up of the Napoleon's campaign in northern Italy

VISUAL NARRATIVE TACTICS		
VISUAL STRUCTURING	***HIGHLIGHTING***	***TRANSITION GUIDANCE***
ESTABLISHING SHOT	*COLOR*	*ANIMATED TRANSITIONS*
CONSISTENT VISUAL PLATFORM	*CLOSE-UP / FRAMING*	*CAMERA MOTION*
CHECKLIST STRUCTURE		*OBJECT CONTINUITY*

NARRATIVE STRUCTURE TACTICS		
ORDERING	***INTERACTIVITY***	***MESSAGING***
LINEAR	*NAVIGATING*	*INTRODUCTORY TEXT*
	SELECTING	*HEADLINES*
		ANNOTATIONS
		ARTICLE
		DETAILS ON DEMAND

Table 19: Applied techniques for the Author-Driven Approach of Use Case 2.

Besides *NAVIGATING,* the user can further *SELECT* one of the battles on the map. When selecting one, additional information appear through *DETAILS ON DEMAND*. An *ANNOTATION* with an image and date linked to the battleground appears alongside more substantial information on the right side in form of portraits of the commanders, a graph showing manpower of participating armies and a longer description of the situation in form of an *ARTICLE* (see Figure 19).

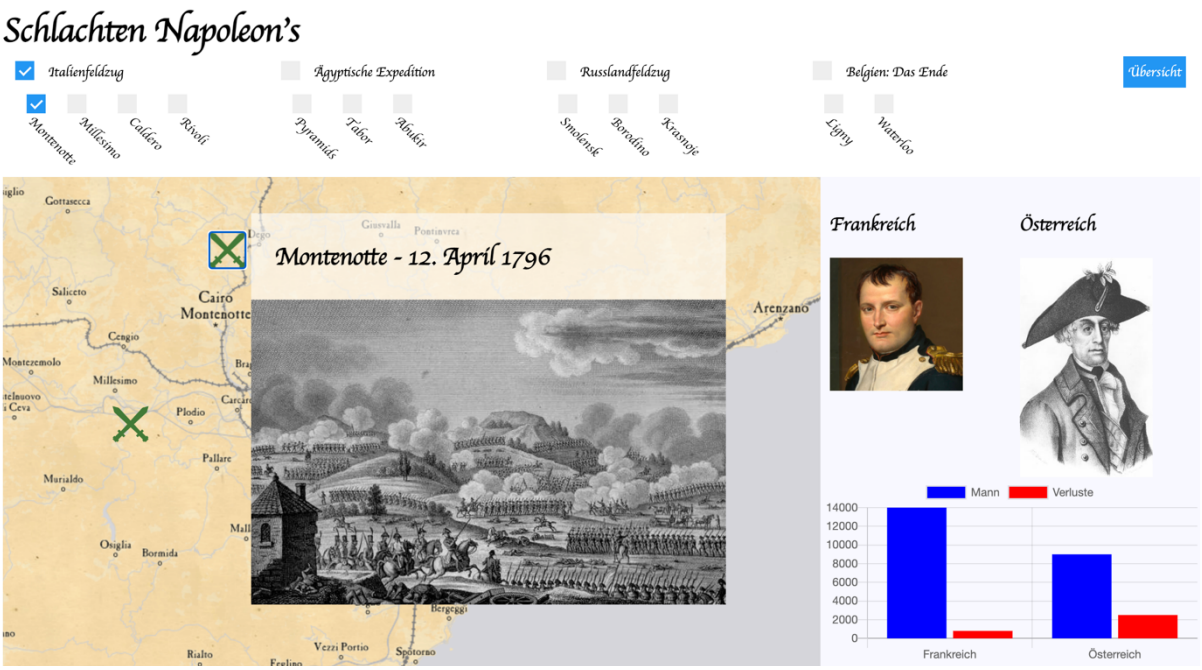


Figure 19: When clicking on one of the battlegrounds, additional information on the right appear.

5.2.2. PROTOTYPE 2-2: READER-DRIVEN APPROACH

Starting again with an *ESTABLISHING SHOT* and an *INTRODUCTORY TEXT*, the user gets an overview over all locations of Napoleon's most important battlegrounds (see Figure 20). As there is no user guidance in form of a checklist in this prototype, the user can choose freely a battleground of interest without following a linear ordering of the scenes (*RANDOM ACCESS*).

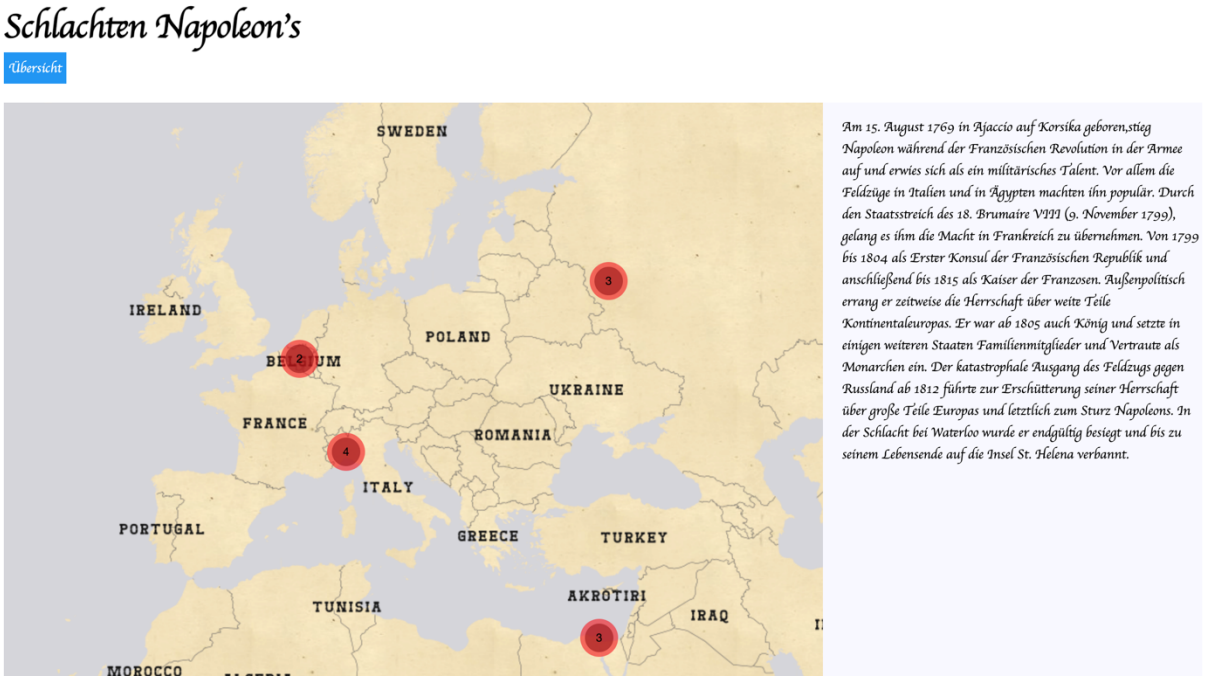


Figure 20: Establishing shot of Napoleon's battlegrounds without a checklist structure in this prototype

Similar to *Prototype 2-1*, when clicking on a battleground, the map zooms to the location of interest using the techniques *CAMERA MOTION*, *ANIMATED TRANSITIONS and CLOSE-UP / FRAMING*.

In terms of messaging and interactivity, the same techniques as in *Prototype 2-1* are applied. However, as any chronological framework between the battlegrounds is missing, *HOVERING* is added to the map. When the user hovers over the battleground, the date appears in a *LABEL (*see Figure 21*)*.

VISUAL NARRATIVE TACTICS		
VISUAL STRUCTURING	**HIGHLIGHTING**	**TRANSITION GUIDANCE**
ESTABLISHING SHOT	*COLOR*	*ANIMATED TRANSITIONS*
CONSISTENT VISUAL PLATFORM	*CLOSE-UP / FRAMING*	*CAMERA MOTION*
	HOVERING	*OBJECT CONTINUITY*

NARRATIVE STRUCTURE TACTICS		
ORDERING	**INTERACTIVITY**	**MESSAGING**
RANDOM ACCESS	*NAVIGATING*	*INTRODUCTORY TEXT*
	SELECTING	*HEADLINES*
		ANNOTATIONS
		ARTICLE
		DETAILS ON DEMAND
		LABELS

Table 20: Applied techniques for the Reader-Driven Approach of Use Case 2

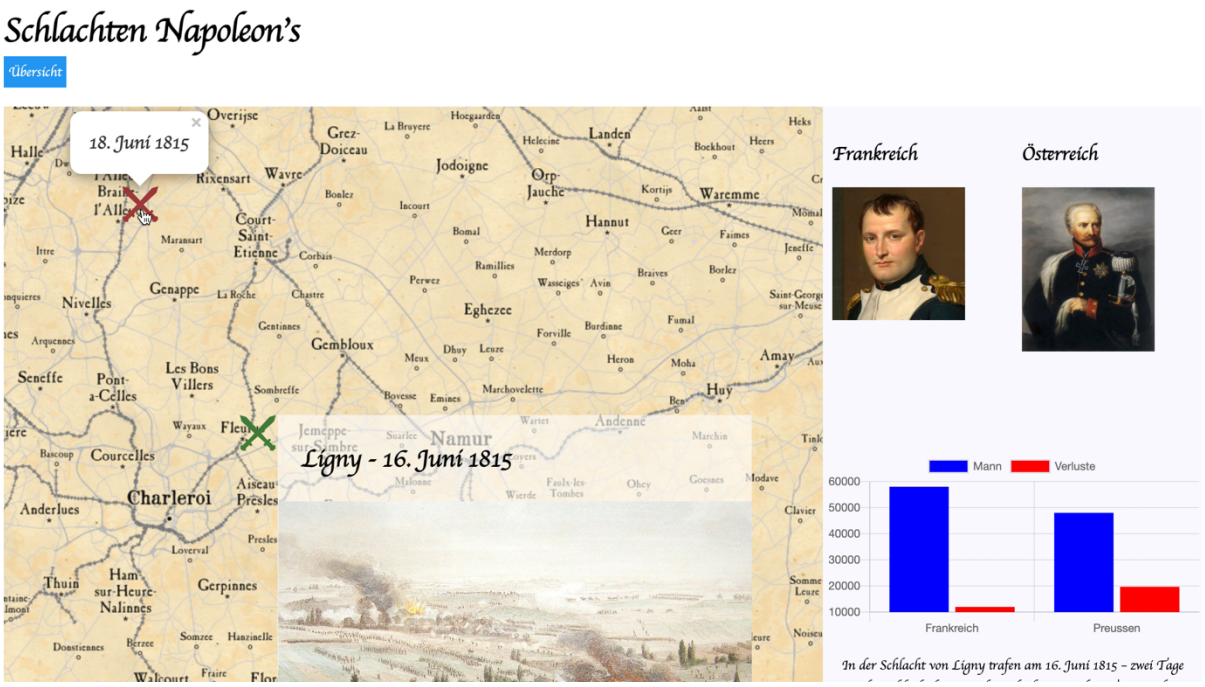


Figure 21: When hovering over a battleground, the date of the battle appears.

5.3. THEMATIC USE CASE 3: *«ZEITREISE: LUFTFAHRT»*

The third *Use Case* takes the user to a journey across different thematic topics of aviation. The user can choose between different topics such as history of aviation, some important numbers of today's aviation or its impact on the environment. This *Use Case* is implemented as a simple storyboard. The purpose of this application would be to provide information to interested users about key numbers of past, current and future aviation.

5.3.1. PROTOTYPE 3-1 : AUTHOR-DRIVEN APPROACH

Figure 22: The establishing shot with introductory text and four thematic topics

The *ESTABLISHING SHOT* consists here of a first scene with an *INTRODUCTORY TEXT* which sets up the entire following context. Furthermore, the user can decide among four thematic topics related to the theme aviation. Inside each topic, a *LINEAR* ordering of scenes provide some facts and numbers related to aviation. As the user can freely chose a topic or does not have to go through each topics, this framework has an *USER-DIRECTED* approach as well. Moreover, a *CONSISTENT VISUAL PLATFORM* is maintained through all topics.

Inside the thematic topics, highlighting is achieved through *FRAMING* locations of interest, *COLOR* and *SIZE*. The transition guidance between scenes in a topic can be achieved using *ANIMATED TRANSITIONS* or *CAMERA MOTION* to for instance fly to a different location. *OBJECT CONTINUITY* and *CONTINUITY EDITING* help thereby combining the individual scenes into a sequence enabling the user to perceive a causal cohesion across the topic.

VISUAL NARRATIVE TACTICS		
VISUAL STRUCTURING	**HIGHLIGHTING**	**TRANSITION GUIDANCE**
CONSISTENT VISUAL PLATFORM	*CLOSE-UP / FRAMING*	*ANIMATED TRANSITIONS*
	COLOR	*CAMERA MOTION*
	SIZE	*OBJECT CONTINUITY*
		CONTINUITY EDITING

NARRATIVE STRUCTURE TACTICS		
ORDERING	**INTERACTIVITY**	**MESSAGING**
LINEAR	*NAVIGATING*	*INTRODUCTORY TEXT*
USER-DIRECTED	*SELECTING*	*HEADLINES*
		ANNOTATIONS
		ARTICLE
		AUDIO
		VIDEO

Table 21: Applied techniques for the Author-Driven Approach of Use Case 3

Figure 23: One scene inside the history topic

Messaging is carried out mainly through the use of *HEADLINES, ANNOTATIONS* and *ARTICLES* (see e.g. Figure 23 or Figure 25). However, instead of or in addition to using pictures, *VIDEO* or *AUDIO* can be added to enrichen the entire experience.

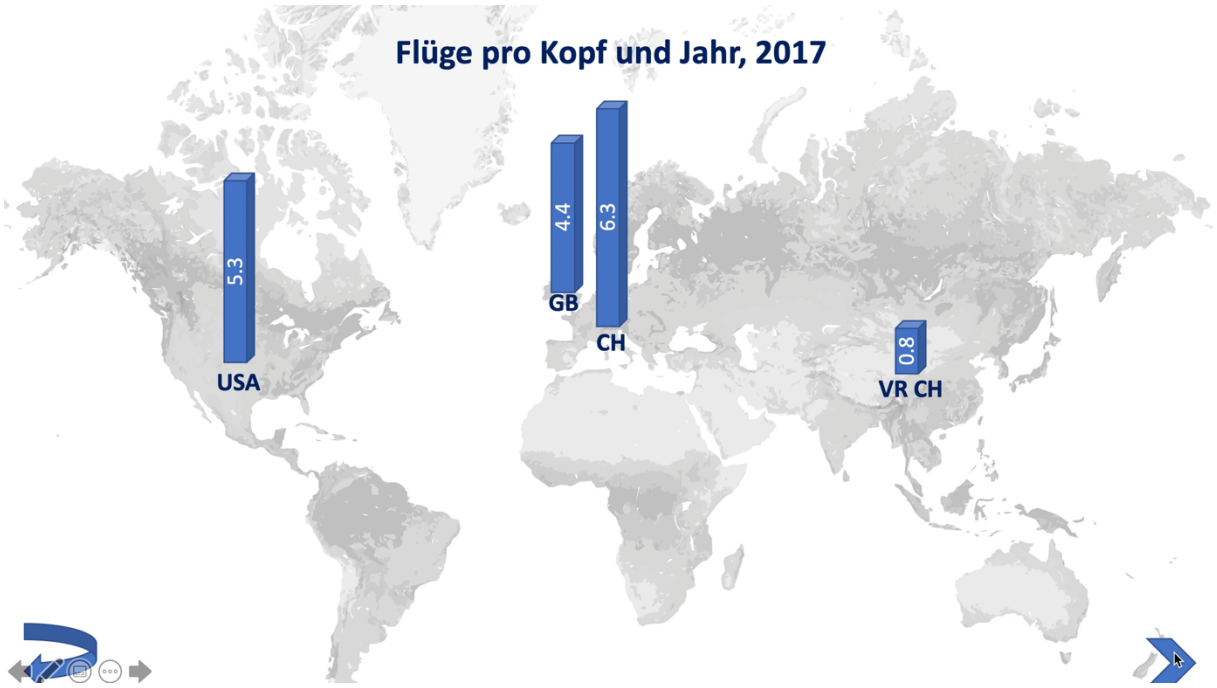


Figure 24: One scene providing statistical data about today's aviation.

Figure 25: One scene displaying the world's largest airlines in Europe

5.3.2. PROTOTYPE 3-2 : READER-DRIVEN APPROACH

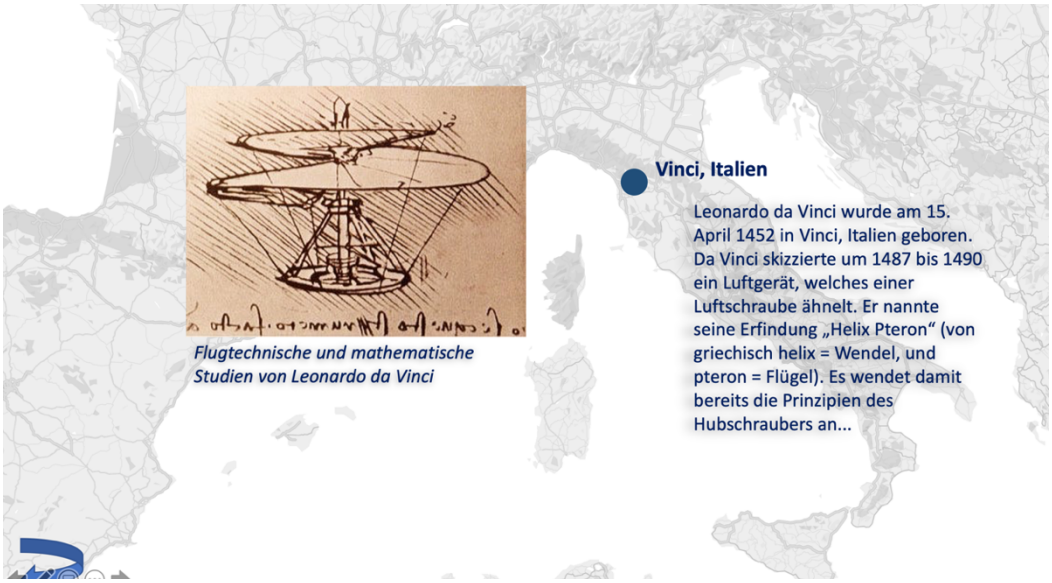
Figure 26: Establishing shot with direct access to the individual maps

As *Prototype 3-2* focuses on a *RANDOM ACCESS* framework for the ordering, in the *ESTABLISHING SHOT* it is possible to directly jump into a map or topic of interest. In other words, the user does not have to go through the entire sequence of a chosen topic as in *Prototype 3-1*. Furthermore, the user can get back to the *ESTABLISHING SHOT* from any scene in the entire application. All the other used techniques are identical to the ones used in *Prototype 3-1*.

VISUAL NARRATIVE TACTICS		
VISUAL STRUCTURING	***HIGHLIGHTING***	***TRANSITION GUIDANCE***
CONSISTENT VISUAL PLATFORM	*CLOSE-UP / FRAMING*	*ANIMATED TRANSITIONS*
	COLOR	*CAMERA MOTION*
	SIZE	*OBJECT CONTINUITY*
		CONTINUITY EDITING

NARRATIVE STRUCTURE TACTICS		
ORDERING	***INTERACTIVITY***	***MESSAGING***
RANDOM ACCESS	*NAVIGATING*	*INTRODUCTORY TEXT*
	SELECTING	*HEADLINES*
		ANNOTATIONS
		ARTICLE
		AUDIO
		VIDEO

Table 22: Applied techniques for the Reader-Driven Approach of Use Case 3



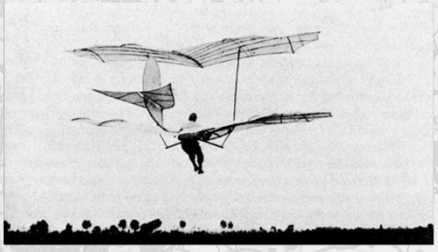
Flugtechnische und mathematische Studien von Leonardo da Vinci

Vinci, Italien

Leonardo da Vinci wurde am 15. April 1452 in Vinci, Italien geboren. Da Vinci skizzierte um 1487 bis 1490 ein Luftgerät, welches einer Luftschraube ähnelt. Er nannte seine Erfindung „Helix Pteron“ (von griechisch helix = Wendel, und pteron = Flügel). Es wendet damit bereits die Prinzipien des Hubschraubers an...

Der Flugpionier Otto Lilienthal führte seit 1891 erfolgreiche Gleitflüge nach dem Prinzip „schwerer als Luft“ durch. Er zeichnete sich dadurch aus, dass er nach seinen Beobachtungen des Vogelfluges verschiedene Flugzustände unterschied und erkannte, dass Auftrieb und Vortrieb voneinander unabhängig zu betrachten sind. Seine Arbeitshypothese lautete: „Die Nachahmung des Segelflugs der Vögel muss auch dem Menschen möglich sein, da er nur ein geschicktes Steuern erfordert, wozu die Kraft des Menschen völlig ausreicht.“ Er entwickelte ab 1874 in ausführlichen theoretischen und praktischen Vorarbeiten die aerodynamische Formgebung von Tragflügeln für ein manntragendes Gleitflugzeug.

Berlin, Deutschland



Flug Lilienthals im Doppeldecker, Fliegeberg in Berlin 1895

Kitty Hawk, USA

Erstflug mit dem Wright-Flyer am 17. Dezember 1903

Der **Wright Flyer** war das erste von den Brüdern Wright hergestellte Motorflugzeug. Beim weitesten Flug legte es am 17. Dezember 1903 in Kitty Hawk, North Carolina in 59 Sekunden rund 260 Meter zurück. Es war das erste motorisierte Luftfahrzeug, das schwerer als Luft war und von einem Piloten gesteuert wurde

Figure 27: A sequence through the history of aviation

6. DISCUSSION

The *Storytelling Toolbox* presented in chapter 4 provides a basic approach to implement storytelling in a cartographic environment. Furthermore in chapter 5, prototypes of maps with storytelling implementation have been successfully created with a proof-of-concept method using techniques from the *Storytelling Toolbox*.

In this chapter, the capabilities of the *Storytelling Toolbox* are further examined. To discuss the capabilities, in section 6.1 the implementations and their used techniques are reviewed with respect to the defined challenges in chapter 3. In section 6.2, the *Storytelling Toolbox* is evaluated with regard to external implementations. In particular, this evaluation should enable us to evaluate, if external examples feature the same or similar elements of the elaborated *Storytelling Toolbox*. With the most important findings, in section 6.3 recommendations for an implementation of storytelling in the Atlas Cartography Environment are given. In the end, in section 0 the defined goals of this thesis are reviewed and examined in terms of their achievement.

6.1. CHALLENGES

Table 23 shows the previously in this thesis defined challenges. They are reviewed and assessed whether they are addressed, half-way addressed or not addressed at all in the implementations using the presented techniques from the elaborated *Storytelling Toolbox*.

	addressed	half-way addressed	not addressed
CHALLENGE 1: *GUIDANCE FOR READER*	**X**		
CHALLENGE 2: *BALANCE BETWEEN AUTHOR-DRIVEN AND READER-DRIVEN ELEMENTS*	**X**		
CHALLENGE 3: *EXPRESSION/DELIVERY OF EMOTIONS*		**X**	
CHALLENGE 4: *HANDLING DIFFERENT SCALES*	**X**		
CHALLENGE 5: *REDUCE AND PRIORITIZE INFORMATION*		**X**	
CHALLENGE 6: *TECHNICAL INCORPORATION OF GRAPHICAL ELEMENTS AND INTERACTION METHODS*	**X**		

Table 23: Defined challenges in implementing storytelling in cartography

The assessment is primarily based on the subjective impression when working with the provided techniques and using the implementations afterwards. In general, all challenges are effectively addressed with the *Storytelling Toolbox*. Considered as the biggest challenge in today's cartography, Challenge 1 is addressed well. As shown in the *Use Cases*, techniques such as a timeline bar, a progress bar or a checklist structure can provide some guidance for the user through the content and the story.

Finding the right balance between *Author-Driven Approach* and *Reader-Driven-Approach* is another major challenge. The techniques from the *Storytelling Toolbox* are therefore assigned to one or the other approach. This allows the user to get an overview and to decide which techniques he wants to implement to rather tell a more *Author-Driven* or *Reader-Driven* story.

Challenge 3 - the expression and delivery of emotions – is not completely covered by the elaborated techniques. There are some techniques such as audio or even video which are able to evoke emotions, but this clearly has to be further examined.

Transition guidance with its techniques such as camera motion and animated transitions, or highlighting with close-ups and framing provide pleasing methods to overcome challenge 4, the handling of different scales in cartography. In particular, it greatly facilitates the possibility to display multiple scales of different spatial settings in a map.

Challenge 5 is only half-way addressed. The *Storytelling Toolbox* does not provide methods for finding and focusing only on the essential information needed to follow the story. However, it provides enough techniques to prioritize or highlight the essential information of a story.

The last challenge is described as finding the right graphical elements and interaction methods for a storytelling implementation. The presented techniques in the *Storytelling Toolbox* provide here a good overview and wide range of possibilities.

6.2. COMPARISON WITH EXTERNAL EXAMPLES

In this chapter the *Storytelling Toolbox* originates from a comparison with two external implementations. The first example is from the Federal Statistical Office of Switzerland (https://www.census1850.bfs.admin.ch/de/) and is called *«Die Schweiz (er)zählen»* (in Engl.: Telling Switzerland with numbers). It tells stories about different thematic topics and numbers related to the Swiss population. The second example is from the World Bank Group (https://datatopics.worldbank.org/sdgatlas/) and is called *«Atlas of Sustainable Development Goals 2020»*. It presents interactive storytelling and data visualizations about the 17 Sustainable Development Goals of the United Nations. The main purpose of this chapter is to evaluate, whether these two external examples feature the same or similar techniques and methods from the in this thesis elaborated *Storytelling Toolbox*.

6.2.1. EXAMPLE 1: *«DIE SCHWEIZ (ER)ZÄHLEN»*

Figure 28: Different sequences of the example «Die Schweiz (er)zählen» (https://www.census1850.bfs.admin.ch/de/)

«Die Schweiz (er)zählen» begins with an *ESTABLISHING SHOT* and an *INTRODUCTORY TEXT* which sets the overall context for the scenes ahead and informs the user where the story will take place. When scrolling further down, the user faces four thematic stories which deal with the history of Swiss people, trends in religion and development of the different languages in Switzerland. In particular, this structure uses a *RANDOM ACCESS* approach, as the user

can decide which and in what order he wants to read through the story. Throughout the entire application, a *CONSISTENT VISUAL PLATFORM* is maintained which makes it easier for the user to orient himself.

Inside a selected story, the order of scenes is mostly *LINEAR*. While scrolling through the content of the story, some *ANIMATED TRANSITIONS* between the scenes are applied and on top of the display there is a blue *PROGRESS BAR* which informs the user where he is standing and also indicates the length of the story. Messaging is mostly done by *HEADLINES* and *ARTICLES*, which are accompanied by visualizations of statistical data in form of graphs or thematic maps (See bottom right in Figure 28). Inside the maps, the data is highlighted using various common techniques such as *COLOR, MOTION, TRANSPARENCY* or *CONTOURING*.

In terms of interactivity, only basic functions like changing between different years in a map is provided. However, there are often links provided at the bottom of the maps which lead to a another website with a more interactive map where the user can explore deeper the underlying data.

6.2.2. EXAMPLE 2: *«ATLAS OF SUSTAINABLE DEVELOPMENT GOALS 2020»*

Figure 29: A fragment of the selectable stories from the «Atlas of Sustainable Development Goals 2020» (https://datatopics.worldbank.org/sdgatlas/)

Using also an *INTRODUCTORY TEXT*, the *«Atlas of Sustainable Development Goals 2020»* outlines firstly the story behind the 17 UN Sustainable Development Goals. As the user continues to scroll down, the 17 selectable stories are presented. There is a story to discover for each of the 17 goals. This *RANDOM ACCESS* approach lets the user here freely decide which story he wants to pursue. There is no path suggested at all by the author. However, the content inside each story is ordered again in a *LINEAR* way, where the user can scroll from top to down through various scenes of the story.

When scrolling through the content with a *CONSISTENT VISUAL PLATFORM* and *ANIMATED TRANSITIONS*, diverse highlighting techniques are used to help direct the user's attention to a particular element. Using for instance *MOTION, LABELS* are flying from down to top which explain the underlying statistical graphs (see Figure 30). In addition, *COLOR*

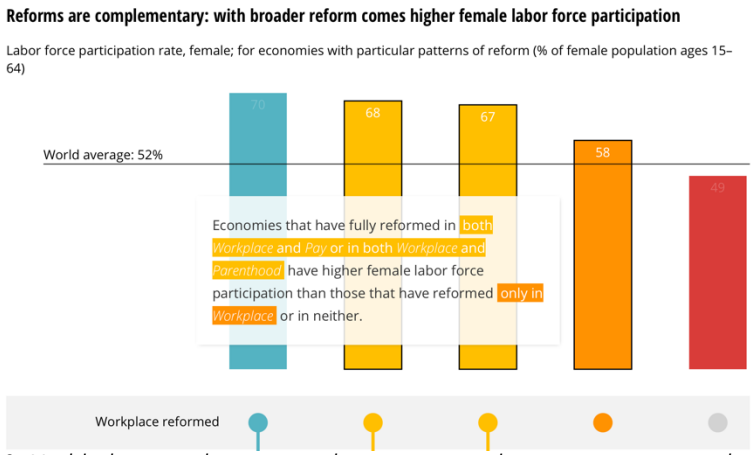


Figure 30: Highlighting techniques such as motion, color or contouring are here used in this statistical graph (https://datatopics.worldbank.org/sdgatlas/)

and *CONTOURING* are also frequently used techniques in terms of highlighting. Moreover, some basic interactivity is also provided. The user can *HOVER* or *SELECT* data in order to get *DETAILS ON DEMAND* about data of interest.

Again, messaging is mostly done by *HEADLINES* and *ARTICLES*. Throughout all stories, there is a button on the top right which opens up a *CHECKLIST STRUCTURE*. This provides an overview of the content at all times and serves as a reminder what each section contains. Furthermore, this enables the user to jump right into another story.

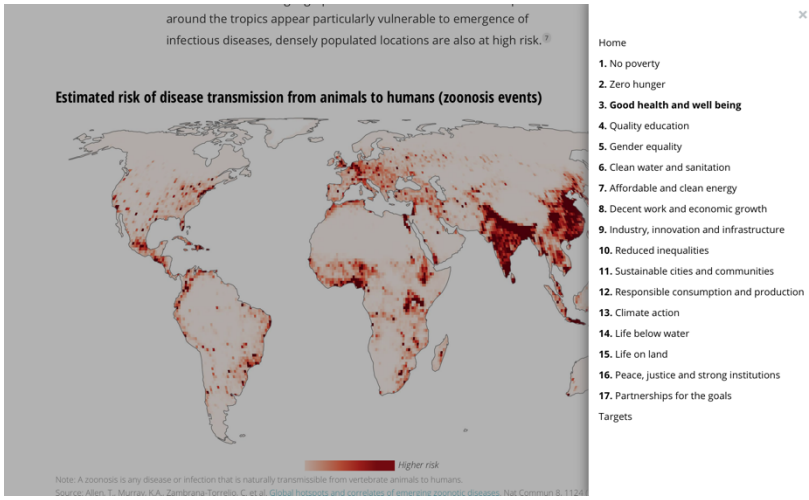


Figure 31: With the checklist on the right, the user can jump right into another story (https://datatopics.worldbank.org/sdgatlas/)

6.2.3. CONCLUSION OF COMPARISON

Generally, many techniques from all the divisions of the *Storytelling Toolbox* can be found in both external examples. Throughout the examples, the visual structuring by an *ESTABLISHING SHOT* and a *CONSISTENT VISUAL PLATFORM* is always given. This is implemented well and indicates the importance of this concept. Furthermore, from highlighting and messaging there are many recurring techniques from the *Storytelling Toolbox* as well. A lot of *CLOSE-UPS / FRAMING, COLOR*, and *SIZE* are used, as well as *HEADLINES, ARTICLES* and *DETAILS ON DEMAND*.

On the other hand, when exploring the different topics and stories of the examples, the ordering of scenes is always structured in a *LINEAR* way. This is mostly achieved by scrolling. The concept of a *USER-DIRECTED* way, where the user has to select a path among multiple alternatives, is never implemented. In summary, this confirms that if the goal of the visual story is to deliver a clear message, like in the two external examples, it works best with a *LINEAR* ordering of scenes.

6.3. RECOMMENDATIONS FOR ATLAS CARTOGRAPHY

Table 24 shows the most recurrent techniques encountered both in own implementations and the comparison with external examples.

VISUAL STRUCTURING
CONSISTENT VISUAL PLATFORM, ESTABLISHING SHOT
HIGHLIGHTING
CLOSE-UP / FRAMING, COLOR, SIZE, TRANSPARENCY, MOTION
TRANSITION GUIDANCE
ANIMATED TRANSITIONS, CAMERA MOTION
ORDERING
LINEAR, RANDOM ACCESS
INTERACTIVITY
NAVIGATING, SELECTING
MESSAGING
HEADLINES, INTRODUCTORY TEXT, ARTICLE, DETAILS ON DEMAND

Table 24: The most recurrent techniques encountered in this thesis

Based on the most important findings from the implementations and the most recurrent techniques encountered, recommendations for an implementation of storytelling in the Atlas Cartography are given.

In general, visual structuring is an important asset for successful storytelling, as the communication of the overall structure to the viewer is crucial. Besides that, three main containers can be distinguished and are equally important (see Table 25). The first container describes the map itself. It includes all means of interactivity such as navigating and selecting elements in the map. Additionally, it incorporates all means of highlighting in order to direct the user's attention to certain elements in the map.

CONTAINER 1: MAP
INTERACTIVITY, HIGHLIGHTING
CONTAINER 2: INFORMATION
MESSAGING
CONTAINER 3: TOOLS
TIMELINE BAR, PROGRESS BAR, CHECKLIST STRUCTURE

Table 25: The three recommended containers for a storytelling implementation in the Atlas Cartography

The second container is all about information. All means of messaging such as text, headlines or even pictures and videos can here be incorporated. Especially, it describes all ways a visualization is communicating observations and commentary to the user. The third container describes implemented tools in the application. Generally, this comprises tools such as a timeline bar, progress bar or a checklist structure in order to navigate between different segments of the story. However, other tools such as a searching or filtering functions can also be considered here.

In conclusion, to achieve a successful storytelling implementation in the Atlas Cartography, the existence of all three containers is a fundamental basis. Furthermore, the cooperation of all three containers including their techniques altogether with a consistent visual structuring is essential, particularly if the goal is to deliver a clear message to the user.

6.4. GOALS ACHIEVEMENT

The defined goals of this thesis and their achievement are displayed in Table 26. The goals are thereby reviewed using a classification with four scales which ranges from fully achieved to not achieved. Overall, the goals have been achieved rather well. However, looking more specific into the two parts of this thesis, minor variances in the achievements can be determined.

	fully achieved	rather achieved	rather not achieved	not achieved
1. PROVIDE CLEAR OVERVIEW OVER EXISTING TECHNIQUES AND CONCEPTS OF STORYTELLING IN THE FIELD OF CARTOGRAPHY.		**x**		
1.1.1. DEFINE SCOPE AND DIFFERENT LEVELS OF STORYTELLING.		x		
1.1.2. HIGHLIGHT CURRENT CHALLENGES OF IMPLEMENTING STORYTELLING IN CARTOGRAPHY.		x		
1.1.3. PROVIDE OVERVIEW OVER CURRENT SOLUTIONS OF IMPLEMENTING STORYTELLING IN CARTOGRAPHY.		x		
1.1.4. DEVELOP A "TOOLBOX", WHICH CONSISTS IMPORTANT CONCEPTS AND TECHNIQUES TO IMPLEMENT STORYTELLING IN CARTOGRAPHY.	x			
2. IMPLEMENT 2-3 USE CASES OF STORYTELLING IN THE ATLAS CARTOGRAPHY ENVIRONMENT.		**x**		
2.1.1. DEFINE APPROPRIATE USE CASES FOR THE ATLAS CARTOGRAPHY ENVIRONMENT.	x			
2.1.2. CHOOSE AN APPROPRIATE OUTPUT FORMAT FOR THE USE CASES (MOCKUPS OF MAPS, STORYBOARDS, VIDEO SNIPPETS OR SMALL APPLICATION).	x			
2.1.3. DEMONSTRATE APPLICATION OF STORYTELLING IN ATLAS CARTOGRAPHY ENVIRONMENT.	x			
2.1.4. PROOF APPLICATION OF STORYTELLING IN ATLAS CARTOGRAPHY ENVIRONMENT.		x		
2.1.5. EVALUATE APPLICATION OF STORYTELLING IN ATLAS CARTOGRAPHY ENVIRONMENT.			x	

Table 26: The defined goals of this master thesis

In the first part, the main goal was to provide a clear overview over existing techniques and concepts of storytelling in the field of cartography. While current challenges and an overview over current solutions are given, the domain of storytelling is truly large and therefore too broad to be covered in its entirety in this thesis. Undoubtedly, there are more concepts and techniques in the wide range of literature which have not been discussed in this thesis.

Nevertheless, the mentioned concepts and solutions here provide a good basis and outline over this wide subject and moreover, the derived *Storytelling Toolbox* incorporates important concepts and techniques to implement storytelling in cartographic representations. Furthermore, the *Storytelling Toolbox* is not a concluding set of tools, as it is designed to be expandable in future works.

In the second part of the thesis, the main goal was to implement *Use Cases* of storytelling in the Atlas Cartography Environment. Using a proof-of-concept implementation, selected techniques of the *Storytelling Toolbox* are used for the creation of prototypes of maps. Particularly, the implemented prototypes show that the techniques and methods from the elaborated *Storytelling Toolbox* have been successfully applied to implement storytelling in an Atlas Cartography Environment. Lastly, the proof and evaluation of application in an Atlas Cartography Environment might fall a bit short in this thesis, as it is done in a rather subjective way. The techniques and methods of the *Storytelling Toolbox* have been evaluated with respect to two external examples, but a wider evaluation with more external examples might have been appropriate. However, this can also be performed in possible future works.

7. CONCLUSION AND OUTLOOK

In this last chapter of this master thesis, the main conclusions of this work are drawn. Additionally, a brief outlook on possible future developments are given.

7.1. CONCLUSION

In the first part, this master thesis focused on providing a clear overview over today's existing techniques and concepts of storytelling implementation in cartography. The aim was in particular to highlight current challenges, solutions and outline important concepts to group different storytelling approaches. The most important findings were then used for the derivation of a "toolbox" which consists of important concepts and techniques for a successful implementation of storytelling. Afterwards, selected techniques of the *Storytelling Toolbox* are used for the implementation of prototypes of maps.

The results of the implementations show that the techniques and methods from the elaborated *Storytelling Toolbox* can be applied to implement storytelling in cartography. Furthermore, examining other external storytelling examples, same or similar recurring techniques and concepts can be found. This result clearly indicates that the presented techniques and concepts in this master thesis are accurate solutions and can provide a fundamental basis for storytelling implementations. One of the main benefits is here a clear and quick overview over possible techniques and concepts. The findings of this work are furthermore used to give recommendations for an implementation of storytelling in Atlas Cartography Environment. The most recurrent and important techniques encountered in this work are presented in the recommendation.

However, the work with the elaborated *Storytelling Toolbox* has a few limitations as well. For instance, the expression and delivery of emotions is not completely covered by the elaborated techniques. This direction clearly has to be more examined to determine and evaluate techniques which are able to evoke the user's emotions. Moreover, aspects such as possible data structures or how the complexity of narratives influence the storytelling should be elaborated more in future research.

Nevertheless, the provided techniques and concepts form a good basis for storytelling implementations and this work proves one more time that storytelling becomes more and more important in the field of cartography. Especially in the Atlas Cartography Environment, it is more than appropriate to further examine these trends.

7.2. OUTLOOK

As storytelling gets more and more important, possible further research work could address the expansion of the *Storytelling Toolbox*. Since in this master thesis this toolbox is designed openly and not concluding, it might be appropriate to expand it with additional encountered new techniques.

Another possible approach would be addressing more the limitations of the *Storytelling Toolbox*. By setting the focus more on how data has to be structured for successful storytelling or considering more the complexity of a story, the provided methods could be adapted or complemented.

Last but not least, as the *Storytelling Toolbox* already forms a good basis, it might be interesting to see what results are possible if someone else would use the provided techniques and concepts. Especially, an application of these techniques and concepts in the Atlas of Switzerland might be a relevant next step.

BIBLIOGRAPHY

Caquard, S. & Cartwright, W., 2014. Narrative Cartography: From Mapping Stories to the Narrative of Maps and Mapping. *The Cartographic Journal,* pp. 3-6.

Cartwright, W., 2015. *Exploring cartographic storytelling. Reflections on mapping real-life and fictional stories.* Rio de Janeiro, Brazil, ICC 2015.

Gershon, N. & Page, W., 2001. What storytelling can do for information visualization. *Communications of the ACM 44,* 44(8), p. 32.

Harley, B., 1989. Deconstructing the map. *Cartographica,* 26(2), pp. 11-14.

Kosara, R. & Mackinlay, J., 2013. Storytelling: The Next Step for Visualization. *Tableau Software,* 46(5), pp. 45-47.

Moretti, F., 1999. *Atlas of the European Novel: 1800-1900.* 1. ed. Italy: Verso Books.

Ormeling, F., 1995. New Forms, Concepts, and Structures for European National Atlases. *Cartograpllic Perspectives,* Issue 20, pp. 12-20.

Pearce, M. W., 2009. *Place Codes: narrative and Dialogical Strategies for Cartography.* Santiago, ICA.

Phillips, J., 2012. Storytelling in Earth sciences: The eight basic plots. *Earth-Science Reviews,* Issue 115, pp. 153-162.

Roth, R. E., 2020. Cartographic Design as Visual Storytelling: Synthesis and Review of Map-Based Narratives, Genres, and Tropes. *The Cartographic Journal*, pp. 1-8, 10-15.

Segel, E. & Heer, J., 2010. Narrative Visualization: Telling Stories with Data. *IEEE Trans. Vis. Comput. Graph.,* 16(6), pp. 1139-1148.

Sieber, R. & Bonassi, N., 2017. *Storytelling in Atlases—The intrinsic way.* Washington, ICC.

Tan, E. S., 1996. *Emotion and the structure of narrative film : film as an emotion machine.* USA: Lawrence Erlbaum Associate: Hillsdale.

Thöny, M., Schnürer, R., Sieber, R., Hurni, L., Pajarola, R., 2018. Storytelling in Interactive 3D Geographic Visualization Systems. *International Journal of Geo-Information,* 7(123).

APPENDICES

I. CONTENT OF USB FLASH DRIVE

The following picture shows the content of the USB flash drive.

Figure 32: Content of USB flash drive

II. CONSIDERED LITERATURE FOR LITERATURE ANALYSIS

Bach, B., Riche, N. H., Carpendale, S., & Pfister, H. (2017). The Emerging Genre of Data Comics. IEEE engineering in medicine and biology magazine.

Bateman, S., Gutwin, C., Mandryk, R. L., & Genest, A. (2010). Useful Junk? The effects of visual embellishment on comprehension and memorability of charts.

Cartwright, W. (2004). Engineered Serendipity: Thoughts on the Design of Conglomerate GIS and Geographical New Media Artifacts. Transactions in GIS.

Cartwright, W. (2006). Exploring Games and Gameplay as a Means of Accessing and Using Geographical Information. Human IT.

Caquard, S. & Cartwright, W., 2014. Narrative Cartography: From Mapping Stories to the Narrative of Maps and Mapping. The Cartographic Journal.

Cartwright, W., 2015. Exploring cartographic storytelling. Reflections on mapping real-life and fictional stories.. Rio de Janeiro, Brazil, ICC 2015.

Cheng, J. (2014). https://thoughtbot.com. Von https://thoughtbot.com/blog/analyzing-minards-visualization-of-napoleons-1812-march

Denil, M. (2017). Storied Maps. Cartographic Perspectives.

Gershon, N. & Page, W., 2001. What storytelling can do for information visualization. Communications of the ACM 44.

Harley, B., 1989. Deconstructing the map. Cartographica.

Kosara, R. & Mackinlay, J., 2013. Storytelling: The Next Step for Visualization. Tableau Software.

Moretti, F., 1999. Atlas of the European Novel: 1800-1900. 1. ed. Italy: Verso Books.

Ormeling, F., 1995. New Forms, Concepts, and Structures for European National Atlases. Cartograpllic Perspectives.

Pearce, M. W., 2009. Place Codes: narrative and Dialogical Strategies for Cartography. Santiago.

Phillips, J., 2012. Storytelling in Earth sciences: The eight basic plots. Earth-Science Reviews.

Robertson, G., Fernandez, R., Fisher, D., Lee, B., & Stasko, J. (2008). Effectiveness of Animation in Trend Visualization. IEEE Transactions on Visualization and Computer Graphics .

Roth, R. E., 2020. Cartographic Design as Visual Storytelling: Synthesis and Review of Map-Based Narratives, Genres, and Tropes. The Cartographic Journal.

Segel, E. & Heer, J., 2010. Narrative Visualization: Telling Stories with Data. IEEE Trans. Vis. Comput. Graph.

Sieber, R. & Bonassi, N., 2017. Storytelling in Atlases—The intrinsic way. Washington, ICC.

Straumann, R., & Sulzberger, N. (2014). Partizipation mit Bundesgeodiensten und Story Maps. GeoSummit.

Tensen, T. (2014). Geo-data animations in television journalism: Animation classes and their effectiveness in telling stories.

Thöny, M., Schnürer, R., Sieber, R., Hurni, L., Pajarola, R., 2018. Storytelling in Interactive 3D Geographic Visualization Systems. International Journal of Geo-Information.

III. DATA USED FOR IMPLEMENTATIONS OF PROTOTYPES

PROTOTYPE 1

Geodata

- **swissBOUNDARIES3D:** Shapefiles of the Swiss cantons downloaded from: https://shop.swisstopo.admin.ch/de/products/landscape/boundaries3D (last accessed: 27 November 2020)

  The shapefiles were transformed into GeoJSON-Files using *QuantumGIS 2.18*.

Pictures

- **Emblem of Swiss cantons**
  https://de.wikipedia.org/wiki/Liste_der_Wappen_und_Fahnen_der_Schweizer_Kantone
  (last accessed: 28 November 2020)

Content

- **Die Geschichte der Schweiz – Zeittafel**
  https://www.swissinfo.ch/ger/die-schweizer-geschichte---zeittafel/29192306
  (last accessed: 28 November 2020)

- **Die Schweiz entdecken**
  https://www.eda.admin.ch/aboutswitzerland/de/home/geschichte/epochen.html
  (last accessed: 29 November 2020)

- **Die Geschichte der Schweiz**
  https://de.wikipedia.org/wiki/Geschichte_der_Schweiz
  (last accessed: 28 November 2020)

- **Helvetische Republik**
  https://de.wikipedia.org/wiki/Helvetische_Republik
  (last accessed: 28 November 2020)

- **Sonderbundskrieg**
  https://de.wikipedia.org/wiki/Sonderbundskrieg
  (last accessed: 29 November 2020)

- **Alte Eidgenossenschaft**
  https://de.wikipedia.org/wiki/Alte_Eidgenossenschaft
  (last accessed: 29 November 2020)

PROTOTYPE 2

Pictures & Content

- **Vom Bastillesturm bis zum Wiener Kongress**
  https://www.mdr.de/zeitreise/weitere-epochen/neuzeit/napoleon-bonaparte-chronologie-voelkerschlacht-leipzig100.html#sprung
  (last accessed: 24 November 2020)

- **Koalitionskriege**
  https://de.wikipedia.org/wiki/Koalitionskriege
  (last accessed: 25 November 2020)

- **Liste von Kriegen und Schlachten im 19. Jahrhundert**
  https://de.wikipedia.org/wiki/Liste_von_Kriegen_und_Schlachten_im_19._Jahrhundert
  (last accessed: 26 November 2020)

- **Koalitionskriege**
  https://de.wikipedia.org/wiki/Koalitionskriege
  (last accessed: 25 November 2020)

- **Napoleon Bonaparte Schlachten**
  http://www.napoleon-online.de/html/nap_schlachten.html
  (last accessed: 26 November 2020)

- **Schlacht bei Montenotte**
  https://de.wikipedia.org/wiki/Schlacht_bei_Montenotte
  (last accessed: 26 November 2020)

- **Schlacht bei Millesimo**
  https://de.wikipedia.org/wiki/Schlacht_bei_Millesimo
  (last accessed: 27 November 2020)

- **Schlacht bei Rivoli**
  https://de.wikipedia.org/wiki/Schlacht_bei_Rivoli_(1797)
  (last accessed: 27 November 2020)

- **Schlacht bei Abukir**
  https://de.wikipedia.org/wiki/Schlacht_bei_Abukir_(1799)
  (last accessed: 27 November 2020)

- **Schlacht bei den Pyramiden**
  https://de.wikipedia.org/wiki/Schlacht_bei_den_Pyramiden
  (last accessed: 25 November 2020)

- **Schlacht bei den Jaffa**
  https://de.wikipedia.org/wiki/Belagerung_von_Jaffa
  (last accessed: 25 November 2020)

- **Schlacht um Smolensk (1812)**
  https://de.wikipedia.org/wiki/Schlacht_um_Smolensk_(1812)
  (last accessed: 22 November 2020)

- **Schlacht bei Borodino**
  https://de.wikipedia.org/wiki/Schlacht_bei_Borodino
  (last accessed: 23 November 2020)

- **Schlacht bei Krasnoi**
  https://de.wikipedia.org/wiki/Schlacht_bei_Krasnoi
  (last accessed: 23 November 2020)

- **Schlacht bei Ligny**
  https://de.wikipedia.org/wiki/Schlacht_bei_Ligny
  (last accessed: 25 November 2020)

- **Schlacht bei Waterloo**
  https://de.wikipedia.org/wiki/Schlacht_bei_Waterloo
  (last accessed: 25 November 2020)

- **Napoleon Bonaparte**
  https://www.planet-wissen.de/geschichte/persoenlichkeiten/napoleon_bonaparte/index.html
  (last accessed: 26 November 2020)

PROTOTYPE 3

Pictures

- **Aircrafts**
  https://www.airliners.net/search?keywords=A350
  (last accessed: 2 December 2020)

- **Maps**
  https://snazzymaps.com/style/55/subtle-greyscale-map
  (last accessed: 2 December 2020)

Content

- **Geschichte der Luftfahrt**
  https://de.wikipedia.org/wiki/Geschichte_der_Luftfahrt
  (last accessed: 1 December 2020)

- **Chronologie der Luftfahrt**
  https://de.wikipedia.org/wiki/Chronologie_der_Luftfahrt
  (last accessed: 1 December 2020)

- **Geschichte des Fliegens**
  https://www.br.de/wissen/motorflug-flugpioniere-flieger-100.html
  (last accessed: 2 December 2020)

- **Die Geschichte der Luftfahrt**
  https://besserfliegen.com/de/die-geschichte-der-luftfahrt
  (last accessed: 2 December 2020)

- **Top 10: Die längsten Nonstop-Linienflüge weltweit**
  https://www.flugrevue.de/zivil/ultralangstrecken-die-10-laengsten-nonstop-linienfluege-welt-weit/
  (last accessed: 3 December 2020)

- **Top 10: Die grössten Fluggesellschaften der Welt**
  https://www.flugrevue.de/zivil/xxl-airlines-top-10-die-groessten-fluggesellschaften-der-welt/
  (last accessed: 3 December 2020)

- **Liste der grössten Kohlenstoffdioxidemittenten**
  https://de.wikipedia.org/wiki/Liste_der_größten_Kohlenstoffdioxidemittenten
  (last accessed: 4 December 2020)

- **Liste der grössten Flughäfen nach Passagieraufkommen**
  https://de.wikipedia.org/wiki/Liste_der_größten_Flughäfen_nach_Passagieraufkommen
  (last accessed: 5 December 2020)

- **Airbus: Maveric**
  https://www.airbus.com/newsroom/stories/Imagine-travelling-in-this-blended-wing-body-aircraft.html
  (last accessed: 5 December 2020)

IV. DECLARATION OF ORIGINALITY

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Declaration of originality

The signed declaration of originality is a component of every semester paper, Bachelor's thesis, Master's thesis and any other degree paper undertaken during the course of studies, including the respective electronic versions.

Lecturers may also require a declaration of originality for other written papers compiled for their courses.

I hereby confirm that I am the sole author of the written work here enclosed and that I have compiled it in my own words. Parts excepted are corrections of form and content by the supervisor.

Title of work (in block letters):

Authored by (in block letters):
For papers written by groups the names of all authors are required.

Name(s):	**First name(s):**

With my signature I confirm that
- I have committed none of the forms of plagiarism described in the 'Citation etiquette' information sheet.
- I have documented all methods, data and processes truthfully.
- I have not manipulated any data.
- I have mentioned all persons who were significant facilitators of the work.

I am aware that the work may be screened electronically for plagiarism.

Place, date	**Signature(s)**

For papers written by groups the names of all authors are required. Their signatures collectively guarantee the entire content of the written paper.