Visualizing Text Data in Space and Time to Augment a Political News Broadcast on a Second Screen

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Abstract: While second screen scenarios – that is, simultaneously using a phone, tablet or laptop while watching TV or a recorded broadcast - are finding their ways into the homes of millions of people, our understanding of how to properly design them is still very limited. We envision this design space and investigate how interactive data visualization can be leveraged in a second screen context. In this paper, we present the design process of a tablet application visualizing content from the stenographic minutes of the Austrian National Council.

1 Introduction

In recent years, watching TV has changed based on the significantly higher usage of mobile devices (Courtois and D'heer, 2012). Traditionally, media content was consumed with one device. TV viewing habits are changing: Viewers are increasingly using several mobile devices in addition to the TV screen. Watching TV and using a second screen (2^{nd} screen) device (e.g., tablet, smartphone, or laptop) has great potential in enhancing the user experience of viewers (Geerts et al., 2014). The study of Busemann and Tippelt (2014) depicts the rapid increase of such settings and the potential for 2^{nd} screen applications. However, so far 2^{nd} screen applications have not had significant economic success (Poggi, 2014). Hence, research is still needed to gain a better understanding of successful 2^{nd} screen viewing settings. Current studies show that the application of 2^{nd} screen settings (Kusumoto et al., 2014, Murphy and Hughes, 2014, Van Cauwenberge et al., 2014) changes TV viewing experiences into a personal and social-interactive engagement. De Meulenaere et al. (2015) focus particularly on how 2^{nd} screen applications are expected to fit into the viewer's everyday life.

TV broadcasts (e.g., documentaries or magazine broadcasts) are generally based on an extensive research generating a vast amount of data. Due to the restricted broadcasting time, this data cannot be fully integrated into the program. Yet, the utilization of interactive data visualization in regular TV formats is relatively uncommon apart from classical infographics and maps visualizations in news programs and weather shows. Most of the visualizations exhibit a relatively low information density (Boria, 2016). It is our aim to bring in the perspective of Information Visualization (InfoVis), the interactive visual exploration and communication of data, to the realm of 2^{nd} screen systems.

Even though 2^{nd} screen applications have been documented in the research literature (e.g., (Centieiro et al., 2014, Cesar et al., 2008, Eversman et al., 2015, Geerts et al., 2014, Murray et al., 2012, Vanattenhoven and Geerts, 2017)), only a few of them integrate InfoVis. The companion app for the drama series "Justified" contains a network graph (Nandakumar and Murray, 2014) for visualizing character relationships. Nandakumar and Murray's (2014) has been continued by Silva et al. (2015), who tried to visualize the characters as an extended pie chart version.

We contribute a design concept for visualizing text data in space and time to augment a political news broadcast "Hohes Haus" (ORF, 2017) on a 2^{nd} screen. We decided to target our interface designs on tablet devices following the survey of Blumenstein et al. (2016) which shows that visualization on mobile devices is more common on tablets than on smartphones. In the paper at hand, we describe our three-stage-design process: (1) definition of design requirements based on literature research, (2) design of high-fidelity concept screens, and (3) small-scale

heuristic evaluation. In the following sections, the design requirements (see Section 2.1), the data basis (see Section 2.2), and the interface design (see Section 2.3) will be described in detail. Afterwards, we come up with a presentation and exploration workflow (see Section 2.4) and evaluate our concept with a small-scale heuristic evaluation (see Section 2.5).

2 Design Process

The design of the 2^{nd} screen InfoVis concept for the political TV program "Hohes Haus" follows design requirements defined as main aims for the developed tablet 2^{nd} screen application.

2.1 Design Requirements

Studies (Holz et al., 2015, De Meulenaere et al., 2015) show that viewers use 2^{nd} screen applications for different practices: 1) to complement the first screen by filling in the gaps necessary to fully comprehend the first screen narrative; 2) to retrieve information that extends the first screen; 3) to diversify the content within the broader narrative; and 4) to provide the means to interact with the content, the content provider, and/or remote others. We designed a concept for parallel usage during the broadcast as well as for stand-alone exploration to allow for deeper data analysis. The visualization tool focuses on the location and context-oriented aspects of the data (topics of the minutes and the corresponding locations). Thus, the main aim is to show the connection between the topic of a particular minute and the corresponding location on a map over time. With this aspect of the data, we aim to establish a connection to the viewer's location, thereby allowing them to relate parliamentary topics to their respective immediate environment. The presented design requirements to visualize textual time-oriented and spatial data are based on literature research in the field of 2^{nd} screen and InfoVis, as well as an analysis of the stenographic minutes data.

D1: App for tablets: The application (app) should be designed for tablets, considering the given problems for touch interfaces such as "occlusion" or the "fat finger problem" (Siek et al., 2005).

D2: Synchronization: The 2^{nd} screen app has to support viewers via an intelligent synchronization between TV and interactive visualization (Blumenstein et al., 2015). By filtering the data of a particular topic of the broadcast, we aim to reduce the cognitive load for the user (Geerts et al., 2014, Van Cauwenberge et al., 2014).

D3: Time-oriented and spatial data: We visualize the given topics of the stenographic minutes in relation to the corresponding location over time on a map. The type of map we selected for visualization allows non-expert audiences to explore the data (Blumenstein et al., 2015, Geerts et al., 2014).

D4: Overview and details on demand: To provide areas for overview and details on demand, the interface should be designed to follow the visual information seeking mantra (Shneiderman, 1996).

D5: Filter always visible: Used filter widgets should constantly be available to users by positioning them on the top of the main view (Johnson, 2014).

D6: Parliament magazine "Hohes Haus": The political news broadcast discussing topics of the Austrian National Council is broadcast every Sunday on the Austrian TV station "ORF 2". The tool should be designed to be used in parallel during a broadcast, but also as a stand-alone exploration tool.

2.2 Data

Data Pre-Processing: The used data is publicly available from the Austrian Parliament (Parlament.gv.at, 2017). In a pre-processing step, the stenographic minutes of all plenary meetings since 1996 have been downloaded from the website and fed into a database. Meta-data from the minutes (e.g., who was speaking, at which time, were there interjections and by whom, calls to order) were extracted and saved accordingly. Further information on the politicians (affiliations to parties over time, role within parliament - i.e., government or opposition) were added to the database to broaden the query-spectrum.

Natural Language Processing: To extract and analyze the data, natural language processing (NLP) was applied (Bird et al., 2009). Due to the large amount of ready to use NLP-libraries in Python, it has been chosen for the DB-queries and analysis algorithm implementation. When applying NLP-libraries, we encountered a major obstacle: as they are primarily aimed at English text-corpora, publicly available German corpora are too small for reasonable training. Therefore, the first step was to reduce the complexity of the NLP-queries. Second, the largest available German corpus (IDS Mannheim, 2017) was tested. This corpus is freely available for academic research purposes. The following data is used for the conceptual approach for a 2^{nd} screen tablet application: legislative period, date of

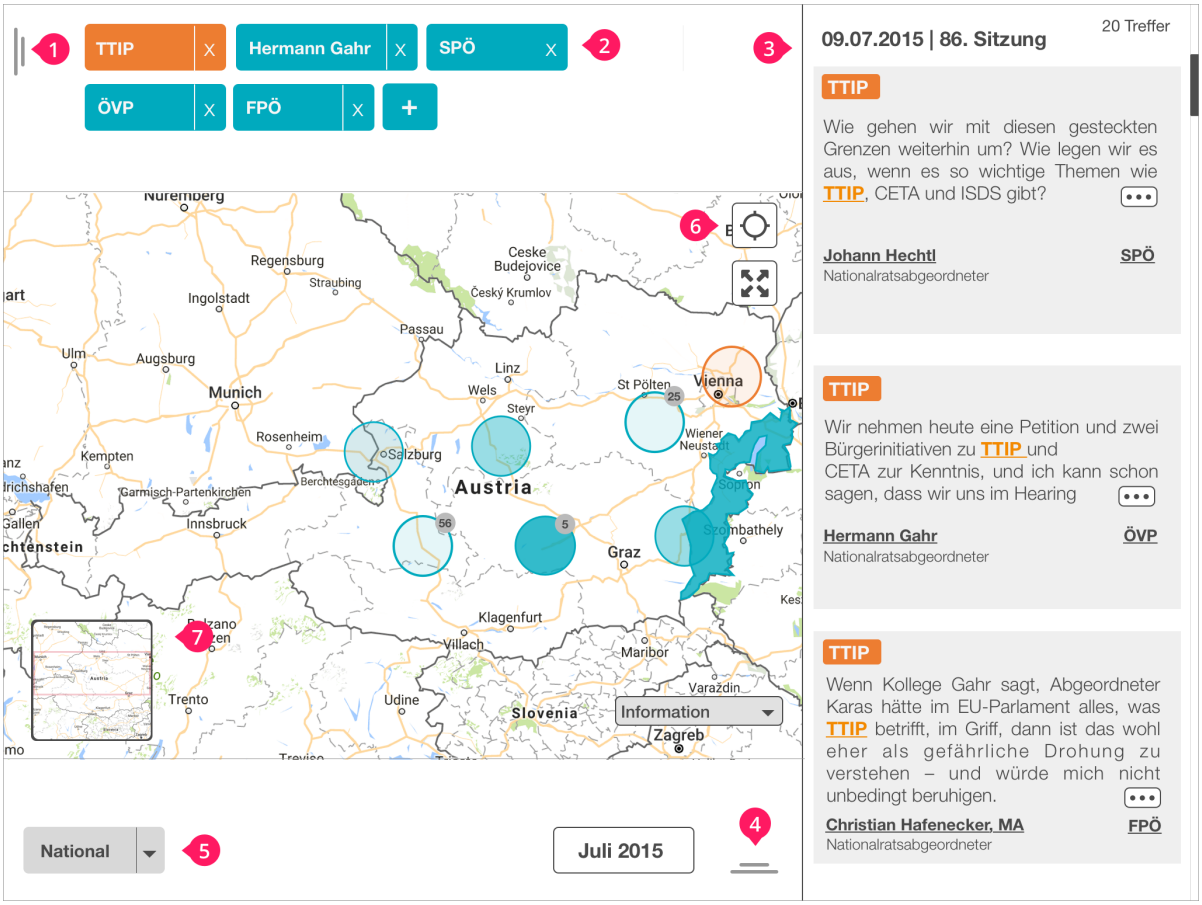

Figure 1: **Main Screen** as starting point out of a broadcast, showing the highlighting concept of a particular topic on the visualization. 1) filter for topic, person and institution 2) selected filter properties 3) detail area showing stenographic minutes of the Austrian National Council 4) filter for time component 5) drop down selection for predefined region 6) button for "my location" and "zoom out for entire map" 7) overview map.

the session, locations or areas, topic, and person. Information on institutional affiliation, professional function, and a photo are also extracted from the DB.

2.3 Interface Design

For the entire tablet application (addressing design requirement D1) we use a collection of well-established visualization methods and interaction concepts for the target group of non-experts.

Layout & Interface: As shown in Figure 1, the interface of the tablet application is split into two areas to provide a structured layout and to separate visualization from the reading area. First, the "main area" with the map visualization on the left and second, the "detail area" on the right (Figure 1 (3)), showing excerpts of the stenographic minutes depending on the information given in the main view (addressing D2 and D4). The user can open the filter sidebar on the left (Figure 1 (1)) and below (Figure 1 (4)) by using the handle elements. As seen in Figure 2, the filters are bundled in a hidden sidebar to provide enough space for the exploration of the data so as not to overwhelm the user.

In the upper part, currently filtered topics, members of the National Council, and institutions out of the broadcast are shown, designed along the common concept of tagging (Toxboe, 2017) (see Figure 1 (2), addressing D5). The user can delete a filter by tapping the "x" or opening the filter sidebar by tapping the tag element. The filter sidebar contains a tab-bar navigation through the different sections (i.e., "topics", "persons", and "institutions"), a full-text search, and a list with check boxes as filter results, seen in Figure 2. The filter results are sorted by frequency of occurrence. The sorting concept is implemented to show relevant elements to the viewer and guide them to relevant information based on the data. The relevance of information is based on the frequency with

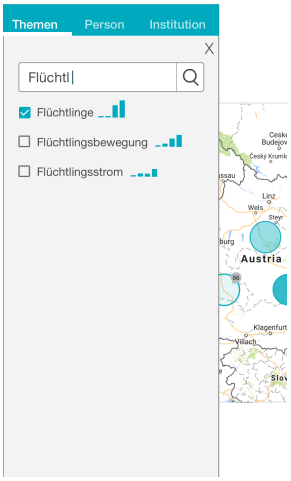

Figure 2: Filter Sidebar: Representation of the filter with the integrated sparklines showing the relevance of the results, calculated by the frequency of the topics incidence, people or institutions over the selected legislative period.

which a topic is addressed over time.

Additionally, the filter results are supported by sparklines (Tufte, 2006) to show the relevance of the results calculated by the frequency of the topics incidence, people, or institutions over the selected legislative period. Selected list elements are pinned on top to give the user selection feedback. A range slider is used to allow DB filtering by the user during a given legislative period by years. To make it easier to use, a snapping effect per month is applied.

Main Area: The main view is a map visualization representing the topics of the stenographic minutes with regard to the respective location, which is circled on the map (addressing D3). The transparency of the circles varies in order to provide the user with information on the frequencies of the topics at a certain location. We use circles instead of the common "pinning" icon for indicating a certain location on a map (unlike Google Maps). The circle symbol makes it easier to show a bundle of multiple locations on the map. We try to use a common metaphor for frequency representation by mapping the frequencies of topics to the transparency. The location circles represent both end-points and clusters of locations. By tapping on an end-point location, a zoom-in action is triggered and the user gets a detailed location view on the map. By tapping on a region cluster, it dissolves into the individual locations displayed as new circle elements on the map.

Two additional buttons for "my location" and "zoom out for entire map" (Figure 1 6) as well as a mini map (Figure 1 7) complete the map visualization. A drop down menu provides a selection of "national," "international," and "European Union (EU)" for an easier selection of countries and regions on the map.

Detail Area: The detail view contains excerpts of the stenographic minutes. The selection adapts automatically (Neil, 2014) depending on the filtered element and the zoom-in state of the map (main view). One excerpt contains the clipping of the transcript, the member of the National Council related to the transcript, and the institutions. By tapping on a topic tag within the excerpt, all relevant circles in the map and filter tags are highlighted (see Figure 1). The user thus receives a focused view on a particular topic. By tapping on the "..." button, the users get a detailed view of the particular transcript as an overlay (see Figure 3), so they can read the details of the transcript. A portrait of the speaker is integrated into the layout.

2.4 Presentation & Exploration Workflow

Interactive information visualization systems often follow the visual information seeking mantra *overview first, zoom and filter, details-on-demand* by Shneiderman (1996). Thereby, the user first receives an overview of the provided visualizations containing all loaded data. Using the system's mechanisms (e.g., filtering, zooming, selecting) the user has the possibility to interactively explore and analyze the data and search for patterns of interest. As a result, the data is visualized in detail. In case of a 2^{nd} screen application, the seeking mantra is provided by two different instances: 1) the *overview first, zoom and filter* related TV content provided by the journalist; 2) the generated *details-on-demand* are then presented to the viewer as starting point for further exploration. Thus, the application layout and information on the map are structured around three main levels:

Present the related: The user starts the exploration with pre-filtered information on topics of the broadcast.

Provide the context: Excerpts of the particular stenographic minutes are integrated on the right to provide information on a deeper level to the user.

Self-organized exploration: Enable deep data analysis by filtering data of interest (topics, people, institutions, and time) to the user.

To allow fully self-controlled exploration of the provided data, the concept also supports **reverse exploration** based on the three levels described above

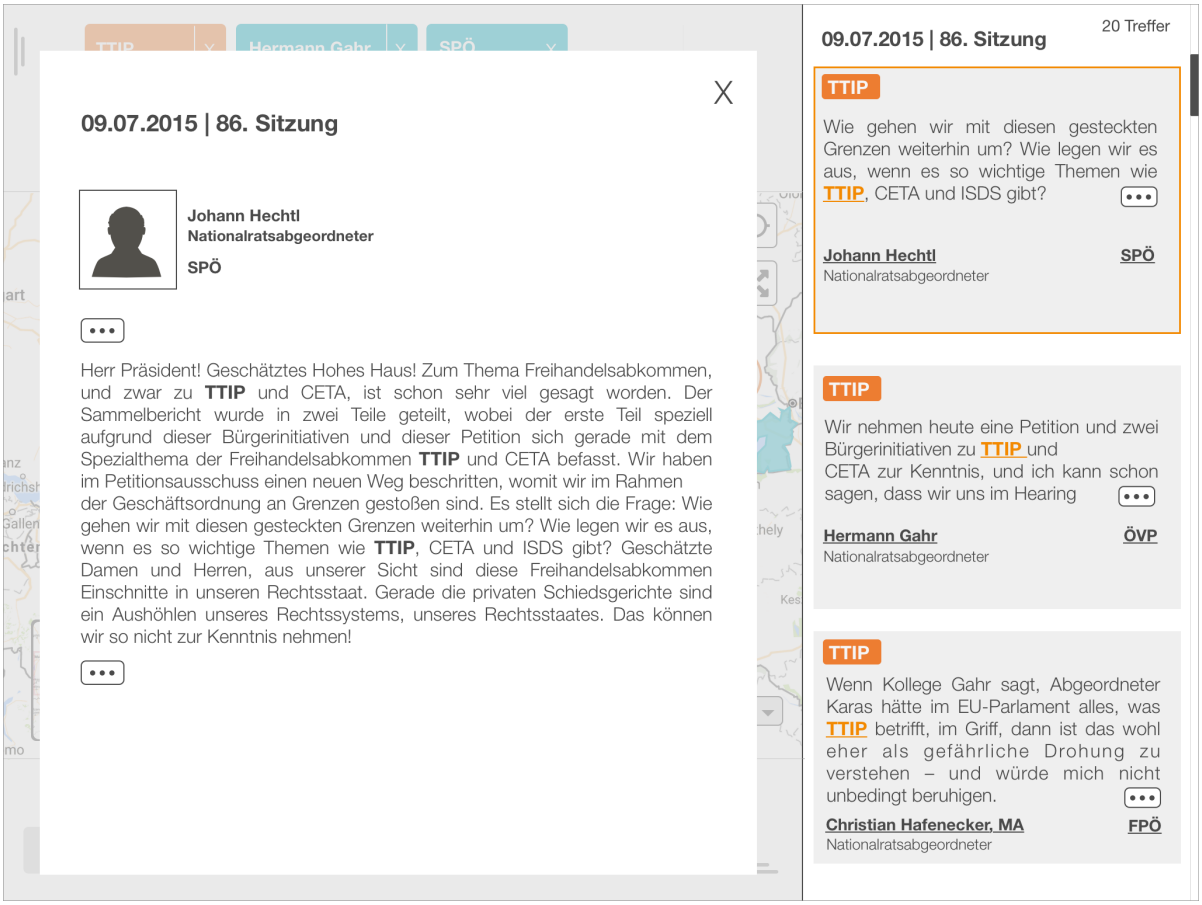

Figure 3: Detailed View: By selecting an excerpt, the detailed view is shown as an overlay with details of the transcript, name, function, and portrait of the speaker.

(*Present the related* ⇒ *Provide the context* ⇒ *Self-organized exploration*). By starting within the detailed view and going from the map to concentrating on the dataset filtering on one specific aspect of the data, reverse exploration is achieved.

2.5 Heuristic Evaluation & Results

To get feedback in an early design phase, we decided to conduct a heuristic evaluation (Nielsen and Molich, 1990) with two experts. In this section, we describe the evaluation process and discuss the results in detail.

2.5.1 Heuristics

Experts have evaluated the paper prototypes with adapted heuristics conceptually grounded on the "principles for information visualization" by Forsell and Johansson (2010) and the "10 Usability Heuristic" by Nielsen and Molich (1990). We chose the particular heuristics by complementing these two heuristic sets to cover the overall usability of the system. The following heuristics constitute the basis for the evaluation:

- *Information coding* (Forsell and Johansson, 2010)
- *Minimal actions* (Forsell and Johansson, 2010)
- *Flexibility* (Forsell and Johansson, 2010)
- *Orientation and help* (Forsell and Johansson, 2010, Nielsen and Molich, 1990)
- *Spatial organization* (Forsell and Johansson, 2010)
- *Consistency* (Forsell and Johansson, 2010, Nielsen and Molich, 1990)
- *Recognition rather than recall* (Forsell and Johansson, 2010)
- *Aesthetic and minimal design* (Nielsen and Molich, 1990)
- *Data set reduction* (Forsell and Johansson, 2010)

Heuristic	(Rating) Issue	Solution
Information Coding & Consistency	(2) Unclear visual representation of clusters on the map. Participants misinterpret the number indicating the number of grouped locations to the circle element. Also the determination of a cluster element and locations constitutes as problem.	Further research is required to explore the best representation of the cluster elements on the map. Adapt the circle element showing the number of grouped locations in the middle of the circle. This representation corresponds to the actual state-of-the-art in the visualization of clusters on a map. It can therefore be assumed that the problem is not solved and the connection between the number and the density of the topics will be reinforced. Further research is required to explore the best representation of the cluster elements on the map.
Consistency	(2) Handle element opening sidebars is unused and unclear. During the observation the subjects do not use the handle elements to open the sidebars, indicating that they do not recognize the element.	Remove the handle elements, because the user can open the sidebars in different ways by tapping a filter-tag and the date-element at the bottom.
Information Coding	(3) The sparklines in the filter sidebar are unclear due to missing axis descriptions.	Rearrange the filter list in the following way: checkbox, sparkline and the name of the result. Implement an interaction possibility to tap on the sparkline, zoom in and show axis description. Instead of the bar chart, a line chart can be integrated with an arrow at the end, indicating the trend. A user test can indicate which type of visualization technique is better understandable for the target group.
Flexibility, Consistency, Recognition rather recall	(1) "more"- button in the excerpt section was interpreted in different ways. They all guess the meaning of the "more"-button.	Instead of the button, implement a link called "more information" to prevent false interpretations. Further, also provide a possibility opening detailed information by tapping on the excerpt.

Table 1: Findings of the heuristic evaluation and suggested solutions to mitigate shortcomings.

2.5.2 Study Design

Based on the heuristics described above, two experts reviewed the paper prototypes. The participants had more than 3 years expertise in the field of usability and visualization. The male participants were aged 28 and 33 years. During the evaluation, we used the high-fidelity mock-ups and for the observation, handwritten notes and video recordings were taken. Each participant was asked to imagine a realistic TV setting in combination with the 2^{nd} screen application.

2.5.3 Results

The identified issues were rated according to Nielsen's severity rating: 1) *cosmetic problem only*; 2) *minor usability problem*; 3) *major usability problem*; 4) *usability catastrophe* (Nielsen, 2010).

Table 1 provides detailed information about the issues of the interface. Overall, the participants suggested improvements concerning consistency and information coding. Only one issue was ranked by the experts as a "major usability problem" (Issue 3). Reflecting the findings of the performed heuristically based expert reviews, the provided visualization techniques and gestures were ranked as known.

3 Conclusion & Future Work

The contribution of the paper at hand is the design of a 2^{nd} screen app on a tablet device for visualizing textual data in time and space while watching the political news broadcast "Hohes Haus". In this context, the viewer receives additional information with regard to the presented topics of the broadcast.

The concept allows for two kinds of data exploration: 1) obtaining information that is adapted to the TV broadcasting process (parallel usage); 2) interactive data exploration and analysis at their own discretion (stand-alone exploration).

During the design development, we identified a usage pattern in the context of a TV broadcast process: *Present the related – Provide the context – Self-organized exploration*. This differs from the process of user-driven interactive data visualization and exploration, which can be described by the mantra of Shneiderman (1996): "*Overview first, zoom and filter, then details-on-demand*".

Future research possibilities might include identifying how users of 2^{nd} screen apps could be guided during data exploration in relation to the context of the TV broadcast and how they could be motivated to perform data exploration which goes beyond the corresponding context. It might be necessary, for exam-

ple, to provide not only the TV broadcast related data but also the data used for story creation. Additionally, further research is needed to validate the appropriateness and usability of established InfoVis concepts a as well as the design and evaluation of novel concepts in relation to 2^{nd} screen approaches based on large-scale usability studies with the target group.

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