DOI: 10.1111/cgf.14285
Eurographics Conference on Visualization (EuroVis) 2021
R. Borgo, G. E. Marai, and T. von Landesberger
(Guest Editors)

Volume 40 (2021), Number 3

Topography of Violence: Considerations for Ethical and Collaborative Visualization Design

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Abstract

Based on a collaborative visualization design process involving sensitive historical data and historiographical expertise, we investigate the relevance of ethical principles in visualization design. While fundamental ethical norms like truthfulness and accuracy are already well-described and common goals in visualization design, datasets that are accompanied by specific ethical concerns need to be processed and visualized with an additional level of carefulness and thought. There has been little research on adequate visualization design incorporating such considerations. To address this gap we present insights from Topography of Violence, a visualization project with the Jewish Museum Berlin that focuses on a dataset of more than 4,500 acts of violence against Jews in Germany between 1930 and 1938. Drawing from the joint project, we develop an approach to the visualization of sensitive data, which features both conceptual and procedural considerations for visualization design. Our findings provide value for both visualization researchers and practitioners by highlighting challenges and opportunities for ethical data visualization.

1. Introduction

How can records of antisemitic acts of violence be visualized in a museum? This question relates not only to the historiographic challenge of remembering the past, but also to the visualization design challenge to arrive at appropriate representations for sensitive data. Through a design study [SMM12], we present our findings from and insights into a collaborative visualization design process that places ethical questions at its center: How can we find visual forms and interactive representations for sensitive historical data? How can we pursue a design process which engenders sensitivity towards the dataset and interdisciplinary collaboration? To find answers to these questions, we frame our design study by ethical aspirations and critical reflections about collaborative design of data visualizations.

In cooperation with the Jewish Museum Berlin, we present *Topography of Violence*, a set of visualizations that convey information about numerous acts of antisemitic violence that were committed between 1930 and 1938 in the German Reich. The results are an animated wall map and an interactive media station, which are integrated into the new permanent exhibition of the museum, as well as a web-based visualization† [JU20]. The project forms part of ongoing historical research that examines allegedly spontaneous manifestations of growing antisemitism before the Holocaust [Fri19]. Jews, Jewish institutions, and Jewish-owned firms and stores in the German Reich were subjected to increasing violence long before 9 November 1938, the date that is commonly associated with the November Pogroms against Jewish life in Nazi Germany. As a result of this violence, many of Germany's two thousand Jewish communities ceased to exist by the end of 1938.

With this research we pursue the question of how insightful and sensitive visualization forms can be found by involving relevant expertises and perspectives into the design process, transparently conveying data limitations, and enabling different levels of engagement with the topic. This work builds on a growing body of research on ethics and criticality in data visualization advancing the need to consider empathy, context, and power in data visualization [Cor19, DFCC13, DK20]. While we extensively draw from this work, we noticed a lack of practical implications for collaborative visualization design that incorporates ethical considerations. To address this, we contribute ethical considerations for collaborative visualization design, apply them in a case study focused on the visualization of sensitive data in a museum, and share critical reflections for future work in visualization research and design.

2. Background

Our research relates to prior work in the context of visualization in museums and for digital humanities as well as critical and ethical considerations in cartography and visualization.

† Available online at:
https://www.jmberlin.de/topographie-gewalt/

2.1. Data Visualizations in Museums

Questions of how humanistic and cultural heritage data can be visualized and presented to a broad public have long reached cultural institutions and triggered a variety of theoretical and practical research projects on visualizing cultural heritage data [WFS*19]. Most certainly, humanistic data are multidimensional, but what is more, they can be imprecise, incomplete, biased, and highly dependent on the interpreter [Dru11]. The humanities in general, but especially the digital humanities, consider themselves influenced and guided by critical thinking, asking for a reflection of their research questions, data, and methods [Reh17]. Still, questions of inclusion, ethics, and intersectionality occupy the digital humanities both on a theoretical and practical level [Ris15, LW19, GMD15]. Accordingly, the claim of building a digital—but also visual—literacy among humanities scholars has reverberated long in the digital humanities [DB18]. This is especially relevant among historians, who have long felt confident in choosing prose as their main method of communication, while implying that illustrations and visualizations were not more than a form of decoration [Sta03]. In contrast, the recently formed field of digital public history aims to document, present, and convey historical research to a broad public through digital methods, including mapping and visualizing their data, and conceiving advanced visual interfaces [Noi15].

Museums, however, already present cultural artifacts in a visual form by arranging and contextualizing them in exhibitions. Furthermore, museums have a long history of using (static or animated) data visualizations to communicate historical developments, such as urbanization [Vos06]. Since the rise of personal computing, digital tools have become an important supplement to museum experiences, with the aim to convey further information and enable active participation of visitors [Hor16, MMF20]. Museums experiment with visualizations as interactive exhibits that offer an additional mode of engaging with cultural content, such as an artist's oeuvre [HSC08], and to enter into dialogues with other visitors [HC11]. Especially when including complex visualizations in exhibition spaces, an aesthetic and informational scaffolding can help to first evoke interest and then gradually increase the analytical depth of a visualization [NPD16]. While museums increasingly implement data visualizations, they tend to be created either for use within the museum or entirely separate from the museum experience via the museum's website, yet seldom for both situations. In our research, we investigate how animated and interactive visualizations of sensitive data can be collaboratively designed for use on the museum website and in its exhibition space.

2.2. Ethics in Cartography

The field of visualization draws from multiple disciplines, in particular cartography [Ber83]. With the growing influence of computational methods in the 1990s, cartography experienced lively academic discussions on its ethical dimensions. Many academics state that cartographers are responsible for the content and morality of the maps they design [Har90, Mon91a]. This includes the awareness that every map has ethical dimensions and that cartographic design can never be neutral. Consequently, cartographers should set themselves ethical guidelines to shape their work, consider the usage context of a map and the effects of all design decisions on the map's viewers and all other participants [Har91, Mon91a]. Cartography should also be open to other disciplines to understand such contexts properly [Har91].

The ethical considerations start with the selection of data, during which the omission of important information—whether consciously or unconsciously—can lead to massive ethical consequences [Har90]. Cartographers should not see their task solely in the representation of data, but should also critically question the origin and selection of the data to be represented in the interest of an ethical result. Furthermore, Harley advocates against the undue reliance on proven cartographic conventions. Rather, ethical cartography must always search for new graphic forms to achieve a situationally appropriate representation of data [Har90]. Towards this end, Monmonier suggests to conduct extensive experiments with different design variants to find visual representations that are as appropriate as possible for a given dataset [Mon91a]. We are building on these principles in cartography and seek to translate them to data visualization in the context of museums.

2.3. Ethical Dimensions of Data Visualization

Visualizations can have a lasting impact on their viewers and are sometimes even created to influence them [PMN*14]. Therefore, the usage of visualizations should be evaluated on ethical terms [DFCC13, Cai14, HC18]. While retracing how visualization can knowingly be used to deceive or mislead—for instance, through hiding or distorting relevant data [Cai15]—visualization research has also triggered concepts and methods to visualize in an ethical manner. Diakopoulos specifies a "range of ethical considerations" that support ethical decision-making throughout data-driven visual storytelling processes [Dia18]. Tufte proposed six principles aiming to maximize graphical integrity: For instance, visualization designers and scholars are supposed to visualize numbers in proportion to their underlying value, or to visualize data within and never outside of their original context [Tuf01]. Arguably, these principles have prescribed an austerity of forms in visualization design to the detriment of their communicative and cognitive functions [BMG*10].

Looking at visualization in the context of the digital humanities, Hepworth and Church define ethical visualization as "the presentation of visualized information in ways that acknowledge and mitigate the potential for harm engendered within the visualization form and content" [HC18]. While subsequently defining an ethical visualization workflow, the authors also add a moral component to this definition, as an ethical visualization practice should consciously consider the societal impact of the design choices. What is more, visualizations in this view are never complete representations of a dataset, but should rather be opened to interventions from and with users. Considering a wider societal frame, D'Ignazio and Klein put forward feminist principles to recognize the hegemonic categories and power structures embedded in data practices [DK20]. Campbell proposes "Techniques for Appealing to Emotion" that engage, humanize, and personalize visualizations for a specific public [CO19]. Nevertheless, the visual abstraction used in information visualization can also lead to a loss of empathy towards the people or topics they represent [Cor19]. To counter this distancing, visualization designers should work in interdisci-

plinary teams and borrow techniques from related disciplines such as data journalism or rhetorics, and search for individual, nuanced, and novel representations to foster empathy [BPE*17, Lup17].

3. Towards Ethical and Collaborative Visualization Design

While our study builds on design as a subjective method which tackles a concrete problem in close collaboration with domain experts [MD20], our work has been particularly inspired by prior writings on ethics in cartography and visualization that define principles and propositions for an ethical orientation of the visualization design process. To be able to assess the used methods and taken decisions in our design process, we propose a series of aims, which are derived from these writings, to imbue the collaboration process of visualization design with *ethical aspirations (EA)*. These aspirations form the foundation for an ethical visualization design process that outlines concrete qualities for the collaboration with experts and stakeholders as well as a deep engagement with data and visualization.

Visualizations should be useful and informative for a variety of users: considering both the use of visualizations and the thematical background knowledge, different people bring different knowledge and demands—from novice to professional. Designing for potential users and stakeholders includes the study of their needs, the development and design of concepts and design solutions, as well as the testing of resulting products [Nor88]. Too often, information visualization focuses on design processes that are either mainly data-driven or only involve users for testing or evaluation purposes. Methods like participatory design or co-design are suitable to establish a productive and trustful work-environment: Here, experts and audiences become active participants in the design process themselves [SS08]. *EA1: Involve target groups and domain experts actively in all relevant decisions of the design process to ensure an appropriate and sensitive outcome.*

Besides the visualization design process and the context of a visualization, a main factor which adds to a visualization's trustworthiness is the underlying data [MHSW19]. Here, criteria such as accuracy, coverage, objectivity and validity can be seen as a measures that lead to a high trustworthiness of a dataset [KFW08]. It is therefore important to openly consider, confront, and convey any biases, issues, or flaws that might occur inside the data. This does not only include gaining a deep understanding of the dataset, but also discussing these topics with the experts, and ultimately searching for design options that are able to convey the limits of the dataset through the visualization itself. *EA2: Openly communicate limitations of the underlying dataset throughout the process and in the resulting visualization.*

When people perceive and make sense of a chart, diagram, or visualization, they bring with them their personal and cultural perspectives and a variety of memories, associations, and emotions. Any visualization itself is part of a tradition of graphical forms for knowledge representations [Dru14]. When striving towards sensitivity in visualization design, it is paramount—though challenging—to consider these latent qualities of a visualization. Visualization abstraction can lead to a gap between the proven injustice of a matter and its visual representation [Cor19]. Therefore, the visualization should use visual encodings that are suitable to express the datasets' nature or ethos [BPE*17]. *EA3: Consider unintended associations with visual encodings and practice sensitivity and care in the use of symbols and other visual forms.*

To ensure interaction on the basis of different interests and to convey the complexity of topics and datasets appropriately, the visualization should allow for various levels of engagement with it. Viewers or visitors should be able to explore and learn about the topic on a level and detail of information that they see as suitable for themselves. The visualization should therefore allow them to start by gaining a basic overview of the topic in a simple and easily comprehensible way, while offering more detailed information on demand [Shn96]. Particularly interested users can aim for an in-depth form of engagement and seek to actively participate in contributing to the visualization and its underlying dataset [VJTVM13]. Such interactions should be encouraged by the visualization itself. *EA4: Support various levels of engagement with the visualization and the overall topic.*

4. Case Study: Topography of Violence

To assess the viability of the ethical aspirations, we present a case study about the visualization of sensitive historical data in a museum setting with the involvement of historiographical and museological expertise. The project *Topography of Violence* was based on an interdisciplinary cooperation between the Jewish Museum Berlin (JMB) and the UCLAB, a visualization research group at the University of Applied Sciences Potsdam. The core project group consisted of two staff members of the museum's department of digital publishing, the chief archivist with a research background in Judaism, the curator of the exhibition section, as well as three members of our research group with backgrounds in interface design, information visualization, and digital humanities. The collaboration was carried out between September 2019 and August 2020. Meetings were held—first in person and later remotely—approximately every second month to discuss the progress, exchange feedback, and decide about further steps.

The JMB thematizes Jewish life and culture in Germany's present and past. Its permanent exhibition progresses in time linearly, from the first traces of Jewish life and culture in Germany to the present. Our research focuses on a crucial span in this timeline: the years 1930 to 1938, during which the National Socialist movement seized power over Germany. For German Jews, this development was increasingly life-threatening, as violence against them rose rapidly. The aim of the case study was to design two visualizations showing the rising numbers of antisemitic attacks in these years: An animated wall map geographically and chronologically visualizes the acts of violence and is displayed in the exhibition space; and an exploratory interface allows for in-depth research during an exhibition visit or via the JMB website. In the following, we share insights into our collaboration, from the underlying dataset and the design process to the resulting visualizations.

4.1. Dataset

In light of our ethical aspirations (EA1), the domain experts working on the dataset were included in the process from the beginning

and invited to share their insights and inputs throughout the collaboration. The dataset was researched and aggregated in a prior meta-study [Fri19, FK20] and ultimately combined with a second one containing historical information about all known German synagogues at the time. The merged dataset includes 4,660 acts of violence between the years 1930 and 1938. Each of these records belongs to a category based on the attack's target: Violence against Jews, against Jewish organizations, or Jewish businesses. Each entry may also include a date, information about perpetrators, the place, a descriptive text, and the sources. Despite the effort of evaluating both primary and secondary sources on the subject, the dataset cannot be considered as representative and complete, neither from a geographical nor temporal point of view:

Geographical bias: The underlying historical research project aimed to research acts of violence in as many places as possible but was naturally limited in time and resources. Therefore, not all acts of violence in bigger cities were fully researched. Some cities might therefore be underrepresented in the dataset. For other geographical areas, no comprehensive sources and studies exist so far and the data must therefore be seen as indefinitely incomplete.

Time bias: The interest of historical research often focuses on the years 1933, 1935, and 1938, when the majority of antisemitic attacks took place. The sources suggest that antisemitic attacks in the second half of the 1930s were no longer systematically recorded by authorities and journalists due to a "habituation effect" [Fri19]. The authorship of the sources, which are largely based on information provided by perpetrators, also has a distorting, sometimes "tendentious" effect. The dates for many attacks are incomplete in the historical sources, often including only the year of the incident.

These limitations became evident in the first data analysis and talks with the experts. The insights from these early analyses and basic visualizations were shared within the project group and discussed throughout the process to find appropriate solutions to disclose them in the resulting visualizations (as per EA2).

4.2. Co-Design Workshop

The workshop represented the transition between two phases in the design process. Prior to the workshop, the main focus was the initial exploration of the data, research on historical backgrounds, and the definition of the basic goals of the visualizations. The results of the workshop served as a basis for the following conception and the visual design and also ensured the implementation of the ethical aspirations. Therefore, several concrete objectives for the realization of the workshop were formulated:

1. *Expectations of experts.* Determine which (a) associations and (b) knowledge the animated wall map should convey.
2. *Suitability of visual representations.* Discuss which forms correspond to experts' expectations and are suitable for visualization.
3. *Relevant perspectives on data.* Find out which parts of the data and which perspectives on them might be interesting for visitors.

In addition to the core project team, the project manager for the conception of the new permanent exhibition and one of the historians responsible for the dataset participated in the workshop. The participants had different levels of knowledge regarding the existing data, but also regarding design, cartography, and visualization.

Figure 1: *Overview of the utilized visual artifacts, grouped by unfavorable (left) and favorable (right) inspirations.*

As an additional insight, the museum's staff members were able to share insights into the target groups and regular visitors of the museum, which helped to align the workshop's focus to the expected target groups (EA1). Based on the previously defined objectives, we divided the workshop into three phases: First, a brainstorming session on the desired effect of the animated wall map; second, a discussion about appropriate visual forms; and third, the design of collages to open new perspectives on the data for visualization.

Brainstorming. We asked the participants what knowledge and impression the animated wall map should leave on visitors. Their written answers were collected, grouped, and discussed. In this way, we identified several relevant requirements for the visualization, which were associated with four different categories:

- *Meaning for visitors*. The animated wall map should raise questions (e.g., about historical backgrounds) and arouse curiosity (e.g., to find out more about the events in one's own home town). In this way, visitors should ideally be directed to the research station, where they can obtain detailed information.
- *Geography of violence*. The animated wall map should give an overview over the spatial distribution of the assaults. Particular regional differences should also be visible.
- *Time course*. The animated wall map should make the temporal development of the outbreaks of violence visible. It is intended to illustrate the growing pressure on Jews and the drastic increase in violence over the years [FK20].
- *Context*. The animated wall map is located in a room together with a collection of antisemitic laws from the 1930s. Before entering, visitors already visited rooms that provide information and exhibits on Jewish life prior to these years. It can therefore be assumed that visitors to the museum are sufficiently informed about the basic historical contexts and that the animated wall map itself requires little explanatory information. Nevertheless, for the web interface, which can be used by both visitors in the museum and remotely, a narrative introduction is needed.

These collectively defined requirements formed the cognitive basis for the second part of the workshop, which dealt with the selection of suitable visual forms for interactive visualization.

Visual forms. To facilitate a productive exchange about suitable visual forms, 26 visual artifacts were selected as a basis for discussion (see Figure 1). They were excerpts from existing visualizations or maps [DW16, Inf19], but also partly artistic or completely

abstract works. The artifacts represented a wide graphical range of different colors, shapes, and visual complexity and were chosen with this diversity in mind. This was intended to expand the participants' imagination about possible visual aesthetics and encourage them to articulate visual ideas using the examples (EA3). In order to guarantee a discussion that was as open-ended as possible, it was ensured that the selected visual artifacts did not tell what kind of data they represent. During the discussion, the participants discussed the visual artifacts one by one and gradually sorted them into two groups. While a large part of them did not appear to be suitable for use, several of the artifacts encouraged an open exchange:

- *Animation.* Participants repeatedly expressed interest in artifacts that represented elements additively, e.g., different sizes of overlapping circles. Additive forms were favored for a gradual appearance in the animation to ensure a lasting visual presence of data points and to make their temporal development visible.
- *Impacts.* The group generally considered visual forms that resembled "impacts" to be interesting, however, had reservations about too figurative resemblance with bombs or explosions.
- *Arrangements.* The group expressed skepticism about forms that created a "grid-like", "physical", or "organic" impression because of the direct and controlled character of antisemitic violence in the German Reich. The same applies to map sections that are based on classical topographic representations, for instance, the usage of isoline-like shapes.
- *Colors.* Black-and-white representations were believed to be less suggestive and therefore more appropriate than saturated colors that may carry blatant associations (e.g., red equals blood).
- *Textures.* The group instinctively associated some visual textures with associations such as "cloud pictures", "wildfire", "blood", or "ashes." Such associative visuals were rejected.
- *Omissions.* An artifact that contained blank spaces as omissions in various forms was taken up the most and the omissions were associated with the terms "erased" or "taken out."

It is noticeable that there was considerable agreement among the participants on some points, such as the rejection of color or specific visual forms. This stemmed mostly from a historiographic and Judaistic perspective which has to carefully weigh the need for visual representation against an inappropriate choice of forms which might for instance replicate the oppressors' language (e.g., "bombing") or show the violence as something that happened "naturally" (e.g., clouds, wildfire). Over all, it was concluded by the participants that it might be necessary to generate new visual forms specifically for this project.

Collages. In addition to seeing the introductory animation in the exhibition space, visitors should be able to engage more deeply with the data via an exploratory interface (EA4). To determine which perspectives on the dataset and what kind of interactions would be interesting and suitable, the participants in the workshop worked on possible approaches by creating collages [CDDR14]. We provided the group with historical material, such as photos and texts from the 1930s as well as a data package. Each of the data packages contained excerpts from the dataset, a simplified cartographic illustration of the data from 1930 to 1938, and a graph showing the overall chronological course of the dataset. The participants were asked to imagine a particular visitor (or group of visitors) as a representative persona and express their possible interests and perspectives on the topic in a collage individually. Afterwards, the group interpreted the collages together. The resulting collages showed several perspectives on the data and ways to explore them (see Figure 2):

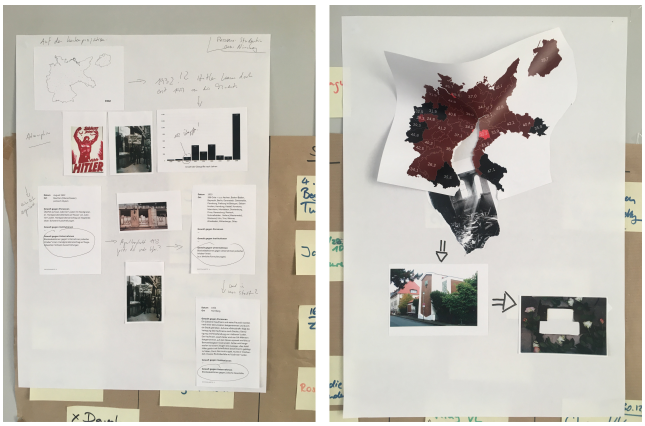

Figure 2: *Two collages created during co-design workshop.*

- *Time.* Exploration could happen through the visualization of temporal patterns and outliers in the data. As usual, exploration could start from an overview and offer details on demand through interactive functions, e.g., applying filters.
- *Location.* A starting point could be on a specific location of interest. The available data entries for this location would subsequently be examined in more detail.
- *Target.* The exploration could also begin with the selection of a target of assaults—such as institutions, symbols, buildings, or life. This involves searching for specific targets or keywords, such as "cemeteries" or "synagogues."

Some collages showed multidimensional perspectives on the data:

- *Time and place.* The combination of time and place could serve as a common filter, for example, to show the number of attacks at a location on a certain date.
- *Combination of all perspectives.* Starting from the location, all the perspectives mentioned above could be combined. This scenario is conceivable, for example, for a group of visitors who want to learn every detail about the events in their home town.

During the interpretation round and the closing discussion of the workshop, the participants exchanged preferences and weighed in on promising and problematic ways of visually encoding and interactively exploring the data records. Given the created collages, it is noticeable that the majority of participants regarded the local distribution of the assaults as relevant. Also, they considered the use of combined perspectives to be beneficial. It was thus a wish for the interactive prototype to be able to filter data by their different dimensions and focus on a specific section of the dataset. Concerning the animated wall map, the participants emphasized that it should focus on the presentation of the main historical developments, mapping the time and place of attacks on a map. At the same time, as in the exploratory web interface, each individual event should be visually

Figure 3: *The co-design process resulted in two visualizations displayed side-by-side in the permanent exhibition of the Jewish Museum Berlin: a cartographic animation projected on a map silhouette (left) and an exploratory interface accessible via a touch display (right).*

discernible to convey both an overview, see connections between the attacks, and give access to all individual records (EA4).

4.3. Design

The co-design workshop was the start of a continuously collaborative design process involving frequent feedback sessions. The ideation was guided by the ethical aspirations and the iterative exchanges with our collaborators. In this section we present the final results yielded from this process. Within the scope of the case study, two visualizations were designed, implemented, and deployed in the museum's re-opened permanent exhibition: an animated wall map and an exploratory web interface (see Figure 3).

The **cartographic animation** is produced as a video loop and projected onto a physical wall map using a projector. It serves as an introduction to the exhibition section that deals with the years 1930–1938. The wall map was therefore supposed to have a scenic effect and introduce the visitors to the topic. It has the shape of the German Reich within the borders of 1937, the last undisputed geographical extent before the expansion in violation of international law, and is mounted floating in front of a white wall, about 4.5 meters wide and three meters high.

While the animated wall map was intended to arouse the interest of the visitors on the topic, the **exploratory interface** deals with the topic more intensively. Users can explore the dataset via a web interface on a touch screen. In addition to a map view, further visualizations are offered that show the dataset from different perspectives (places and targets of violence, timespan, and perpetrators). While designed primarily for use on a touch screen in the museum, the JMB also hosts a web-accessible version online [JU20].

As both visualizations are part of a single project, they have a common, coherent visual language—both in terms of the visual design and encoding. In the following, we will therefore discuss the basic visual representation and the design considerations behind them. According to the iterative approach and ethical aspirations, a large number of variants and intermediate results were produced. Those were evaluated with domain experts to ensure that they represent the topic and the data in an appropriate and sensitive way (EA1, EA3). The most important of these decisions are discussed here and related to the workshop results, the ethical aspirations, and feedback from exchanges with our collaborators.

4.3.1. Visual Representation and Cartographic Visualization

All acts of violence are shown in a single cartographic visualization. This visualization is used as a basis for both the animated wall map as well as the interactive application. Each act of vio-

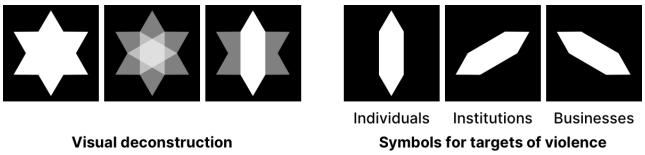

Figure 4: *Visual encoding based on the Star of David.*

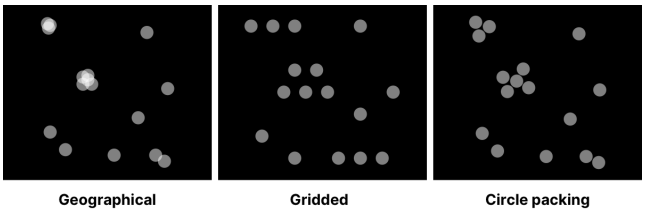

Figure 5: *Comparison of examined spatial alignment techniques.*

lence should be represented by a **symbol** that encodes the target of the attack—against Jews, against Jewish institutions or Jewish businesses. To make them distinguishable, different *shapes* and *orientations* were taken into consideration and discussed with the experts, while taking the following criteria into account:

1. *Power of expression*. All symbols must have equal power of expression. Thematic symbols must not be used as generic shapes.
2. *Differentiability*. All symbols must be easily distinguishable from each other.
3. *Formal language*. All symbols must appear in an equal and fitting graphic style.

During the design process, various combinations of symbols were developed and evaluated on the basis of these criteria (EA3). While generic shapes such as circles or squares are easily distinguishable, however, their assignment to the three categories above seems arbitrary and detached from the topic of the visualization. The use of Hebrew glyphs, on the other hand, promised a meaningful symbolization for the three targets of attack, but was met with clear rejection by the experts and Jewish people at the museum.

The final idea comprised the graphical modification of the *Star of David*, which is formed by two triangles interwoven in the shape of a hexagon. Today, the Star of David is a central symbol of Judaism and can be found in Jewish cemeteries, in synagogues, and on the Israeli flag. To represent three categories in the visualization, the star was geometrically deconstructed to extract three hexagons (see Figure 4). The vertically oriented hexagon is used to illustrate attacks directed against humans, as it is remotely reminiscent of the human silhouette. Jewish institutions are encoded by a hexagon leading from the bottom left to the top right. The remaining hexagon, leading from top left to bottom right, is used to depict assaults against companies. The usage of these shapes also offers the possibility of visually representing combinations of categories: For instance, attacks that were directed against several targets can be encoded. In talks with the experts, the symbols found broad approval since they established new visual forms while being slightly reminiscent of a traditional Jewish symbol. The grouped representation of the symbols was found to create interesting patterns and a graphically evocative effect. Furthermore, the symbols were seen to be easily distinguishable even in small scales.

Colors can have an associative effect, even when they are not directly linked to a specific symbolic meaning [Hol11]. During the co-design workshop, all participants consistently expressed that some colors had a suggestive impact on them or that colors lead to unintended associations, which they deemed unsuitable. This effect was not observable for achromatic colors, such as white, gray, or black shades. We built upon this observation and limited the color use in the visualization to achromatic colors. As the animation is supposed to be projected onto a physical map, we opted to display the symbols in white. To ensure visual consistency, we applied this coloring principle in the exploratory interface, too.

The **spatial alignment** of events raised a difficult challenge about the accurate and appropriate visualization of the data (EA2). As many acts of violence occurred in densely populated areas, visualizing them as single icons on their correct geographic position would lead to numerous overlaps and visual clutter. To ensure the equal visibility of every single event, do justice to the victims, and take into account the preferences expressed in the co-design workshop, overlaps needed to be avoided. A method described by [Mon91b] as *displacement* was used to reach this goal. To implement displacement and layout symbols on a map, two basic methods could be used: (a) aligning all symbols to a grid or (b) aligning them dynamically, using a circle packing algorithm (see Figure 5, middle and right). Using a grid leads to a coherent, but artificially aligned result, which was met with skepticism during the workshop and does not do justice to the nature of the data: the violence occurred not in a grid, but in irregular geographical patterns. Circle packing allows to preserve this impression and was therefore used to position the acts of violence on the map.

4.3.2. Cartographic Animation

The cartographic animation (see map silhouette in Figure 3 and still frame in Figure 6) runs through the years 1930 to 1938 at a constant speed of about one second per month. At each turn of the year, the respective year is displayed to allow viewers to locate the visualized attacks in time. For each act of violence, a symbol fades in once the event's date is reached. All symbols remain on the map until the end of the animation. As suggested during the co-design workshop, this creates an additive, complete representation of the assaults from the observation period. The simultaneous presence of all prior attacks reflects the increasingly growing pressure and the high density of violence against the Jewish population. When fading in, the symbols initially appear large and almost transparent. Immediately after their appearance, they transition their size and opacity and are finally displayed smaller and opaque. This speed of the individual transition is not the same for all symbols, but is slightly randomized in several points to create subtle visual differences. During the transition, individual symbols also change their opacity and size randomly against the trend and are thus displayed larger and more transparent for a fraction of a second. This adjustment leads to the impression of a short flickering or rearing up. Animations adapted in this way appear less peaceful or fluid and more abrupt, disturbing, or violent to appropriately convey the violent character of the assaults.

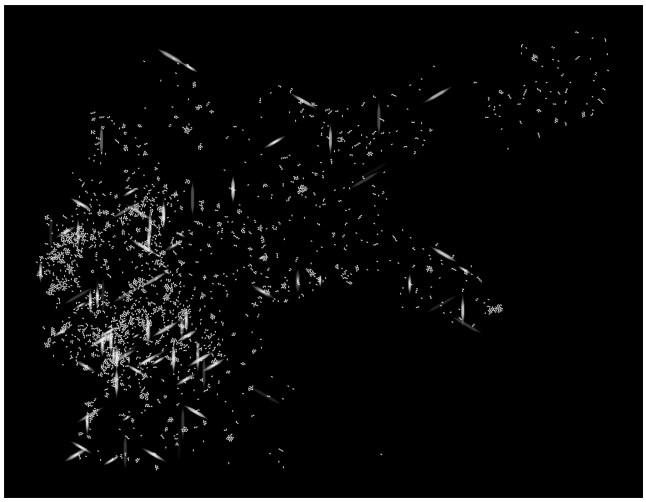

Figure 6: *Still frame of the cartographic animation.*

Figure 7: *A part of the visualization without (left) and with (right) active filtering.*

4.3.3. Exploratory Interface

The exploratory interface also contains the cartographic visualization included in the animation (see Figure 8). The interface is intended to be used on a touch screen in the museum as well as for web-based use on various devices. It consists of three interconnected parts: the filter panel on the left side of the screen, the visualization in the middle, and the list panel on the right side of the screen. Visually, the interface is kept in dark colors to provide a clear contrast to the light hexagons representing the attacks. Its background is a very dark, almost black blue-grey and the interface elements are colored in dark grey or blue tones. Active elements are displayed in a lighter blue tone. Texts are set in white or light grey tones.

The upper part of the **filter panel** on the left displays the number of currently visible events. The phrase "3,174 of 4,660 registered acts of violence" indicates that the dataset cannot be considered complete, as described above. The interface thus follows the aspiration for transparent data handling (EA2). The search field placed below allows a guided search in the dataset, searching for matches along the different categories. In addition, it is possible to find results in the descriptive texts of the assaults using a full-text search. The application also allows to filter the dataset along different categories: Places of attacks, targets of attacks, time and perpetrators. The filtering is not done on separate interface elements, but directly in the visualization itself. All filters work in combination across the individual perspectives. They are applied to the visualizations as well as to the detail view. At the bottom of the panel, visitors are invited to enter a contact form to report further attacks that have not yet been recorded. This offering allows users to go beyond interaction with the visualization itself and to actively contribute to its base data (EA4).

The **main view** initially contains a cartographic map that visualizes all acts of violence at once. All applied filters or searches are applied to the symbols, which are either faded out into a darker tone or rearranged accordingly. Zooming on a map section applies this selection as a geographical filter for the dataset, and only attacks within the visible map area are displayed in the list panel. When applying a time filter, a temporal visualization replaces the map which represents the historical course of the attacks in a histogram (see Figure 8, top right). Cluster visualizations are used to visualize data regarding the perpetrators and targets of violence (see Figure 8, bottom right). Here, the data points are grouped into circular clusters. Each individual cluster can be selected to be applied as a filter on the dataset. When switching between the cartographic, temporal, and clustered view, the symbols transition to their new positions fluidly [EMJ*11]. Through visualization changes and transitions, a filter never leads to the disappearance of an attack. Acts of violence that are not matched by the current filter are not displayed in a bright gray, but in a darker shade (see Figure 7). Like this, the complete extent of violence is always visible and present, while it is clear which attacks are currently selected and available in the list panel.

The **list panel** on the right side shows information about all displayed attacks in a scrollable list of cards. To preserve a clear visual layout, each card initially shows only the date, place, and description of an act of violence. A card can be expanded to display additional data like sources and classifications into categories. The cards are ordered by the level of detail their data provides. This ensures that cards with a high informational value are easy to reach.

5. Critical Reflections about Ethical Visualization Design

At the beginning of our design process, we formulated a combination of requirements that we aimed to reach. The ethical aspirations represent those requirements. They enabled us to pinpoint a set of desirable sensitive outcomes and allowed us to discuss, check, and argue potential decisions between the collaborating experts and ourselves. Throughout the case study, we recorded observations concerning the viability of the approach and the resulting design. While we are confident that the result of the case study deals with the historical data responsibly, there are some aspects of this research that need further discussion. Based on our own observations, the responses by others, and related research, we share critical reflections along our ethical aspirations. These reflections are explicitly not formulated as design guidelines, considerations, or recommendations, but may rather serve as potential anchor points for ethical visualization design in other contexts.

Figure 8: *Initial state of the exploratory interface; right: View of the visualization for time (on top) and perpetrators (below).*

5.1. Limits to Involvement

Collaborative and participatory methods are well-established techniques in interaction and visualization design, and are destined to be included in an ethical visualization design process. For example, domain experts as well as those who are potentially affected by or will make use of a visualization need to be involved (EA1). With Topography of Violence, the involvement of experts—from historical, Judaistic, and museological backgrounds—has significantly contributed to the design process, both in terms of idea generation and deliberation about different variants. The co-design workshop at the beginning of the process stands out, yet the iterative process that followed in the form of meetings and discussions ensured the frequent exchange of feedback, negotiation of design directions, and the coordination of the joint work.

There are limitations to the circle of people involved in this process. While the detailed records by historical scholars and accounts shared by survivors form the foundation of the visualization, it is important to note that neither visitors nor descendants of victims were directly involved in the project. Arguably, this is a missed opportunity to include the perspectives of the people whose lives or livelihoods have been destroyed by the visualized acts of violence. The potential group of experts to be included into such a visualization design process is typically larger than seems to be practically feasible at first. While the data collection and historical research have been explicitly set up to be ongoing and open-ended, this framing could also be extended to the data visualization.

Unfortunately, we were also unable to evaluate or validate the visualization with exhibition visitors or other potential users due to the ongoing pandemic. While we are confident that the work with domain experts led to valid and sensitive results, we would argue and recommend to involve additional groups of people (EA1) to strengthen the project's outcome and to include sufficient deploy time into the project [SMM12]. For future work, the prototype could be discussed and tested for use and effect with both victim's descendants and visitors in the museum.

5.2. Data Issues

The data underlying a visualization has to be verifiable and transparent (EA2). Criticism, objections, suggestions, or additions to the data basis and visualizations must be heard and taken into account. It should be ensured that relevant additions and criticism are possible at each step of the process and also after the visualization's completion. The visualization process should be seen as a research tool itself, as it can convey the limitations of a dataset: In our case, this meant the disclosure of blank spots on a map, which lead to a revision of and addition to the dataset. While such iterations and discussions about the limitations of the data are important, the visualization itself should also make them visible.

In the case of our project, it was important to include the limitations of the dataset in terms of its incompleteness. Accordingly, the visualization shows the total number of documented cases ("4,660 registered acts of violence") and explains the circumstances of the incompleteness in detail on demand (museum version) or in an introduction (web version). What is more, it is possible for users to submit further cases via the web interface (EA4). The visualization also allows users to learn about each single attack by reading its description or researching it in the historic sources that are listed for each entry. Still, the utilized dataset shows geographical and temporal biases that could not fully be taken into account for visualization. Early acts of violence were often well described and included the victims' names and even personal details, while the historic sources got less detailed as the number of attacks rose over the years. To treat all attacks and victims equally, we intentionally decided not to show any personal specifics about victims to achieve

a similar level of detail for all entries. While this poses an opportunity for future research, both on a project as well as on a more general level, we believe that new narrative and visual forms need to be found to better acknowledge the gaps and biases in data.

5.3. Visual Sensitivity

An ethical approach to visualization design needs to carefully consider unintended associations with visual encodings such as symbols (EA3). In our visualization, the Star of David lays the graphic foundation for the symbolization of violent acts against Jews, Jewish institutions, and Jewish businesses. While this symbol is today commonly known as a representation of Judaism itself, in the 1930s, the National Socialists perverted its usage and misused it as a symbol of oppression and exclusion. We are aware that there is a risk of unintentionally replicating the attackers' visual language, symbolism, or intention and discussed this with the experts. Consequently, we use a deconstructed version of the Star of David and tried to frame it oppositely: not as a badge to separate Jews from society but to indicate where the society failed their Jewish members and committed attacks and injustice against them.

It nonetheless needs to be considered that statistical forms and visual symbols can be used in an ethical, but also in a deeply unethical way. A telling example is the usage of statistics and infographics during the German National Socialism [Cor19]. Statistical methods were also central mechanisms of the lethal machinery of the Holocaust, and information graphics were used to cover the cruelty and injustice committed against minorities. It is our responsibility as visualization designers to find a way to differentiate our work from perpetuating the aesthetics and techniques of destructive and hateful quantification. As for visual encoding, there cannot be a single solution for such a task. The boundary between our own ethical standards and the misuse of related techniques must be defined and made clear each and every time.

What is more, visual forms can disguise individuality. In our visualization, every hexagon stands for the suffering of humans, the destruction of a building, or even lives. Considering that personal and relatable aspects of data and visualizations have a broad impact on potential viewers [PAEE19], we have to ask whether empathy can be felt towards a symbol which will to a certain extent hide the individual fates of people affected by this violence. For future work, it might be possible to include selected cases in detail, for instance by showing names of victims in the animation or including more elaborate accounts by the victims. But seen from a different angle, it would be neither possible nor ethical to quantify the impact of an attack, as it would allow to compare different violent acts and individual fates with each other. Here, we see a great need for future work to investigate the sensitive representation of oppressed groups and individual fates within them.

5.4. Levels of Engagement

An ethical design process cannot be limited to the visual representation: it needs to consider the entire process from the thematic conception, the data collection and processing to the implementation of the visualization and supported interactivity (EA4). In our case study, this included getting involved in the refinement, selection, and extension of the utilized dataset. We could spot gaps and biases in it and initialize the addition of further entries together with our partners. These exchanges have also led to inviting users of the visualization to add missing knowledge via a form, and thus engaging much more actively with the issue. Still, as mentioned for (EA1), the inclusion of a more diverse audience would have benefitted the project and probably have lead to even more ideas of participation and levels of engagement. For this, a user testing would have been beneficial, although the wishes and needs of the audience arguably have to be balanced with what is possible in a given amount of time and resources.

Another form of engagement emerged briefly after the opening of the new permanent exhibition of the JMB and thus the launch of the visualizations. We had the chance to collaborate with a German newspaper which featured the exploratory interface on their website as an embedded data visualization along with an interview with the historian and archivist we collaborated with [LM20]. While these discursive and public engagements could not be planned for, we believe that it is of great importance for projects to actively search for contact and cooperation with related disciplines and try to incorporate a diverse set of methods into the design process, marketing its results, and broaden its impact.

6. Conclusion

Based on the notion that datasets on sensitive topics need to be processed and visualized with an additional level of carefulness and thought, we formulated a set of ethical aspirations and described their application throughout our work on *Topography of Violence*. With this case study, we presented results and reflections from a participatory design process, including a co-design workshop with domain experts and further partners. By describing and explaining our major design decisions, we demonstrated how a participatory approach can foster an ethical and collaborative design process. The case study resulted in the creation of two visualizations that represent a dataset of 4,660 acts of violence against Jews and Jewish institutions in 1930s National Socialist Germany. Both visualizations—an animated wall map and an interactive media station—depict the increasing pressure that these antisemitic attacks created on Jewish life. While the animated map serves to provide an overview of the temporal and spatial distribution of the attacks, the exploratory interface allows researching the dataset in more detail and along further dimensions . Resulting from our experiences and in response to our own ethical aspirations, we shared a set of critical reflections that sum up our lessons and may be suitable for similar efforts by both visualization practitioners and researchers. However, these reflections are based solely on one case study. We see great potential for future research in widening this view and developing more robust guidelines based on the experiences from several comparable projects.

7. Acknowledgments

We would like to thank the project team at the Jewish Museum Berlin, especially Sarah Binz, Michael Dorrmann, Dagmar Ganßloser, Mischa Geiger, and Aubrey Pomerance. Furthermore,

we would like to express our gratitude to Christoph Kreutzmüller, Jana Fritsche, and Marc Grellert for the underlying data and historical research and to Boris Müller for his advice on visual and interaction design. We are grateful to Mark-Jan Bludau, Sabine de Günther, Francesca Morini, and Fidel Thomet for their feedback on drafts of this paper. Finally, we would like to thank the anonymous reviewers for their positive feedback and constructive suggestions.

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