Illustrative Data Graphics in 18th–19th Century Style: A Case Study

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1 Introduction

The well-known historic hand-made visualizations that were created in the 18th and 19th centuries by artists such as Charles Joseph Minard, William Playfair, Joseph Priestley, and Florence Nightingale have long been a great source of inspiration for contemporary visualization work. Tufte [12], in particular, praises much of this early work—such as Napoleon's march—for its graphical excellency but also its aesthetic, elegance, and technique. The specific style of the early graphics arose from a combination of hand-crafted appearance, clear and clean graphic design, precise data depiction, coupled with a storytelling layout. We present a case study in which we attempted to imitate the graphical appeal of historic infographics. Our goal was to emulate, in particular, the hand-crafted style and aesthetic for a modern personal data graphic that shows the historic evolution of research activities from the perspective of our team leader. We provide details on the type of data we chose to tell his story and how we emulated the style of historic data engravings to create a unique present on the occasion of his 50th birthday. The graphic was well received and is now permanently being exhibited.

2 Stylization in Illustrative Visualization

There are several reasons for wanting to emulate the style of a particular visualization such as that of historic information graphics. A specific style adds more than a unique aesthetic—it can also amplify a visualization's function as a representation of data. The hand-drawn character of the historic visualizations, for instance, indicates to viewers that—among other things—the visualization author has spent considerable time and effort in contemplating and creating it. A viewer may thus similarly want to spend ample time investigating details and appreciating both the artistry and the data. We thus argue that by creating a visualization with hand-crafted aesthetic we may be able to entice people to engage more with a visualization than they would otherwise.

Our work thus contributes to the debate on the scope of our field's sub-domain of *illustrative visualization*. Traditionally, researchers have argued that illustrative visualization primarily relies on principles from traditional illustration such as abstraction and emphasis to create better computer-generated visualizations [9], and less so on the visual style of the depiction. In contrast to this focus on what Rautek et al. call "high-level visual abstractions" [9], our poster makes use of its unique illustrative style to affect people's attitude toward a visualization. This principle of affecting viewers by means of stylization is well-known in the field of non-photorealistic rendering (NPR; e. g., [4, 8, 10]) and can even provide a general motivation for using non-photorealistic techniques in the first place [7]. The use of a specific visual style can also assist visual communication in general [1] because one can use it to guide both a viewer's perception and cognition. The use of stylization, therefore, can be tremendously useful for visualization applications—in the sense of engagement described above and otherwise (e. g., providing an aesthetic that emphasizes a visualization's message). We can thus argue that the illustrative visualization design space comprises both the use of illustration principles such as abstraction and emphasis [9] as well as the use of a unique graphical style and a set of well-chosen design principles [1]. Our own work of emulating a 18th and 19th century infographics style as described in more detail below then marks a point in the second part of the illustrative visualization design space.

3 Data Representation

An essential aspect of our visualization is its unique aesthetics, emulating the compelling exemplars in both layout and graphical style. We combined a hand-crafted appearance with a story-telling layout of six individual visualizations. The individual parts are arranged to convey both the personal and professional data of our team leader. We created a *partitioned poster* (one of Segel and Heer's [11] narrative visualization genres) in which we only suggest a loose reading order while the individual views comprising the poster used a *comic strip style* suggesting reading paths. The poster, thus, tells a story that is both reader- as well as author-driven [11].

3.1 Overall Visual Story and Framing

Many famous historic data graphics center their data narratives around time. Similarly, we use time as a reference for the visualized content. The six visualizations are framed by two large visual timelines that serve as anchors [6] and visual structuring aids [11]. The bottom timeline is annotated with small, hatched, black/white portraits of our team leader. As he is known for his beard and hairstyle, the portraits serve as references to the years of the timeline. Each of the actual visualizations is accompanied by a paragraph of textual annotations as focus points for the viewer's attention and to serve as messaging aids for the data narrative [11]. Similar to many historic visualizations, a prominent title serves as the entry point to viewing the poster from a distance. To create an effective visual story, we further ensured to have a *consistent visual platform* [11] where the individual visualizations' general layout strongly resembles each other through the use of aligned timelines—only the data content is changed for each as discussed next.

3.2 Personal Events, Travel, Social Media, and SVN

The top three visualizations (Fig. 1(a)) represent parsed calendar data from the shared group calendar, voyages undertaken aggregated from several calendars, and two different kinds of data "commits": postings to social media sites as well as commits of code to our group's shared software versioning system. The data for each of the three visualizations was partially automatically extracted but had to be extensively cleaned by hand. Data from the calendar and social media sites was chosen to be amusing as well as representative of our knowledge of the frequent professional and personal interests and activities of our team leader.

The top visualization shows four frequent calendar event types: working from home, going to the gym, playing music, and vacations. As the calendar was otherwise mostly populated with work meetings, these rather personal events serve as contrasts [6] to what we would otherwise expect to find in the group calendar. The second visualization encodes travel whith each individual trip being represented by a small flag. Its width encodes the duration of the travel, the stem length represents travel distance from Paris, and vertical orientation indicates the general direction on the globe in which the travel occurred (Asia vs. Americas). These work-related travels provide an interesting contrast to the vacation and leisure activities in the timelines above. The third visualization contrasts Facebook/Twitter posts with SVN commits—drawn as bar charts. Call-outs highlight several unique social media quotes. These highlights also provide representative examples that were both amusing and interesting to capture the reader's attention and encourage further exploration.

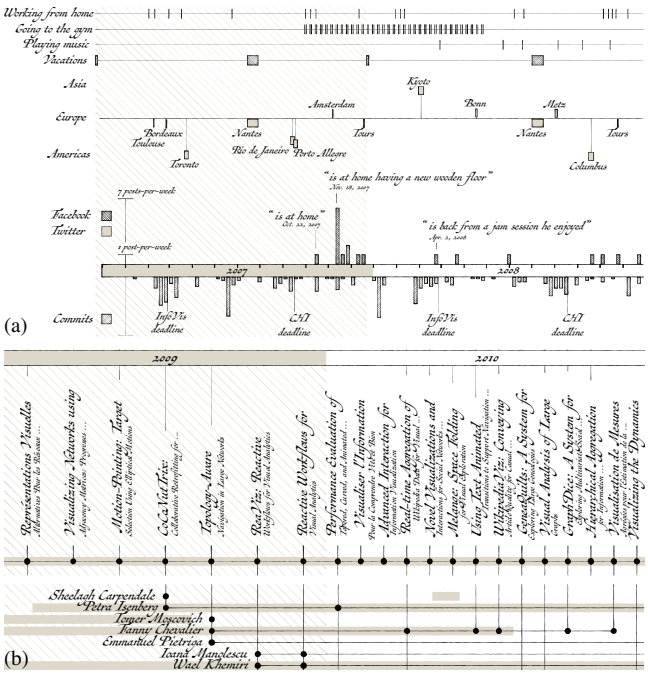

Figure 1: Details: (a) events; (b) publication & collaboration.

3.3 Publications, Citations, and Collaborations

The poster center shows a citation and collaboration graph. As publications and co-authorship are an important aspect of a researcher's activities, this graph is large and is placed prominently on the poster. We scraped publication data from several sources and cleaned the data by hand to create the final collaboration and citation graphs. The collaboration graph shows the co-authorship network from 2003 to 2013 (Fig. 1(b)). Paper titles are typeset vertically at the top, ordered by publication date and serving as a reference for the citation graph. Co-authors are listed below the paper titles in a separate grid-like visualization. Each author occupies a horizontal row in which the vertical order corresponds to the date of their first co-authorship, indicated by a black dot and the author's name. Black dots connect authors to their publications; vertical lines connect all authors of a given paper with its title on top. Horizontal lines connect all publications of the same co-author over time; beige bars indicate the periods when collaborators were AVIZ research team members. The citation graph uses the ThemeRiver [5] and Stacked Graphs [2] aesthetics as they also have previously been used in works of, e. g., Playfair's import/export charts [12, pp. 32, 91–92]. Each year's citation counts are marked at the end of that year since citations accumulate annually. Citations are stacked based on the publications' temporal order. Citations of omitted publications or of those prior to 2003 are depicted as a single hatched stream at the bottom. A line connects each publication from its title to its stream. The streams themselves are rendered as connected cubic Bézier curves to indicate the gradual and non-linear accumulation of citations. The stack of paper citations from every other year is rendered in beige to facilitate the following of a year's worth of publications over time.

3.4 Process and Visual Style

The poster creation was a highly collaborative process: A total of ten team members contributed to the final design, each working on one or more visualizations. The poster and all visualizations were developed in Java2D. A previewer allowed us to rapidly pan and zoom the poster being crafted to assess its rich detail. We made layout choices early-on to achieve a consistent look. After perusal of historical data graphics we chose to limit our use of visual variable to color hue (light ocher, light gray, black, and white) and texture (no hatching, single hatching, cross hatching—each with individually adjustable line distance). We used light gray, black, and white as fill colors rather than as a value modifier (i. e., there was no dark ocher). We also developed an inking library [3] whose role was to imitate the inking style of historic infographics with little modification to the existing rendering code. In addition, we chose a font that resembled a historic scribe's hand-writing and wrote all annotations to imitate historic English grammar. Finally, the poster was designed to be exhibited in a wooden frame with an antique appearance.

4 Discussion

The design of this poster was unique in several aspects: the re-creation of the aesthetic and layout of historic infographics has, to the best of our knowledge, not been attempted before. We are happy with our result and informal feedback has been positive. During our multi-author creation process, however, we noticed that more tools are needed at the intersection of programming and visual authoring. At the end of the day, infographics such as ours require much manual adjustment and refinement. We spent much time modifying the positions of various visualization elements and text labels—both in the code and, toward the end, in Illustrator. We thus need workflows that involve interactive graphic design tools throughout the process, rather than just at the very end. When placing Facebook post labels, e. g., a designer could draw all of the labels next to their marks programmatically, and then interactively adjust their size, position, color, and other aspects in an outside tool. A more flexible rendering pipeline that parses the SVG and includes those adjustments back into the infographics for re-rendering could free designers to do interactive tuning early-on and more often in the process and mix programmatic and interactive authoring styles.

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References

[1] M. Agrawala, W. Li, and F. Berthouzoz. Design principles for visual communication. *Comm. ACM*, 54(4):60–69, 2011. doi> 10.1145/1924421.1924439

[2] L. Byron and M. Wattenberg. Stacked graphs – Geometry & aesthetics. *IEEE TVCG*, 14(6):1245–1252, 2008. doi> 10.1109/TVCG.2008.166

[3] P. Dragicevic, W. Willett, and T. Isenberg. Illustrative data graphic style elements. In *Expressive Poster Abstracts*. ACM, New York, 2013.

[4] D. J. Duke, P. J. Barnard, N. Halper, and M. Mellin. Rendering and affect. *CGF*, 22(3):359–368, 2003. doi> 10.1111/1467-8659.00683

[5] S. Havre, B. Hetzler, and L. Nowell. ThemeRiver: Visualizing theme changes over time. In *Proc. InfoVis*, pp. 115–123. IEEE Computer Society, Los Alamitos, 2000. doi> 10.1109/INFVIS.2000.885098

[6] J. Hullman and N. Diakopoulos. Visualization rhetoric: Framing effects in narrative visualization. *IEEE TVCG*, 17(12):2231–2240, 2011. doi> 10.1109/TVCG.2011.255

[7] T. Isenberg. Evaluating and Validating Non-Photorealistic and Illustrative Rendering. In *Image and Video based Artistic Stylisation*, chap. 15, pp. 311–331. Springer, London, 2013. doi> 10.1007/978-1-4471-4519-6_15

[8] D. Mould, R. L. Mandryk, and H. Li. Emotional response and visual attention to non-photorealistic images. *Computers & Graphics*, 36(6):658–672, 2012. doi> 10.1016/j.cag.2012.03.039

[9] P. Rautek, S. Bruckner, E. Gröller, and I. Viola. Illustrative Visualization: New Technology or Useless Tautology? *SIGGRAPH Computer Graphics*, 42(3):4:1–4:8, 2008. doi> 10.1145/1408626.1408633

[10] J. Schumann, T. Strothotte, A. Raab, and S. Laser. Assessing the Effect of Non-Photorealistic Rendered Images in CAD. In *Proc. CHI*, pp. 35–42. ACM, New York, 1996. doi> 10.1145/238386.238398

[11] E. Segel and J. Heer. Narrative Visualization: Telling Stories with Data. *IEEE TVCG*, 16(6):1139–1148, 2010. doi> 10.1109/TVCG.2010.179

[12] E. R. Tufte. *The Visual Display of Quantitative Information*. Graphics Press LLC, Cheshire, CT, USA, 2nd ed., 2001.