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Illustrative Data Graphic Style Elements

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Abstract

We describe a set of straight-forward techniques for the precise ink rendering of lines, hatching patterns, and hatched portraits that we employed in a personal data graphics poster inspired by 18th and 19th century visualizations. We outline our approach and rendering techniques and also discuss the relationship and relevance of our techniques to illustrative visualization.

1 Introduction and Motivation

We recently created an illustrative personal data graphic poster for the occasion of our visualization team leader’s 50th birthday [Dragicevic et al. 2013]. Our goal was to replicate the visual style of historic hand-made visualizations that were created in the 18th and 19th centuries. Such visualizations were created, for example, by well-known artists such as Charles Joseph Minard (e. g., see the example in Fig. 1), William Playfair, Joseph Priestley, and Florence Nightingale. These early versions of what we now consider to be infographics have generated considerable interest among visualization researchers and are generally seen as quite compelling. One reason for this interest lies in the unique aesthetics that these visualizations exhibit: a combination of exact data depiction and a unique hand-drawn visual style that shows a good understanding of graphic design principles. The hand-drawn character also indicates that the visualization author has spent a significant amount of time creating it, thus a viewer may want to spend a corresponding amount of time looking at the details and appreciating both the artistry and the data. Thus by imitating this unique aesthetic we may be able to entice people to spend more time engaging with a visualization.

Our work thus falls into the larger scope of illustrative visualization as an application domain of NPAR and also touches on aspects of computational aesthetics (CAe). While illustrative visualization typically relies on principles from traditional illustration to create better computer-generated visualizations [Rautek et al. 2008], we use a unique illustrative style in order to affect people’s attitude toward a visualization. This principle is well-known in NPAR (e. g., [Duke et al. 2003; Mould et al. 2012; Schumann et al. 1996]) and even provides a general motivation for it [Isenberg 2013]. Visual style has also been suggested as an important aspect of visual communication [Agrawala et al. 2011], as it can guide both a viewer’s perception and cognition. We can thus argue that the illustrative visualization design space comprises both the use of illustration principles such as abstraction and emphasis [Rautek et al. 2008] as well as the use of a unique graphical style and a set of well-chosen design principles [Agrawala et al. 2011].

To explore this second part of the illustrative visualization design space, we implemented a number of stylistic rendering techniques to allow us to simulate the style of 18th and 19th century visualizations. We attempted to match the precise data depiction and hand-drawn character of the originals by using simulated ink strokes to render the line paths and fills used in the visualization. We also rendered regular, 2D hatching patterns and used a limited choice of colors for data depiction. Finally, we added portrait images in a unique cross-hatched style.

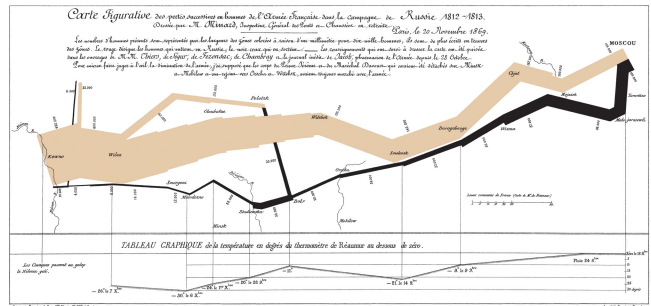


Figure 1: Minard’s visualization of Napoleon’s 1812 Russian campaign, published in 1869. The image is in the public domain.



Figure 2: Two exemplary detail sections from the AntiquarianScribe font that inspired our inked line rendering: lines and letters.

2 Emulating Precise Inking

The inking in the poster attempts to emulate the ink lines created by a pen as it is moved over the paper. As such it is motivated by the large body of NPAR work on pen-and-ink rendering and, specifically, other pen-like media simulations (e. g., [Rudolf et al. 2005; AlMeraj et al. 2009]). The specific inspiration for the rendering comes from the font *AntiquarianScribe* which we use for the poster because it imitates the writing style used by the 18th century cartographer Henri Abraham Chatelain. The characters in this font exhibit many of the characteristics of ink lines that we aimed to replicate for the poster overall (see the detail sections shown in Fig. 2).

We thus developed a replacement for Java2D’s normal rendering that supports vector output—necessary to be able to reproduce the poster at a large scale with sufficient quality [Isenberg et al. 2005]. We based our inking class on a visual examination of characters the *AntiquarianScribe* font (Fig. 2), in particular the shorter and longer horizontal dashes. To approximate the appearance of these strokes, we implemented an inked line renderer that manipulates the outline of a horizontal line shape—in contrast to distorting a stroke’s path or width (e. g., [Finkelstein and Salesin 1994; Schlechtweg et al. 1998]). The outline of each stroke is represented as a rectangular shape using a number of cubic Bézier segments, depending on the length of the line. We then add horizontal and vertical random offsets to the 2D position of the first and last control points, while retaining the horizontal orientation of the tangential “handle.” The random offset is seeded based on the location of the control point and its degree can be parameterized. In addition, we vary the line width (for non-closed paths) over the course of a line to simulate a slow start when drawing (thicker line), a faster middle section (thinner line), and a slow ending (thicker line again)—visible, e. g., in Fig. 4. Angled lines are realized by rotating the horizontal line, while curved paths are realized by drawing lines along Bézier segments as a polyline with a sufficient number of sub-segments. Fig. 3 shows an example with several straight and curved lines.

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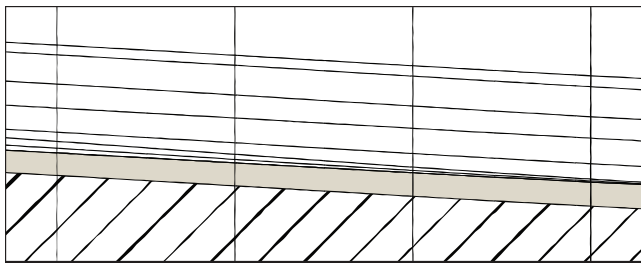


Figure 3: Detail section from the poster with inked lines.

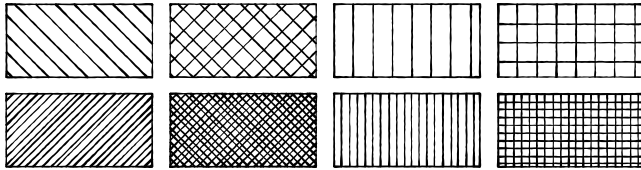


Figure 4: Examples of hatching styles generated using our line inking class. Each vertical pair uses the same hatching pattern but different parameters for line spacing and variation between strokes.

3 Hatching and Cross-Hatching

Traditional inked illustrations often use hatching patterns to shade and differentiate regions. To simulate this effect we extended our inking class to provide a variety of 2D hatching patterns that can be used as fills (Fig. 4). We use the inking class to render individual strokes and provide parametric control over the widths, spacing, and variation between the strokes. This allows us to produce a wide variety of hatched patterns that exhibit the subtle variations in spacing and line weight that characterize hand-drawn fills.

4 Portrait Hatching

We also wished to use hatching to illustrate less-geometric figures—specifically portraits—in a similar hand-drawn fashion and inspired by b/w NPR portrait styles such as hedcut stippling [Kim et al. 2010; Son et al. 2011]. We base the hatched portraits on black-and-white portraits created manually from photographs—images that were historically understood to be the silhouette portrait of a person. We then apply two layers of 2D hatching, one with thick beige lines in the background and a second one, at a 90° angle, with thinner black lines in the foreground (see Fig. 5). Each line of the hatching is clipped to only cover the black part of the source portrait. Some random over-shooting ($\approx 10\%$) is applied in a multiplicative fashion such that short lines only show little variation while longer lines exhibit more randomness. This effect can be nicely seen in Fig. 5.

5 Conclusion

These few tools allowed us to create an aesthetically pleasing large personal data visualization that, in our own view, nicely resembles some of the aspects of 18th and 19th century infographics. In particular our inking process and the subtly non-regular hatching patterns allow us to maintain a precise form of data depiction while still emulating and suggesting the hand-drawn character of our examples.

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Figure 5: Hatched portraits from the poster (left and center) are generated from simple black and white drawings generated by hand. The center portrait was derived from the drawing to the right.

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