Plenary Presentation: Visual Explanations

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Professor Edward R Tufte brings presence, commitment, and energy to the message that words and numbers need to be seamlessly integrated in the visual display of information.
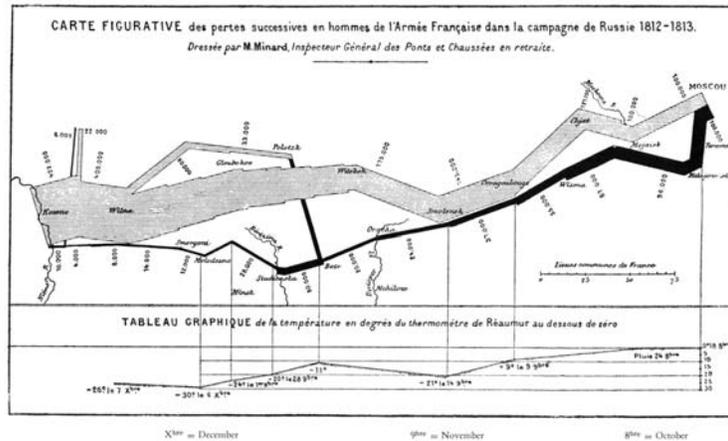
Today's world, says Tufte, is multivariate with three-plus dimensions, and the goal of 6000 years of information design has been to escape flatland—the tyranny of two-dimensional images on paper.

Sharing a 1520 edition of the first English translation of Euclid—previously owned by Ben Jonson—Tufte showed the paper triangle pasted into the back of the book, calling it a "brute-force method of escaping flatland". True to his visual principles, Tufte gave each attendee a poster that reproduced the same graphic and others he used to illustrate his talk.

Tufte used Minard's famous graph of the fate of Napoleon's army in Russia, which he described as "*War and Peace* told by a visual Tolstoy", to demonstrate his five grand principles for showing information:

1. *Enforce visual comparisons*. This graphic, perhaps the best in the 19th century, provides a clear answer to the question "Compared with what?" Of all Napoleon's soldiers who marched to Moscow, only one in 42 returned.
2. *Show causality*. The main part of the graphic shows the numbers of soldiers and their locations—descriptive information. Tying the path of the retreating army to a temperature chart makes it immediately apparent that "General Winter" played a large role in the defeat.
3. *Show multivariate data*. Minard shows six dimensions with clarity: the size of the army, the direction it was taking, its location in two dimensions, the temperature, and the dates.
4. *Integrate word, number, and image*.
5. *Provide quality, relevance, and integrity of substance and content*. Minard hated war; his deep caring about the content of this story—the decimation of the French army—drove him to expend the monumental effort it took, in the precomputer age, to create his complex, enduring, and exemplary graphic.

More than just displaying information, good visual explanations tell us how to reason and think about evidence. After asking rhetorically, "Where do the principles of information display come from? How are they derived?", Tufte went on to compare them with the principles of analytic thinking.

The goal of graphics is to assist understanding in a multivariate world, although they can distort the truth. To illustrate the dangerous trend toward dequantification, the handout included a dramatic still picture from a NASA video flyover of Venus created from data collected during the 1992 Magellan space probe. "The soaring mountains and deep canyons are a lie!" announced Tufte, pointing out an unacknowledged vertical exaggeration of 22.5 to 1.

Using another volume from his library, Newton's *Opticks*, published in 1704, Tufte explained how the original, hand-written manuscript looked like a geometry textbook, with illustrations interspersed among the text. Even today, the publisher would have to use a high-resolution printing process to combine the type and drawings. Instead, the figures were separated from the text, and there were 6,500 letter-code references to the figures in the first 80 pages of the book!

Tufte brought home the message that graphics are an integral part of scientific communication. ◉