A Recent Publication on Graphics and Some Application to Graphics in NEPA

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I begin with three assumptions about graphics in NEPA documents:

1. **NEPA documents would benefit from more and better graphics.**

2. **NEPA graphics should be planned early (before text).**

3. **Early, provisional graphics should help NEPA specialists discover and then clearly explain their conclusions.**

The following article discusses the three assumptions and includes review comments on an excellent recent book on graphics: Howard Wainer's *Visual Revelations: Graphical Tales of Fate and Deception from Napoleon Bonaparte to Ross Perot* (Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers, 1997). I recommend that NEPA practitioners interested in graphics order Wainer's book.

1. NEPA documents would benefit from more and better graphics.

Most reviewers of EISs (Environmental Impact Statements) or EAs (Environmental Assessments) likely would agree that graphics (except for tables) are rare in the typical NEPA document. Good graphics are even rarer!

Why are most graphics rare? The major reason is that resource specialists, trained in traditional scientific disciplines, view text as their main product in reports. Specialists routinely write text before considering what graphics would help readers understand the text. Finally, graphics are traditionally a late-stage addition and, as such, often get cut out in the rush to get the document published.

So traditional writing processes mean that NEPA documents have few graphics. And tables are the most likely type of graphic to appear if a writer even chooses to use a graphic. Graphics ignored include bar charts, numerical graphs, illustrations, and well-chosen photographs. I omit pie charts/graphs from this list because they are often poorly done, sometimes more misleading than informative.

Over the last several days I have been reviewing an internal draft of a major Forest Service DEIS. All of the preceding observations apply to this DEIS. Almost the only graphics in the entire 300-page DEIS are tables. Key conclusions appear in the text, not in the tables. Readers must search through dense text for guidance on how to interpret the tables.

Graphics in an EIS or EA should focus on resource conclusions. They rarely do. Even tables should focus on conclusions as to the context and intensity of potential impacts. Instead, tables often provide columns of numerical values without any clue as to how readers should interpret the values.

Resource conclusions are important because each resource discussion should clearly summarize and then explain major conclusions about potential impacts. These conclusions are the key disclosure information in an EIS or EA.

Howard Wainer, in the book mentioned above, analyzes dozens of actual graphics. He routinely asks if a graphic captures useful conclusions and then if readers would clearly and rapidly identify these conclusions.

Wainer's answer is that many graphics fail. In a delightful first chapter, Wainer lists and illustrates 12 rules for graphics designed for failure. He illustrates each rule with real-world graphics drawn from both current and historically interesting topics.

One of his 12 rules for failure is "Rule 9: Alabama first!" (p. 35). This rule points out that an alphabetical order in graphs and tables is often not helpful. It may even be misleading.

Assume, for instance, that a writer presents a table with average per person income listed by state. A reader is likely to want to know how his or her state stacks up. If the table presents the state averages in an alphabetical list, each state's rating is difficult to compare to those from other states. Sometimes, a second column provides each states' comparative rating. But even this added column would not be a memorable way to show each state's rating.

Consider, however, a table that listed income averages beginning with the state with highest per person income and ending with the state with the lowest. A reader could easily see each state's score but also whether the state was toward the top or at the bottom of ratings. The mere spatial placement of a state illustrates its status in a comparison of personal income. The placement makes conclusions about a state visually memorable.

Wainer's observation about unnecessary alphabetizing is but one of three simple positive rules he later discusses for tables. These rules appear in his Chapter 10 (pp. 95-102). The other two rules are equally simple:

Rule 2 is "Round—a lot" (p. 97).

Wainer argues that readers frequently get lost in unnecessary digits. In the example above, per person income data averaged by states should not be carried out to the nearest fraction of a cent. Rounded dollars values are more memorable and actually more honest, given that averages do not have strings of significant figures.

Rule 3 is "ALL is different and important" (p. 99).

Wainer is suggesting that overall summary values or sometimes a column median helps readers to understand numerical values in a table. And these summary values should be highlighted. So a table might put shaded boxes around the median or around numerical values unusually high or low. He is suggesting that tables should provide a context and a possible intensity for numerical values used.

As in the preceding three rules about tables, Wainer is excellent at keeping his suggestions both practical and useful.

To conclude with a NEPA example, assume that a specialist wanted to provide a table with comparative usage data for recreation in a project area. One way would be to list recreational activities alphabetically and give their usage rates, perhaps average users per day. Water skiing would be at the end of the alphabetical list.

But what if water skiing was the most popular activity? The table should begin with usage data on water skiing and move down to activities with the least recreational use. The spatial order in the listed data would visually reinforce conclusions about the importance of each activity.

2. NEPA graphics should be planned early (before text).

All Shipley Group writing sessions emphasize this assumption. Participants always comment that if they attempted to choose and then sketch graphics early (before writing a lot of text), then they would be more likely to pare down and to restructure the necessary text.

Early planning of graphics would also remind resource specialists that their graphics should highlight and illustrate major resource conclusions. If, instead, they begin writing pages of text, major conclusions will likely appear only in text, not in graphics.

Wainer does not directly discuss this assumption, but I take it to be an implication of his general approach to graphics. And some of his examples clearly show that a well-done graphic would or could replace much text.

For example, Wainer focuses his Chapter 4 on "Three Graphic Memorials." The three examples discussed all capture information and conclusions in powerful, data-rich graphics.

The first of his three examples is a historically interesting 1869 graphic by Charles Joseph Minard. Minard's classic graphic plots the fate of Napoleon's army in its tragic 1812 campaign into Russia. The beginning of the graph shows 422,000 men leaving France in June of 1812, represented by a plotted line on a graph. "In the original scale, each millimeter of its [the line's] width represents 10,000 soldiers" (p. 63). The broad plotted line narrows as the year goes on, until only a very narrow band remains on the graph when the surviving 10,000 French soldiers cross into Poland early in 1813.

Wainer does not state that Minard's graphic would replace text, but his discussion of the graphic implies this conclusion. His discussion of the graphic argues that the original graphic is a powerful and data-rich picture of Napoleon's campaign.

(Note: Here, as elsewhere in this article, I do not include copies of Wainer's graphics. I would encourage those interested in the graphics themselves to buy Wainer's book. Also, I would not want to reproduce Wainer's graphics without having copyright permission from him. He might have been willing to grant permission, but many authors are reluctant to permit key graphics to be reproduced because they are so central to the content in a discussion.)

3. **Early, provisional graphics should help NEPA specialists discover and then clearly explain their conclusions.**

Wainer does not directly address this assumption, at least as it applies to NEPA documents. Wainer does explain that well-designed graphics often reveal conclusions that investigators would otherwise miss.

This is the point of Wainer's "Chapter 2: Graphical Mysteries" (pp. 47-53). In this chapter Wainer analyzes three mysteries and shows how a well-conceived, early graphic could have helped solve the mystery.

The third mystery analyzed by Wainer deals with the Challenger disaster on January 28, 1986. The mystery was why an O-ring failed on the Challenger launch and why the National Aeronautical and Space Administration decided to authorize a flight when the temperature in Florida was well below 40 ^{o}F.

Wainer's solution (the one actually discussed by the Presidential Commission on the Challenger) is that NASA decision makers likely looked at only the seven prior shuttle flights with O-ring problems. These seven flights were few and had not been catastrophic. None of these flights had flown at under 55 ^{o}F. The few instances with O-rings problems meant that the causation between low temperature and O-ring failure was unclear. The probable risk appeared low.

Wainer presents a graph plotting all 41 prior shuttle flights and their launch temperatures, not just the seven launches with O-ring problems. This data-rich graph clearly shows that the lower the temperature, the greater likelihood of O-ring failure. A visualized plot of a failure line would have suggested that O-ring failure was likely, even inevitable, under 60 ^{o}F.

So in this Challenger example, a well-designed, data- rich graphic would have given NASA a reason for canceling the Challenger flight. Without this graphic (and the thought process behind it), NASA decision makers did not have a clear picture of the risk and probability of failure to the Challenger.

To turn to NEPA applications, resource specialists should begin their NEPA analyses by considering how best to convey their impact conclusions to readers. Is text the only and best option? Or would a well-designed, data-rich graphic be a more forceful way to show and to convince readers as to the credibility of a specialist's conclusions?

Such a graphic must provide a context and intensity for the specialist's impact forecast. This interpretive information is central to full legal disclosure of impacts, as NEPA mandates.

Conclusion

The preceding discussion shows that many of Wainer's concepts would be useful for NEPA practitioners—hence, my recommendation that you obtain a copy of Wainer's book.

Note: Wainer cites examples and concepts from the three earlier publications on graphics by Edward R. Tufte. For readers of my article who have not discovered Tufte's publications, I recommend them highly, especially his 1983 volume *The Visual Display of Quantitative Information* (Cheshire, CT: Graphics Press).