A Lay Mapmaker's Perspective on the Dilemma of Cartographic Design

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ABSTRACT

Aesthetic, accessible, astounding, and accurate—these four adjectives best describe the value drivers of maps from a lay mapmaker's perspective. Aesthetics is the marketing of the map, as an unappealing map will not attract readers. It also needs to be accessible: readers need to understand the message correctly and recognize the locations of their interest, otherwise they will turn away quickly. If the content of a map is astounding, readers will get engaged with the map. Accuracy, which refers to the correctness and precise measurement of the data as well as its visual representation, builds reputation—inaccuracy kills it. Frequently there are trade-offs between these four main value drivers to consider, requiring a dilemma approach to cartography.

KEYWORDS: Aesthetics, Design, Dilemma, Audience Orientation, Choropleth

Recent work by Field and Demaj (2012) explores the relationships between cartography, technology, design, and aesthetics.[1] I would like to add to the insight of those two professionally trained cartographers the perspective of a lay cartographer. I will label lay cartographers[2] like myself henceforth as *mapmakers* for ease

1. The authors also have the main references in their paper, which are therefore left out in this note.

2. Lay cartographers share many of the traits of, say, hobby botanists. A hobby botanist knows something about plant life, but is not a professionally trained expert in the field and does not practice botany

of distinction. As an economist, I have become a mapmaker out of the need to study the geographic distribution of housing prices during the Great Recession (Moenius 2009). Had I had the choice, I would have liked to be simply presented with the maps I wanted, but I had to learn how to formulate my mapping needs so that professional GIS analysts could create what I wanted. As in Field and Demaj (2012), they contributed their knowledge about technology, science, and art, while I remained focused on output, trying to achieve as high marks as possible on the value drivers for our readers. Thanks to the success of our analysis of the housing market, my colleagues and I now regularly produce thematic maps for media outlets. While necessary for all audiences, producing maps for media requires a strong focus on creating value for their viewers. For each map we create, we would like it to be as aesthetic, and its content or message as accessible, astounding, and accurate as possible. We often face trade-offs as we need to sacrifice a little on one value driver to increase the value of another. Thus, I would like to re-emphasize the well-known need for orientation towards the consumer of maps, and add the role that trade-offs play to meet consumers' wants. I will discuss these trade-offs and how to navigate them with an emphasis on the role of aesthetics.

How does one make a great map? As Field and Demaj (2012) point out, following the well-established design principles and ethical requirements for mapmaking is already hard. Creativity and aesthetics are welcome additional features to add value, however, they also add complexity to mapmaking. While technology helps professional cartographers with integrating these different aspects, it has also put mapmaking capability into the hands of lay mapmakers who frequently have little or no knowledge about cartographic design principles. This allows them to infest the World Wide Web with questionable "mapoids": map-like displays that do not deserve the name "map" if one wants to preserve the historical prestige of the word. This may sound like harsh criticism of the group I belong to, but there are also good justifications for our existence; the relevant one for this note is that we are close to the audiences of our maps, so we understand their interests and needs well.

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Contrary to arguments by Strebe (2013), I claim that maps as representations of space and spatial thinking play a more important role in people's lives today than ever before. Aside from the weather report, I saw few maps in newspapers or on TV during my childhood. Now they are ubiquitous: newspapers regularly publish maps on all kinds of issues, and Google, MapQuest, and others have put maps first on to computers and later on to cell phones, most of which are connected to the Internet, making those maps accessible to almost anyone. The bad news: many of these maps distort the perception of information. Choropleth maps are particularly popular for displaying socio-economic data, but consistently violate Tufte's (2001) first principle of graphical integrity, as their visual representation of numbers is rarely proportional to the underlying quantities. Proportional representation of social phenomena requires each object (e.g., a polygon) that represents information to be proportional in size to the number of people it represents, unless data has been normalized by land area, such as in population densities. In maps, these objects are geographic units such as states or ZIP code areas. In the maps I see, however, social phenomena are almost always displayed in proportion to land area without any normalization. How large an issue of concern this is depends on how frequently—or even systematically—this visual distortion occurs: if area and

professionally. Lay cartographers, however, apply their cartographic skills—or lack thereof—frequently as part of their professional fields, as I apply maps in economic analysis.

population across geographic units are highly positively correlated, there might not be much of an issue. For the United States, however, this is generally not the case; for example, state and ZIP code areas are uncorrelated with population. Census tract areas are even *inversely* related to population (U.S. Census Bureau 2010). Consequently, at least for the United States, visually distorted map images of social phenomena are likely the rule, not the exception. The good news is that the more maps are produced for general audiences the more people will learn how to read, evaluate, and appreciate them. As general audiences improve their map literacy, media outlets need to fear the loss of reputation as quality information providers if they publish low quality maps. Thus, the more maps available and the faster general map literacy advances, the quicker the media will develop professional skills in evaluating maps, and therefore the better the maps distributed by the media will ultimately be. The question, however, remains: what constitutes a good map?

Good maps have high information content, follow established design principles, and are aesthetic. The following exercise illustrates this point: in their companion paper, Demaj and Field (2012) present 39 examples selected by experts to showcase excellent cartography in 13 different categories. Regardless of category, I find that each map scores highly on at least one of those criteria—information content, design, and visual quality—and many of them in all. I would also expect agreement that almost all score high on aesthetics.

For mapmakers concerned with their audiences, meeting this standard turns into a four-word mantra: maps need to be *aesthetic*, and their content *accessible*, *astounding*, and *accurate*—frequently in that order. Aesthetics is the marketing of the map: an unappealing map will not attract readers. Once a map has attracted a reader, accessibility is key to maintaining interest: readers will quickly turn away if they cannot grasp the message of the map and recognize locations of their interest. A map not understood is a map not worth making. Map readers want to find something new: nobody looks at a map for directions if the way is already known. If readers are amazed by what they find on a map, they will engage in it. Accuracy is not only an ethical or academic requirement, it is pertinent for mapmakers who want to be published more than once, as the correctness and precise measurement of the data and their visual representation are prerequisites for being published again—inaccuracy kills reputation.

Including attractiveness of informational content and accessibility should be obvious; the cases for aesthetics and accuracy deserve some more discussion. Let me start with accuracy: Monmonier (1996) claims cartographers to be masters of compromise and tolerance of inaccuracy. This should not come as a surprise as part of his assertion applies to all modelers, including cartographers, who have to make choices about what to include and especially what not to include. After all, modelers want to solve a problem and need to capture only the relevant information. His assertion also has a specific component which is rooted in cartography being a visual art and craft: projections distort area and line features; choice of symbols and the assignment of features to categories as well as presentational choices can be used to alter the perceived message of the data—and many of these choices are entirely unavoidable.

As documented by the flourishing markets for designer products and the large number of galleries, art and design as two manifestations of aesthetics (one would

hope!) have substantial commercial value. Therefore, aesthetics can increase the value of maps not only in terms of individual appreciation, but also in terms of commercial value, establishing a business case for aesthetics. In fact, a beautiful map may draw an audience which may be seduced to study it simply because the audience wants to know where its beauty originates from. Figure 1 shows an example of such a map.

Figure 1: Willamette River, Oregon, by Daniel E. Coe (2012).

Note that the artist-cartographer chose to leave out all reference points, labels, or place names and only used shades of blue instead of a multi-colored approach, thus compromising on accessibility and (perceived) accuracy in favor of aesthetics. As the example illustrates, map marketing through aesthetics can not only function as a multiplier of the values created by informational content, accuracy and accessibility; it may require to compromise on the latter three to boost the aesthetic component and thus increase the overall value of the map.

The example demonstrates the importance of compromises—or trade-offs—for mapmaking, but how should one choose amongst the different trade-offs? Field and Demaj (2012) suggest that map design should be at the center of science, technology, and art. Transforming those three inputs[3] into a visual representation of our four-word mantra, the output of the mapmaking process finds good map design inside a triangular pyramid as in Figure 2.

The corners of this outcome choice pyramid represent the maximum achievable degree for each of the four value drivers. As science, technology, and art progress, higher levels of each value driver are achievable, and the length of the edges of the pyramid may consequently change.[4] The sphere inside the pyramid represents the audience's preferences: in Figure 2(a), the closer towards the center of the pyramid, the higher the valuation of the map by the audience. The spherical segment in Figure 2(b) could represent the preferences of a military audience, which will likely put high value on accuracy and accessibility, close to zero value on being astounding and low value on aesthetics. Generally, there will be unavoidable trade-offs: for example, the choice of scale, projection, color schemes and cut-off values in any map all simultaneously influence accuracy and accessibility. In the case of color-coding and cut-off values, they may simultaneously influence aesthetics and whether the information on a map appears to be astounding. The following three maps illustrate the issue; we start out with a standard choropleth map (Figure 3).

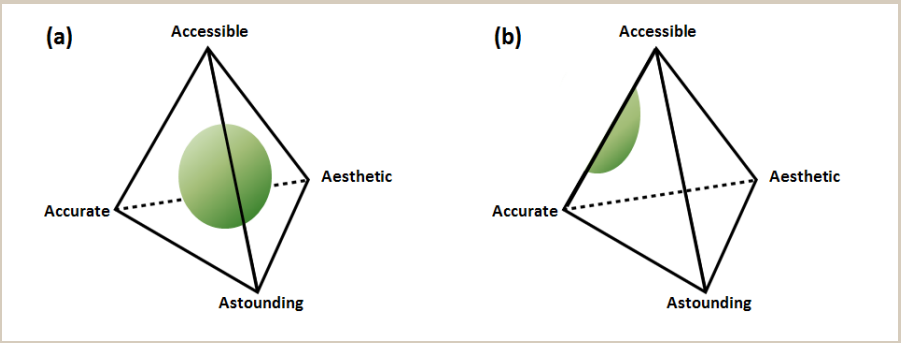

Figure 2: The outcome choice pyramid and audience preference sphere for (a) general and (b) military audiences.

3. Art can be both an input as in artistic capabilities, rules, and knowledge as well as an output: a piece of art. Here I refer to the first interpretation.

4. To see this, assume we start with a perfectly symmetric pyramid. Further assume that there was only technological progress in terms of technology such as LIDAR which predominantly influenced accuracy. This would increase the range of possible trade-offs between accuracy and each one of the three other value drivers. But it would not change the possible trade-offs between those other three value drivers.

The map displays the average share of income households spend to drive to work. Households in the mostly small red areas spend a high share, households in the mostly large green areas a low share of income on driving to work. Without awareness of context and audience, using hue for encoding values is a poor choice because readers cannot associate different hues with different values. On the national level, however, low shares of income spent on gasoline have been historically associated with positive economic growth, while high shares have been associated with negative economic growth. Areas with high shares of income spent on gasoline raise red flags for the economy, and these areas are represented in red color on the map (Moenius 2011). Thus, audience and context—economists and economic growth—may suggest possible departures from standard cartographic choices to increase accessibility for the target audience. Moreover, the association of these traffic light colors with stop, caution, and go highlight how astoundingly large and geographically concentrated areas in the United States are at risk (yellow, orange, and red) for economic slowdown. Arguably, the choice of hue instead of saturation or brightness reduces aesthetic value, but increases how astounding the information presented in the map appears for the target audience.

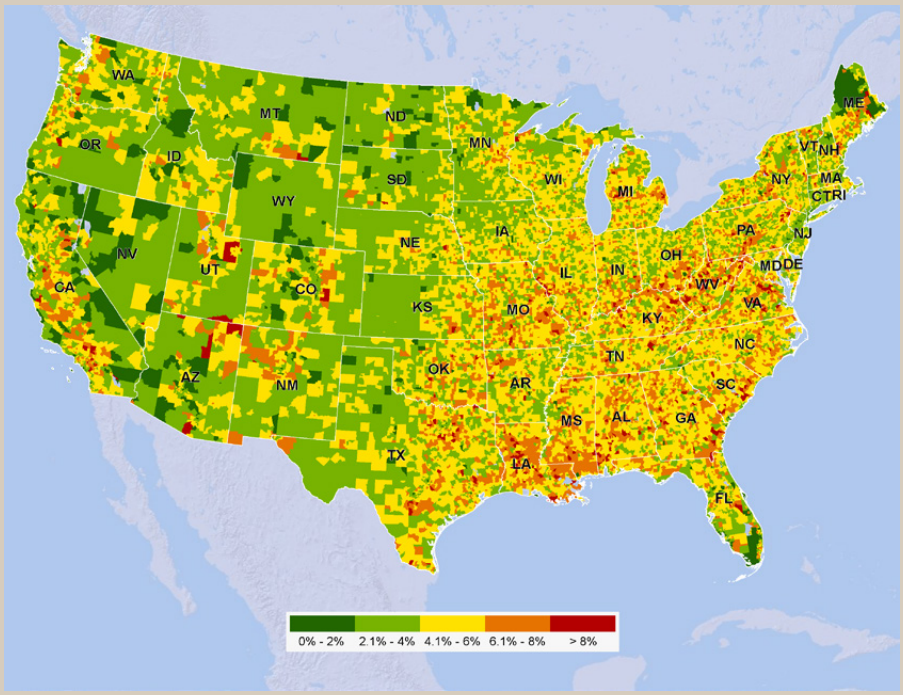

Figure 3: Choropleth map of the average share of disposable income spent on gasoline to drive to work by ZIP code in May 2011. Data source: GasBuddy.com, Esri, U.S. Census Bureau.

Often the large green areas are sparsely populated, thus over-representing the importance of these areas. To address this criticism, we next create a cartogram where ZIP code areas are shown proportionally to the number of households residing in each ZIP code (Figure 4).

The visual impression now is closer to the fact that there are few households that spend less than 4% of their income on gasoline to drive to work. The unusual appearance of the cartogram may invite readers to engage for a longer time with the map. Nonetheless, the downside of this map is that it is harder to access: how can I find my ZIP code in there? Correcting the issue of misrepresenting population-proportional phenomena with land area by changing to a population-weighted land area cartogram makes it much harder to find places on the map and thus reduces accessibility.

The last map offers a compromise, which only partially addresses overrepresentation of less populated areas by using transparency to distinguish between densely populated (more than 500 persons per square mile) and less populated areas (less

than 500 persons per square mile), where the transparency setting comes from census block data.

While the examples illustrate trade-offs within the pyramid, namely between astounding and aesthetic in terms of color choice, and accessible versus accurate in terms of area proportional representation, they cannot explain where we can find good maps in this pyramid, since the answer depends on the audience's preferences as represented by the sphere inside the pyramid. Does identifying the preferences and trade-offs allow us to make a good map? Unfortunately, not always: even if mapmakers were able to perfectly identify their audience's preferences, skills, technology, ethical considerations, time, and budget play an important role in determining the attainable places inside the pyramid. These attainable places may not overlap with the audience's preferences—and may thus determine a map probably not worth making.

Aside from suggesting four often conflicting components of mapmaking, the discussion in this note emphasizes two aspects: first, the need to be aware of the trade-offs in our choices. Improving one value driver of a map may come at the cost of another. Second, the value of a map to its audience is jointly determined by the choices on outcome value drivers as well as audience preferences. In an analogy of what Deidre McKloskey (2000), a well-respected economist and prolific writer requested in her book "economical writing," I would like to suggest that a map should not be designed so that the message it has can be understood, but rather so that it cannot possibly be misunderstood. To escape the dilemma of the trade-offs, electronic media may offer a solution at least for mapmakers

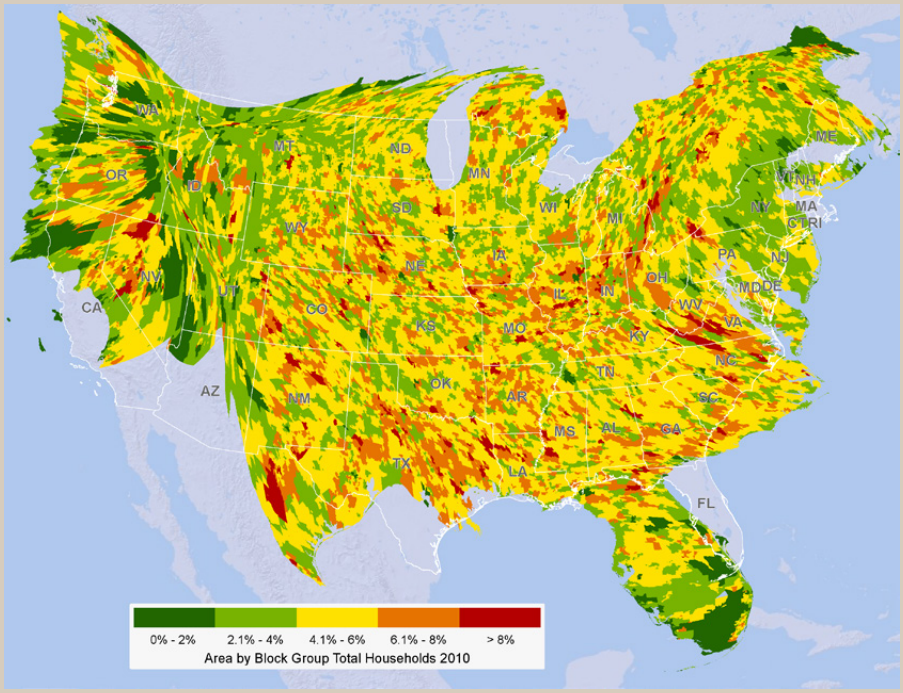

Figure 4: Cartogram of the average share of disposable income spent on gasoline to drive to work by ZIP code in May 2011. Data source: GasBuddy.com, Esri, U.S. Census Bureau.

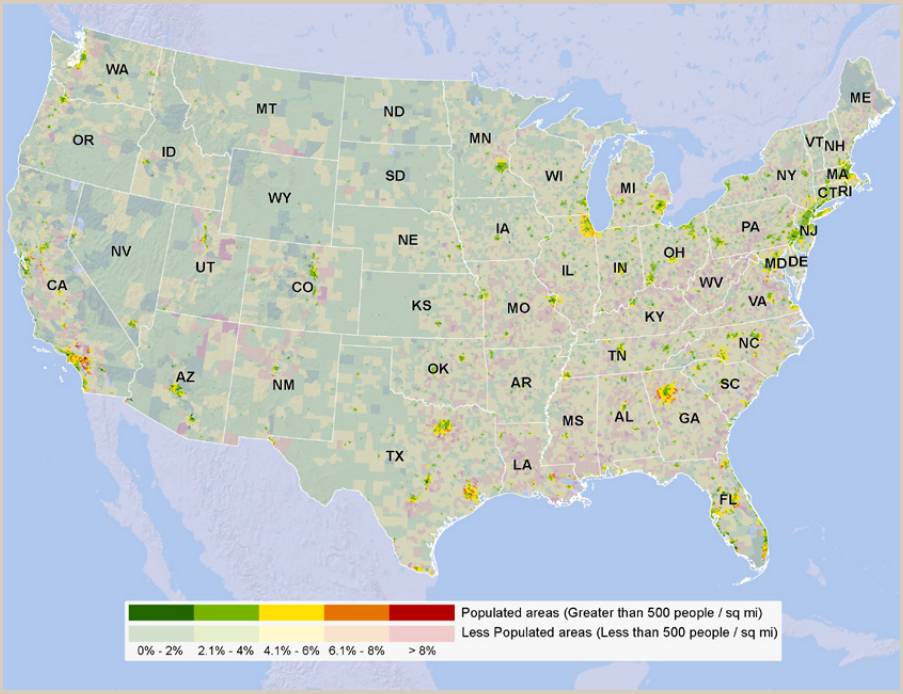

Figure 5: Modified choropleth map of the average share of disposable income spent on gasoline to drive to work by zip code in May 2011. Data source: GasBuddy.com, Esri, U.S. Census Bureau.

that are not on a budget: how about morphing a map into four different versions, each one optimizing only in the direction of one of the four aspects? For example, why not transform a standard choropleth map into a cartogram into an interactive map and finally into a piece of art? Figures 3 and 4 document examples of the first two steps. A realization of the third step can be found in Moenius (2011). My artistic limitations prevent me from accomplishing the fourth—but I would love to see that accomplished in somebody else's work!

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REFERENCES

Coe, D. E. 2012. "Willamette River." *Atlas of Design*, edited by T. R. Wallace and D. P. Huffman. Milwaukee: NACIS.

Demaj, D. and K. Field. 2012. "Reasserting Design Relevance in Cartography: Some Examples." *The Cartographic Journal.* 49 (1): 77–93.

Field, K. and D. Demaj. 2012. "Reasserting Design Relevance in Cartography: Some Concepts." *The Cartographic Journal.* 49 (1): 70–76.

McCloskey, D. N. 2000. *Economical Writing.* Long Grove, IL: Waveland Press.

Moenius, J. 2009. "Inland Empire Housing Market." *Institute for Spatial Economic Analysis.* Accessed April 18, 2013. **http://isea.redlands.edu/analysis/2009/04/18/inland-empire-housing-market/**.

Moenius, J. 2011. "Places with the Worst Pain at the Pump in Southern California." *Institute for Spatial Economic Analysis.* Accessed April 18, 2013. **http://isea.redlands.edu/analysis/2011/05/10/places-with-the-worst-pain-at-the-pump-in-southern-california/**.

Monmonier, M. 1996. *How to Lie with Maps, 2nd Edition.* Chicago: University of Chicago Press.

Strebe, D. 2013. "The Impotence of Maps, or Deconstructing the Deconstruction of their Construction." *Cartographic Perspectives.* 73: 31–37.

Tufte, E.R. 2001. *The Visual Display of Quantitative Information, 2nd Edition.* Connecticut: Graphics Press.

U.S. Census Bureau. 2010. *Geographic Terms and Concepts - Census Tract.* Accessed August 14, 2013. **http://www.census.gov/geo/reference/gtc/gtc_ct.html**.