Great Grids: How and Why?

Maureen Stone
StoneSoup Consulting
stone@stonesc.com

Lyn Bartram
Simon Fraser University
lyn@sfu.ca

Diane Gromala
Simon Fraser University
gromala@sfu.ca

1. Introduction

Grid design is surprisingly subtle. A grid that is too bold distracts and obscures, but one that is too light is illegible. A well-designed grid is legible when required, but does not create visual clutter or compete for attention with the information it supports. From the disciplines of art and graphic design, we know that there are many dimensions of subtlety and richness to such visual reference cues [Tufte 1998; Gombrich 2000]. Understanding both how these properties are achieved, and to what extent they can be generalized to elements beyond grids, is our broad research goal.

2. Design Principles

The first question a good designer would ask is "what is the function of the grid and its relative importance in the design?" Once the multiple functions are determined, graphic designers work to balance the visuals through well-understood design principles of hierarchy of information with formal principles, such as line weight, contrast, color and texture. Factors such as the possible contexts of use are taken into consideration, including the thresholds of display technologies and methods of reproduction.

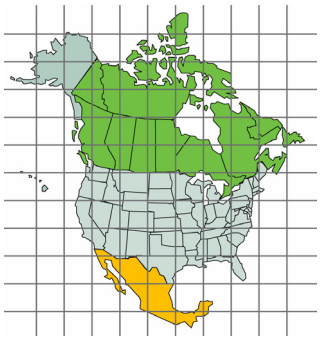

Figure 1 (a). A badly designed grid that impedes attention.

Figure 1 (b). This grid enables variable levels of attention.

3. Perception

The lines that define the grid in Figure 1(b) are both lighter and thinner than those in Figure 1(a). Contrast, which is a function of both relative lightness and spatial frequency, is the perceptual metric that seems most salient.

There are various formulations for contrast as a function of the psychophysical metric luminance. The form used in the specification of text and symbol legibility [Legge et. al. 1987] is the Michelson definition, which assumes a relatively small symbol on a much larger background (background controls adaptation).

Given sufficient information about a display system, the luminance of any pixel value is relatively easy to calculate. For small symbols such as text and grids, however, interpixel effects (as described by MacIntyre and Cowan [1992]) must also be considered when calculating contrast.

Legibility studies typically involve tasks requiring focused attention. While legibility metrics for grids would be useful, our goal is not a minimally legible grid, which would be highly sensitive to viewer and technology variation. Instead, we need to find a specification that allow the grid to be robustly legible, but only when needed.

4. Visual Attention

We can define this quality of "legible only when needed" as a property of visual attention: why does a well-designed grid seem to be more visible when we pay attention to it, and what exactly does that mean? The art historian Ernst Gombrich describes a visual *middle ground* [2000] where features can be "extruded" into the foreground or "receded" into the background by slightly changing the degree of attention. Previous theories of visual attention as a "spotlight" could not explain this, but recent research in active vision [Findlay and Gilchrist 2003] and attentional effects on visual acuity [Gobell and Carrasco 2005] promise some perceptual and cognitive ground for these effects. The theory of active vision suggests that a top-down, task directed process directs attention to the grid such that it moves up or down in an attention scale. Once the object has been attended to, it may be subsequently *more* visible: reported attentional effects on visual acuity include increased contrast sensitivity and spatial resolution.

5. Conclusions

There are various ways to subtly yet effectively create a great grid. Our key result in terms of modeling the designer's art is that the interaction between perception and attention cannot be ignored in the evaluation of subtle stimuli such as a well-designed grid. Perceptual attributes like contrast and line thickness are not necessarily visually constant but may be modulated by attention. We now seek to create a framework that modulates perceptual thresholds as a function of attention, thus providing a fundamental component for understanding what makes great visualizations.

6. References

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