LAWS & RULES

Evidence-Based Human Factors Guidelines for PowerPoint Presentations

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Tips for improving comprehensibility of slide presentations are drawn from human factors/ergonomics research.

For 30 years, Microsoft PowerPoint has been available to aid in the transfer of ideas in virtually every professional and pedagogical venue. Although important work is being done to investigate other means of idea transfer (e.g., Miller et al., 2008), PowerPoint is the primary medium and is likely to remain so for some time to come.

The Microsoft program gives the speaker a large number of options along a variety of dimensions, from font type and size to text color and background. The options provided by PowerPoint permit virtually boundless flexibility. However, if the objective is to be clear and informative, many of the options available would be contraindicated by basic human factors/ergonomics (HF/E) principles. In this article, we apply a number of HF/E principles to help you increase the impact of your presentation and to help avoid common missteps.

Adding Human Factors Power to PowerPoint

Much of the information needed to design effective PowerPoint slides already exists in the arsenal of empirical research, standards, and principles of HF/E professionals. Indeed, the issue of translation from existing data and first principles is a characteristic of much of human factors engineering and engineering psychology that allows for the fast and effective modification of design. The translation problem we address here is one of applying already existing facts and principles from HF/E to the PowerPoint presentation.

We have all experienced the presentation that falls short of clarity because of poor choices in the design of the PowerPoint slides. There are many reasons that a presentation may be unclear or uninteresting. Indeed, experienced presenters know that the PowerPoint slides are only a supplement to the presentation, not the presentation itself. In addition to experience, other sources (e.g., Toastmasters, rhetoric analysis) are available to aid the orator in improving public speaking skills. In the current work, we restrict our guidelines to the perceptual and cognitive principles relevant to designing good PowerPoint slides.

In lieu of guidelines based on empirical comparisons or basic principles, a number of documents on the Web offer advice, presumably on the basis of personal, and perhaps professional, experience. These documents offer, at best, arbitrary suggestions and, at worst, guidelines than can compromise idea transfer.

Instead, we take advantage of scientific and engineering sources, such as Sanders and McCormick (1993) and the Department of Defense (1999) design criteria standard. Some of the criteria were intended for printed text, but we find them to be applicable to presentations, given the high resolution of modern projectors. We also apply basic display principles (e.g., Lehto & Buck, 2008; Wickens, Lee, Liu, & Becker, 2004) to the PowerPoint presentation. When more recent empirical work is available, we note the findings, although there is not always sufficient research to warrant sweeping claims. Surprisingly, although a considerable number of empirical studies have investigated the HF/E of hard copy and computer displays, far fewer studies directly assess the HF/E of projected presentations. In this article, we use principles developed for nonprojected text and cautiously generalize to projections.

In an effort to make this report easy to use, we report advice in boldface type, with relevant points to the discussion made afterward in plain text. On occasion, we depart from our lean format to offer an explanatory paragraph. Also, we depart from the standard style guide by reporting page numbers in brackets when we cite support for a particular guideline to allow interested readers to explore further the evidence underlying the guideline.

The goal of supplying a clear, easy-to-use set of guidelines also required that we

AT A GLANCE: For decades, the vehicle of choice for idea transfer has been Microsoft's PowerPoint. PowerPoint gives the orator a plethora of options in the design of a presentation. Choosing configurations for the most effective presentation can prove daunting, and even professional presentations bear witness to the difficulty of choosing wisely. Guidelines based on a collection of basic human factors/ergonomics principles and a few empirical studies are presented for effective PowerPoint presentations.

KEYWORDS: text, font, display, graphics, PowerPoint, visual aids

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take into account the vagaries of the situations in which orators may find themselves. For example, although the presenter can adjust the font size in PowerPoint, the direct factor is the visual angle subtended. This angle would depend on the distance between the projector and the screen. Similarly, the best-laid plan to present in a light-controlled room may not be realized. Finally, a speaker may choose a combination of font set and color that exists on the computer back home, only to find that the chosen font is not available at the destination. We offer advice that circumvents such concerns. To increase the portability of a presentation, we made every effort to make choices that would be universally effective.

Font Guidelines

Use Tahoma or similar font (e.g., Arial, Verdana, Microsoft Sans Serif). These are sans serif fonts, which have advantages in short, bulleted text of the kind that should populate your PowerPoint slides. In cases in which long lines of text are warranted, such as this report, the "little feet" of serif fonts seem to help readers follow along (Lehto & Buck, 2008 [p. 666]; Sanders & McCormick, 1993 [p. 105]).

Tahoma has a ratio of stroke width to height and letter width to height that makes it highly legible. Empirical comparisons with the use of computer screens found support for fonts such as these (Sheedy, Subbaram, Zimmerman, & Hayes, 2005). For Tahoma, the ratio of letter width to height is near the recommended 3:5, and the ratio of stroke width to height falls in the range from 1:5 to 1:8, which is legible (Department of Defense, 1999 [pp. 33, 101]; Sanders & McCormick, 1993 [pp. 103–104]).

Use a font size of at least 22 point for bullets, 16 point for figure legends and axes. This font size will project to screens at least 22 minutes of arc or 16 minutes of arc, recommended for critical legibility or legibility, respectively (Sanders & McCormick, 1993 [p. 112]). We make this recommendation assuming that you will be projecting on a screen that subtends a visual angle of 13° to 15° and that the projector is set to ensure that the slide will take up the entire screen. These assumptions are reasonable for most venues. (Note: Fonts differ in physical size even when the same point number is used. This guideline is based on our recommended fonts.)

Use sentence case for your bullets. Lowercase letters produce a distinctive envelope for words that is lost, for example, with all uppercase (Sanders & McCormick, 1993 [p. 108]). Making the initial letter of the bullet uppercase is thought to aid in directing attention.

Avoid overly compressed or extended texts. Character spacing between letters should be at least one stroke width (Department of Defense, 1999 [p. 102]). Some font families spread letters too far, threatening the integrity of individual words (e.g., see the KaiTi font, which otherwise has acceptable font ratios).

Minimize the use of font embellishments. The use of bold and italics should be restricted to emphases and headings. Avoid the use of other font embellishments, such as highlighted and flashing text (Sanders & McCormick, 1993 [pp. 105, 117]).

Color Guidelines

Use high-contrast text-to-background combinations. Contrast has a large impact on legibility. The highest contrast will be achieved by using black and white, but there are a number of other text-to-background combinations that can produce an acceptable contrast (see the split complementary colors section below). However, this simple principle helps one avoid the especially poor combinations noted by Greco, Stucchi, Zavagno, and Marino (2008): light orange on white, red on blue, or red on black.

Use dark text on a light background. You can meet the high-contrast criterion with dark text on a light background, or the opposite: light text on a dark background. Dark text on a light background is easier to read in well-lit rooms. Also, maintaining good contrast ratios is less difficult with dark on light when ambient light is present (Greco et al. 2008).

This advice may raise a concern about eyestrain. It is reasonable to expect some eyestrain and fatigue after prolonged exposure to a bright white background. Casual reports and an appeal to first principles suggest that this may be the case for at least some viewers. Thus, if the speaker prefers (but at some sacrifice to contrast), a light gray background rather than a stark white background may be used (cf. Greco et al. 2008).

Consider split complementary colors. If you want to include some color in your presentation, you can achieve high contrast by using complementary colors (colors directly opposite each other on the color wheel). However, true complementary colors often create a tension and may appear jarring. Using a split-complementary color scheme (e.g., Fraser & Banks, 2004) commonly used in the arts begins with choosing two complementary colors, but instead of using the direct contrast, you would use one of the two colors adjacent to the contrast. An example would be using a dark blue on pale red-orange or on pale yellow-orange. A monochromatic example of split complements is the black text on a light gray background we mentioned earlier. Remember to fade the colored background to keep contrast high.

Avoid red-green contrasts. Even though red and green are complementary colors, that combination should be avoided. From 5% to 8% of males have some color deficiency. The most prominent one is red-green colorblindness (Schiffman, 2001 [p. 135]).

See Figure 1 for an illustration of the font and color guidelines.

Layout Guidelines

Be consistent. Keep aspects of your presentation, such as font and colors, consistent from slide to slide (e.g., Wickens et al. 2004).

Line spacing should be half a character height. For the space between lines in the same bullet, allow a space of at least one half a character height. Additional spacing between bullets will aid in grouping your points (Department of Defense, 1999 [p. 102]).

Respect the slide margins. Because you will not always be able to control precisely the extent to which a slide fills the screen, it makes sense to leave a margin around the slide that does not contain critical information.

Comprehension Guidelines

A considerable amount of work exists on how humans comprehend. Even novice writers realize that a paragraph should be a coherent expression of a single idea and that one idea should be related to the next. Much of what is needed to make a PowerPoint presentation comprehensible maps neatly onto this notion, such as having a single main

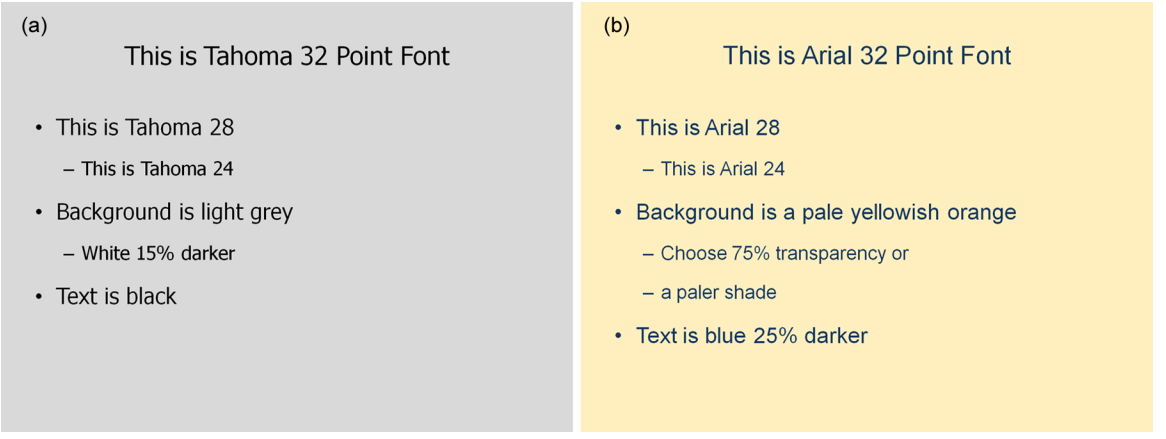

Figure 1. Recommended font characteristics using (a) a monochromatic and (b) a split-complementary color scheme. These backgrounds will project lighter than they appear here. Because of length constraints, this figure has been reduced to fit this space, and font sizes noted do not appear in their actual size.

idea per slide with bullets related to that idea.

Use bullets (not multiline paragraphs). For a variety of reasons, both ergonomic and rhetorical, the slide should be a collection of short bullets that assist you in making the presentation. This recommendation will also help you avoid the urge to read the slides as your presentation.

Bullets should be affirmative and in active voice. People have difficulty processing negatives or marked nouns (e.g., short is more difficult than tall; Clark, 1969). They also more easily understand active rather than passive statements.

Use no more than 4 ± 1 bullets on a slide. The bullets on a slide are meant to be integrated to support the main idea of the slide. This requires people to process the bullets in working memory, which seems limited to three to five pieces of information (e.g., Cowan, 2001).

Avoid distracting elements. If attention is moved to an irrelevant part of a situation or divided between the distraction and the situation, comprehension will suffer (Lehto & Buck, 2008, [p. 97]). This general principle warns against the use of animation and other features that will distract from the expository point. It allows, however, for ancillary materials, such as photographs or images, that will emphasize the main points or make the main point more memorable.

Charts, Graphs, and Tables

Avoid the 3-D graph option. The 3-D graphs appear to give two estimates for the *y*-axis and can make it difficult to discern values. They can also give the false illusion of volume (Sanders & McCormick, 1993, [p. 118]).

Do not use more than five or six colors or shapes. When using colors to label categories in graphs or charts, do not use more than five or six colors. People will have difficulty making the necessary distinctions (Wickens et al., 2004, [p. 187]). This recommendation also applies to the shapes used to designate data points. Adding redundancy (e.g., texture, patterns) to the graphs will enable viewers to discriminate among more objects and will also aid those with color deficiencies. (See Figure 2.)

Preview the color graphs. Although it is advisable to preview all aspects of your presentation, this guideline is especially true for colors. Projectors will not faithfully render the colors you choose. Colors that look obviously different on your computer may look less discriminable when projected. In fact, it may be possible to find out precisely the projector that will be used and plan accordingly. A call to the Red Rock Hotel revealed that a 5,000-lumen Sony PLC XP56 would be a best guess for most speakers at the Human Factors and Ergonomics Society's 2011 Annual Meeting.

Organize tabular data into groups and keep these groups as close to 5° of visual angle as feasible. Search time for information is a function of the number of groups, so minimize the number of groups by keeping each group as close to 5° of visual angle as feasible (Sanders & McCormick, 1993, [p. 116]).

Less is more as long as it is enough. Search time and errors increase as the amount of information increases, so keep density low but make sure you include the crucial information (Sanders & McCormick, 1993, [p. 114]). Targets in sparse groups are searched earlier, found faster, and less likely to be missed (Halverson & Hornof, 2004). See Figure 3.

Position the legend to minimize information access costs (Wickens et al., 2004, [p. 189]). PowerPoint's default presentation of a marginal legend might be improved by either explicitly labeling curves with the use of the text box feature or, in more complicated graphs, by moving the legend closer to the data. (See Figure 2.)

Conclusion

The guidelines presented here have received support from cognitive and HF/E research, standards, and basic principles. Like any technology, the effective use of PowerPoint requires that it be integrated effectively into the human-technical system. A variety of HF/E principles with a long history can be used to improve the PowerPoint presentation, just as such principles can improve any display used by humans to accomplish a task.

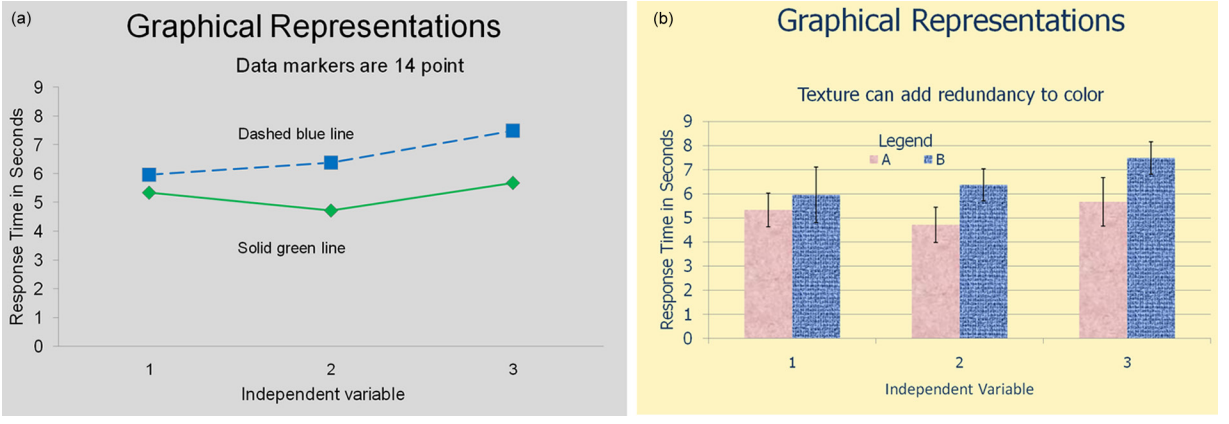

Figure 2. Illustrations of the redundancy gain of color and texture on a column chart. The use of text boxes in (a) and the position of the legend in (b) minimize information access costs.

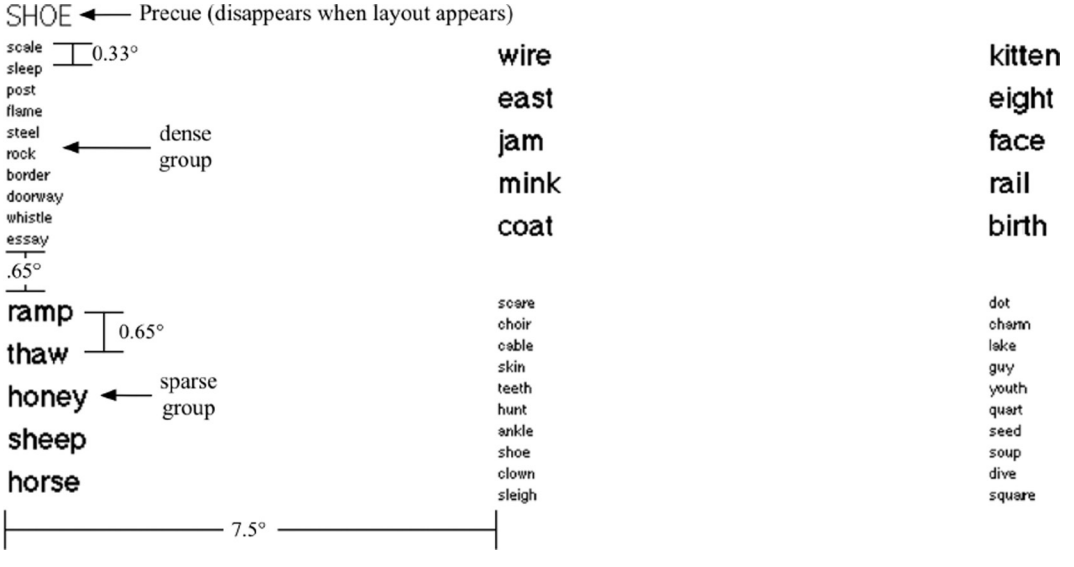

Figure 3. A sample layout from a mixed-density trial that Halverson and Hornof (2004) used in their research of local density on visual search. Their study found that targets in sparse groups are searched earlier, found faster, and less likely to be missed.

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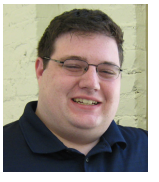

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