Illuminated Diagrams: Using Light and Print to Comparative Advantage

W. Bradford Paley
Digital Image Design Incorporated (didi)
brad@didi.com

Abstract

A hybrid medium is presented; it exploits the best characteristics of contemporary print and projector capabilities. This large-scale display consists of a print carrying static data, and light projected onto the surface of the print. The projected lightr adds many capabilities: interactivity, attention direction, and transient detail, while the bulk of the information still comes from the print's ultra-high information density.

1. Introduction

Ultra-high resolution large-scale displays have been in use for centuries, e.g. prints, drawings, and paintings; but their use as an information visualization medium has been largely unexplored. This may result from the difficulty of designing a data representation that takes advantage of the high resolution (with small details or glyphs) but still has enough variation on the global level to help direct the viewer to interesting areas.

We have developed a hybrid display technique that may be easier to design for, since it uses two presentation technologies, feeding different channels of human perception, and begins to describe which information should be presented in which channel.

2. Related Work

Fine artists have projected onto sculpture, paintings, prints, and people for decades, but the intent has been self-expression rather than the representation of information.

Raskar's "Shader Lamps," e.g. [4] project onto dioramas to add textures and simulate physical motion, but do not assume that anything more than the three-dimensional shape of the diorama carries information. The "Virtual Showcase" [1] of a raptor skull superimposes 3D images of muscles on a model of a skull, but again doesn't assume information in the skull itself. Tangible interfaces to projections, e.g. [5] concentrate on manipulating the projected image, not exposing features in the physical projection substrate. The Focus+Context work of Baudisch [2] relates to the current approach but still has significant differences, including an opposite use of the projector: here we use it to direct focus, in that work it is used to provide context. RASA and related work by McGee et. al. [3] project onto paper as we do here, but the purpose is still primarily to augment the paper with projected low-resolution symbolic information, rather than using the lower resolution as a "smart spotlight."

Figure 1: An illuminated Diagram at SIGGRAPH 02

3. Physical Setup

An information-dense print (in Fig. 1 roughly 6' by 4' print of a TextArc of Lewis Carroll's *Alice's Adventures in Wonderland*) is mounted on a wall. A projector is focused on the print, and the computer running it is calibrated so that the computer can locate any point on the print. A touch screen (seen at the bottom of Fig. 1) allows user control.

4. Two Channels, Two Kinds of Information

An Illuminated Diagram uses two technological channels, print and projection, to display two very different types of data: A representation of a vast amount of spatially arranged static data, and a relatively small amount of moving data.

4.1. Static printed data

Some kinds of static data can be well represented as tiny, self-contained glyphs. In TextArc, the individual words fit this description, as do the star-like "distribution glyphs" to the left of each word, as seen in Fig, 2, a detail of a print.

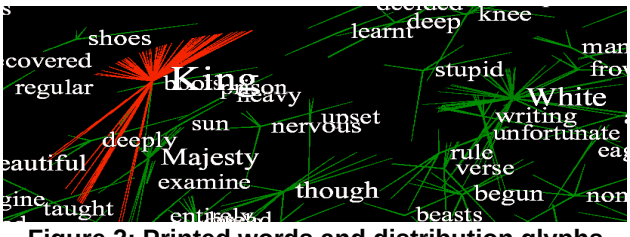


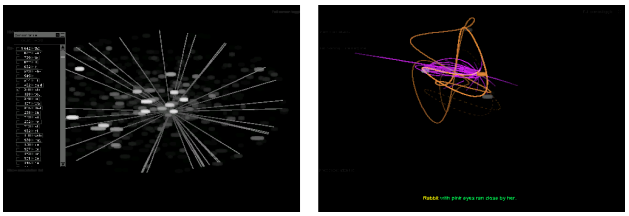
Figure 2: Printed words and distribution glyphs

Other static data might be represented as tiny charts, graphs or full networks, e.g. Connecting lines or enclosing contours that would become hopeless tangled in an ordinary static print this dense can become useful once we can indicate and group them with the light from the projector.

4.1. Dynamic projected data

The type of dynamic data that seems to work well in an Illuminated Diagram directly addresses or enhances the static image. Projected dynamic data can serve many distinct information visualization purposes. It can:

- Direct attention to a specific spot, static or moving
- Identify a specific shaped area, and how it may change
- Relate several elements to one another (with color, brightness, a network of lines, or motion similarities)
- Reveal a complicated diagram a section at a time, helping people learn how to use it
- Add annotation in the form of new lines, shapes, glyphs, an overlay window, or text
- Override a visual encoding in the print—e.g. a bright spot in the print left unlit will draw less attention



Figures 3a, 3b: Projected overlays, by themselves

5. Poster Example: an Illuminated TextArc

In a TextArc the static data is relative word frequency (controlling the brightness and size of a word) and distribution (each word is positioned at the centroid of its uses around the ellipse representing the entire text; its glyph points out each use). The dynamic data takes six forms: spotlights, glyph extensions, a "story line," word association nets, an overlay concordance window, and a subtitle; all controlled by a touch screen on the projector's computer.

Spotlights pick out each word as the viewer scans their fingers over the TextArc by using a touch screen. The touch screen displays only a very crude representation (Fig. 3a) encouraging the user to look at the print for details. Spotlights are matched in size to the word the viewer is touching, and "feathered:" gradually reduced in brightness around the edges. Feathering helps reduce distracting aliased edges—harder to overlook than they are in a normal projection because of their juxtaposition with the fine resolution of the print. The concordance window is readable despite the fact it is projected on black.

Glyph extensions extend the lines that make up the distribution glyphs. This helps find relationships between the touched word and words in the ellipse, and also directs attention more firmly back towards the touched word.

The story line, word association nets, and subtitle get projected when the viewer tells the TextArc to show the original sequence of words—demonstrating the mapping from the linear text as originally written to the spatially hashed version produced by the rules that make a TextArc. Fig. 3b shows them as they are projected on the print.

6. Other Domains

Other knowledge work domains have a similar split between a vast amount of static details and a need for dynamic data overlays. We have identified such splits and done initial conceptual design for Illuminated Displays in shipping, trucking, rail and air traffic control; industrial and chemical process control; bioinformatics and financial statistical information; and science, art museum, and educational displays.

7. Effectively Engaging Human Perception

Illuminated Diagrams engage with at least two different capabilities of human perception more effectively than many other information visualization techniques. They provide the eye with as much information as can be distinguished (or more), at the borders of acuity, while retaining the ability to use animation, light and color changes and motion to direct attention. They may also tap into the extreme dynamic range of light levels that the eye can distinguish—more than either the best print or best projector can independently.

8. References

[1] O. Bimber, B. Fröhlich, D. Schmalstieg, and L.M Encarnação. "Virtual Showcases" *SIGGRAPH '01 Proceedings* ACM Press, July 2001, pp. 277.

[2] P. Baudisch, N. Good, and P. Stewart. "Focus Plus Context Screens: Combining Display Technology with Visualization Techniques" *Proceedings of UIST '01*, November 2001, pp.31-40.

[3] D. McGee, P. Cohen, and L. Wu. "Something from nothing: Augmenting a paper-based work practice with multimodal interaction" *Proceedings, Designing Augmented Reality Environments*, ACM Press, 2000, pp. 71-80.

[4] R. Raskar; G. Welch, K-L Low, D. Bandyopadhyay, "Shader Lamps: Animating Real Objects with Image Based Illumination" *Eurographics Workshop on Rendering*, June 2001

[5] B. Ullmer, H. Ishii, "The metaDESK: Models and Prototypes for Tangible User Interfaces" *Proceedings of UIST'97*, ACM Press, 1997, pp. 223-232.