Typography Day ~ 2012

Typography in Publication Design

Vision and the Visual

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Slide 1: Title

Thank you for inviting me to IDC and IIT. It is wonderful to be back on this beautiful campus where I have spent some very enjoyable time in the past. I'd like to thank Professor Ravi Poovaiah and Professor G.V. Sreekumar especially for this opportunity to address you today.

Having begun my career as a letterpress printer my thoughts about design are grounded in craft. I'm also a teacher of typography and book design and for the last 10 years or so I've been investigating how design thinking occurs and how to teach it as a process. There have been two parallel paths in this work that have begun to overlap and inform each other in ways I hadn't predicted until recently. One path has to do with craft and the design thinking that is inherent to the practice of the artisan. Coming to India the first time was revelatory for me because of the abundance of artisans who continue to produce so many everyday objects. The other path— the one I will speak about today— has to do with our physical and cognitive visual processes, how the eye receives and the brain perceives. In other words, how vision is created in the brain. For the last several years I've been developing a curriculum for the design student based in visual cognition structured around two fundamental questions: First, how does the way we see shape the way we design? And second, is there a relationship between visual complexity or ambiguity on the one hand and its salience, our ability to remember it, on the other.

Slide 2

In other words, is there a difference between *this*

Slide 3

And *this*? How do we discuss the role of ambiguity with our students?

This entire line of research occurred almost by accident. Several years ago I was notified by my dean that I had volunteered—unbeknownst to me— to attend the kick-off lunch meeting for the new Center for Aging at our university. I had had no previous experience with the subject of aging, other than actively doing it myself, nor did I have any clue as to why I was asked to attend. I just figured I would go, fulfill my obligation, have a good lunch, and that would be the end of it. But once inside that meeting I was impressed by the range of creativity focused on this massive demographic shift toward a rapidly aging society (at least in the west).

Sitting next to me during the meeting was a cognitive psychologist who was as surprised to meet a designer in that setting as I was to be there. He was eager to tell me about new research into typographic preferences of older adults for reading type on the screen. I was surprised to discover anyone was even doing that kind of work, and eager to hear the findings.

Slide 4: Comic Sans

He cheerfully told me "Comic Sans, older readers prefer Comic Sans overwhelmingly." "What??? Are you kidding me?" Of course, I was horrified at the idea of scientists telling people they had to design everything in comic sans, you know you tend to believe someone in a lab coat. I could see he was surprised by my reaction, so I asked him the questions that would occur to any typographer, "what was the context for this test, how long were the line lengths, how big was the type, how much leading was there, what was the screen resolution, what was the background behind the type, and what were they reading?" He answered, "Wow, I guess I didn't know there was so much to it."

Slide 5: Aging Eye title slide

That conversation got me thinking: What else had he not thought about in designing these tests? Aren't these design problems? Shouldn't designers be at the table when tests for design preferences are being devised? And isn't it important for designers to understand this information so we may serve the aging population in the most effective way possible?

Slides 6-10: 5 slides on aging eye. Discuss.

Slide 6

This first slide, shows decreasing light sensitivity in the aging eye. The top shows a typical change in focal length due to the stiffening of the lens. On the left is how a document appears to the 20 year old eye, and on the right is how it appears to the 65 year old.

The bottom three images show decreasing sensitivity in the 20, 60, and 80 year old eye, and you can see a dramatic change occurring as the eye ages. As the lens ages, it also yellows making it more difficult to distinguish between shades of blue and green. Contrast becomes a big issue then for older readers, as well as for those seeking signage and other environmental graphic design.

Slide 7: Os and Cs

This slide shows the difficulty finding subtle differences in form when characters are embedded in larger fields. It is easy to see that for clusters of complex information choosing a face that has clearer differentiation in the character shapes, say apertures, terminals, etc, and would have great benefits for older readers.

The image at the bottom is a screen shot from a typical website. It's obvious we must think differently about how clusters of information are presented to be usable to the older user.

Slide 8: AARP

Here's the website of the American Association for Retired People and it does almost everything wrong. Those low contrast fields of blues and greens are difficult to distinguish; it's as if the entire site was designed for lowest usability.

And that's because it was probably designed by a 25 year old who was designing what she thought older people liked as opposed to what she knew was most usable.

The other two images are ads intended for older audiences, advertisements for products that are almost unreadable, all based on assumptions about preference but no evidence-based design strategy.

Slide 9

Target Stores in the US are an anomaly, a big box retailer that defines itself by design. They've done some serious work on redesigning prescription drug bottles for ultimate usability, and typography was a primary concern. Adverse drug reactions, a leading cause for hospitalization of the elderly, usually occurs due to the inability to read the tiny type that tells the patient what other drugs NOT to combine with the one they're already taking. But here those potential conflicts are clearly readable thanks to thoughtful design.

Slide 10

Here is the work of one of my students who produced a design guidelines manual for local businesses as an independent project for the Center for Aging.

But I began to realize the limitations of what we were doing in the classroom by being only focused on aging. If this knowledge was going to help students think more broadly about designing for a diverse population we would need to dig more deeply into cognitive vision in general.

Slide 11

These are some of the works that became my classroom, and there is wonderful information in all of them. But two things became clear to me from studying these texts. First, the study of vision was a very complex project, and many of the visual models they had created to explain complex processes were excellent examples of how to create really confusing graphics. Second, almost all of these books use examples taken from fine art—impressionist or cubist or renaissance painting seemed to be used over and over again to explain the complexities of visual processing.

I made a three-part resolution. First, I would have my students learn about the visual phenomena by using clear information design strategies in order to redesign the inadequate visual models found in these texts. Second, I wanted to use existing works of graphic design to illustrate these principles instead of fine art because design had one great advantage over fine art— it was aimed at a user and, therefore, more clearly illustrative of the visual principles we were studying. And third, I wanted to create a more precise vocabulary to critique students' work, one grounded in the science of vision.

Slide 12: Zeki quote

"Vision is an active process requiring 3 separate
but interlinked processes:

to extract only necessary information from the vast body reaching it in order to identify the constant, essential properties of objects and surfaces;
to discount and sacrifice all the information that is not of interest to it in obtaining that knowledge; and **to** compare the selected information with its stored record of past visual information and identify and categorize an object or scene."

This quote by the eminent neuroscientist Semir Zeki is amazing to me because while Zeki is defining the visual process he could just as easily be describing part of the design process as well. When I read this I was shocked at the degree of overlap— it made me question just how much is shared between visual cognition and design process.

Slide 13: Cognitive vision title

Slide 14: Image of fovea and surrounding area.
I began developing models of the visual system with my students. This slide shows, in an abstract fashion, the basic makeup of the photoreceptors of the retina, the rods and cones. That central area of enlarged cells represents the fovea, the 1.5 mm wide area of the highest acuity cells of the retina. What is most important, I believe, about the biology of our eye is that the different cell structures are highly specialized in visual processing.

Slide 15
The most highly acute cones can be thought of as relating directly to our "**what" system** where the detail and color features of an image are processed. The areas outside the fovea -- the parafoveal and the peripheral -- are less acute in vision. They do not detect detail and are virtually color blind. These cells send signals to the "**where" system**, helping to locate a thing in space. They are also more highly sensitive to motion and brightness contrast. A good illustration of how this works can be found by looking at the night sky. We see stars more clearly by not looking directly at them because when we see them in our peripheral vision the faint light is more apparent to our contrast-sensitive where system.

Slide 16
This is a page from the book *Vision and Art, the Biology of Seeing* by Margaret Livingstone, and maps the "what" and "where" system pathways. I felt we could do better with the model of the system, in order to better reflect how the process really works..

Slide 17

Here is my version of the what/where pathways using as an example the processing of a simple shaped object on a page. Using graphic tools such as transparency seemed to allow for a better understanding of the permeability of brain centers instead of the solid mass they appear to be in Livingstone.

(The area called the Primary Visual Cortex, located after the thalamus in the pathway is the point at which specialized signals get rerouted to various centers of the brain that process those impulses, such as color, form, contrast, position, depth, etc. *(Roughly they are V1= spatial information/contrast; V2 = orientation, color; V3 = motion and depth; V4 = color selective; V5 = motion analysis.))*

Slide 18: Title slide

What we see, and what we *think* we see can be two very different things. Zeki describes ambiguity as "the ability to represent simultaneously on the same canvas not one but several truths, each of which has equal validity with the others." He goes on to say that ambiguity is not defined the way it popularly is today: "not the vagueness or uncertainty, but, on the contrary certainty—the certainty of many different and essential conditions, each of which is the equal to the others. . ."

How does one stimulate cognitive function by using the graphic vocabulary of visual design? For my work I limited myself to four specific categories of visual processing that seemed to have the most impact on how we produce and understand graphic design. These are:

- 3D in 2D, the perception of depth from a flat plane
- Completion, seeing things that are not there
- Color and Contrast
- And the very particular cognitive problems presented by reading

Slide 19: Flat oval

Let's look at a simplified example of our predisposition to see shape.
The first drawing is most likely being read as a flat oval.

Slide 20 and 21: Illustration of flatness becoming depth.

In the next slide duplicate that oval and we immediately see it as having depth. Finally, by erasing part of the lower oval that would lap the upper one the indisputable sensation is of the upper oval occluding the lower, enhancing the perception of depth even further. We do so because it would be inconsistent with our visual experience to think of the asymmetrical shape at bottom to be a whole shape, even though that's precisely what's drawn above it. We want to experience this as 3-dimensional even though we know it's a 2D rendering.

The brain is predisposed to see images and patterns based upon established norms of regularity and symmetry. But we are also adept at making what we see conform to our prior experience of the world. That is how we are able to obtain strong three-dimensional cues from two-dimensional pictures. But as much as the brain likes patterns and regularity, it craves surprise and delight. This is why humans like puzzles, because the brain, after having done its work of deciphering a puzzle, will reward us with a shot of dopamine, which makes us feel good about the experience.

Since visual processing takes up about 1/3 of the area of the brain then it follows that the more cognitive "load" demanded by an image, the more salient that image might become.

Slide 22: Donald Hoffman illustration

In this slide we sense a phenomenal shape in the center of the lines, a bright square that seems to be occluding the lines behind it. What we are actually seeing is simply a bunch of line fragments, but what we are sensing is the subjective figure of the square in the center, one that does not exist. And something truly extraordinary occurs over the course of these three diagrams. The figure to the left has the least lines but we see the subjective square very well, it appears brighter than the area around it. our perceptual system, in order to bolster the notion there might be a shape where there is none creates brightness where there is none in order to enhance the illusion (literally to trick ourselves into seeing something): the white of the paper in the center of the subjective square actually appears brighter than that just outside the area of the lines, a phenomenon called Simultaneous Brightness Contrast. In the center diagram we sense the phenomenal figure even more strongly, due to an increase in number of lines. But the diagram on the right should produce an even stronger sensation of the square because it has the darkest lines, the most actual black, bounding the area. Yet the square has almost disappeared. Why? In the first two diagrams we see line fragments that appear to be part of one, continuous line, they don't appear to us as stable independent objects bounding an area, and with our brain's intention to find shape it will create the perception if it must. But in the third figure the presence of the 'v' shape gives our perceptual system enough to go on, we sense the Vs as stable, complete shapes that might be familiar to us and don't feel the need to "complete" it in any way. The phenomenal shape then disappears.

Slide 23: More examples of subjective shapes

On the left we have the strong perception of the square because the shapes are not what we know of as symmetrical and regular. The same square area on the right disappears as our visual systems shows its preference for the symmetry of the crosses bounding the area. Because the shapes are stable—they make sense, in other words— the brain's system of ordering and comparing arranges them as the important information and discards the sensation of the interior square.

Slide 24: Os

I began to consider how this would relate to typography. I wondered if that sense of a phenomenal brightness occurring entirely in the brain might relate to the way letters have historically been designed. Here we see two Os, Futura and Bembo. The O on the left is a geometric, symmetrical form, and so we read the shape of the stroke as a stable object. The one on the right has strokes that are of irregular shape which, I believe, give a stronger identity to the counters as being solid shapes that are occluding an irregular black solid. I believe that one of the important reasons the geometrics are felt to tire the eye is that they lack the strong identity of counterform due to the symmetry of their stroke. An irregular stroke surrounding a counter has a way of amplifying that counter and maybe allowing the letter to demand just that much more of our cognitive function. Is it possible that when we read the O on the right a stronger sensation of the counter improves, in a very subtle way, the reading experience?

Slide 25: Trademarks

In this grouping of trademarks designed by Chermayeff and Geismar it is possible to read these as a full menu of cognitive tricks intended to make the mark more memorable by requiring a bit more cognitive function. We see examples of occlusion, interposition, shading for depth, completion, and Gestalt grouping and it is this vocabulary that can be inserted into the critical discourse we have with our students about their work. We can use clearer terms when suggesting to them how to improve their work, as in *try an occluding form* or *consider different strategies for evoking a phenomenal shape*.

Slide 26: Reading section title

As my research continued it became clear that a meaningful curriculum in typography should include some serious thought about how reading occurs in the brain. Reading is a fascinating and sophisticated cognitive process that uses retinal signal firing combined with a high-speed guessing game based upon stored linguistic knowledge and our experience in word construction. It is also one of the most recent of all brain functions to develop.

Slide 27

This image taken from the book *Reading in the Brain* by Dehaene shows how lines of different orientation— those lines that define letters—are received as neural signals by retinal photoreceptors. I gave this diagram as an assignment to my class for redesign.

Slide 28

This is the diagram re-imagined by my student Michelle Knight, an excellent use of hierarchical structure to support clarity. This chart illustrates the transmission of signals from the retina to the language center of the brain to begin a process of mix and match.

Slide 29

A slide from Dehaene mapping the parallel processing routes reading takes as it travels toward meaning.

Slide 30

And my re-imagined version of that diagram.

Slide 31: Word shape

Word shape, sometimes referred to as “bouma” is a powerful predictor in the speed and retention of reading. An experienced reader can skip over a huge range of words that an inexperienced one must dwell on to read. And here we return to the what and where system of vision as shown in that early slide. Remember that only the fovea has acute vision, and imagining the detail of a small letter you can imagine is the incredible amount of visual processing just to get from letter to word. Once outside the foveal area visual acuteness dramatically declines. The further away from the fovea that information is received, in the para-foveal and peripheral areas, receptors are specialized for shape, not fine detail, so we can imagine that while our eye is skimming text, shapes of words are already being recognized even before we fixate on them because we can see their shape in our peripheral vision and make a guess about their meaning.

I think there might be some implications here for type design, especially when thinking about applications for populations of low-vision users.

Slide 32

This is an interpretation of how a page of text might actually be read by an experienced reader. The areas in focus represent “saccades”, those places of fixation of the fovea, and the blurry areas represent those areas skipped over, or seen primarily in para-foveal or peripheral vision. The text is by Keith Rayner, a leading researcher into dyslexia. Dyslexic readers most often describe their difficulty in reading as the sensation of the text moving on the page. But this was always considered to be a problem of the person’s language processing rather than vision, and that idea has historically guided treatment of dyslexics. Recent research has revealed, however, that the processing problem might be in the area of the brain that fixes location and orientation, functions of the receptors in the non-foveal parts of the retina and this could give rise to the sensation of things moving on the page. But while the dyslexic has difficulty with orientation, he has a greater sensitivity to shape, also a function of the non-foveal retinal receptors. Visual artists as a group have a higher percentage of dyslexics, a fact that is being linked to their higher sensitivity to shape. While it is commonly thought of only as a liability, there might be some greater value to being dyslexic than previously thought — or allowed.

Slide 33: Saccadic reading.

In an effort to more fully envision how saccadic reading works I made this diagram. The diagram includes as part of the reading process those backward eye movements called regressions, a part of the saccadic reading experience. All readers have regressions and they increase with age.

Slide 34: Disfluency title

Slide 35: COLOR title

Color is also a good method for introducing disfluency to the reading experience. We've all experienced seeing work that seems to vibrate uncomfortably because of the combination of colors. You should be experiencing a little of that from this slide. Again, this goes back to the function of the what and where systems, which require enough contrast to do their jobs effectively. Because the where system -- which is contrast sensitive but not color sensitive -- is faster at processing the challenge of locating a thing in an image and finding its edges takes precedence in our visual hierarchy. But if colors are very low contrast, meaning of equal value, a condition the psychologists call "equiluminance", the where system cannot do its job to locate the thing in a stable position. The reason colors of equal value cause things to appear "jittery" is because their edges are, in effect, melting into one another and we cannot establish the exact location of the edges. It's not the colors that are sometimes called "jittery", but the signals in our own visual system.

Slide 36

These type examples are taken from Livingstone's book and present some interesting questions about psychologists doing work with typography. In her book Livingstone states that the slower the reading, the more difficult it is to obtain a textual message, the more fully it will be retained. But when I questioned Livingstone about her conclusions she agreed that it is important, "necessary" in her words, for designers to be working in this area of research because we would have insights she was not trained to have. I think the question is about thresholds, those moments when the typography presents so many challenges that the reader gives up and moves on to the next thing.

Slide 37: Disfluency text

Some of you may have seen a recent Princeton study on disfluency as a factor in reading retention. Disfluency is defined as simply making something more difficult to read. In a controlled experiment researchers took college students' notes and set them in difficult—or unfamiliar—fonts, to slow down the reading process. They found that retention of information increased with the introduction of disfluency into the reading process. Of course, as the researchers recognize, this was a controlled experiment, and the students were paid to participate. There should be a follow-up test in which notes are set in a familiar and easy to read font like Times Roman, as they would be normally encountered. I'd be willing to bet that if the students were paid to complete the test retention would go up in that study as well. But the study begs the question, if we read best what we know best, then isn't it a matter of exposure to weird fonts? Wouldn't the retention of texts set in these unfamiliar fonts go down as the subjects gained familiarity with them over time? Seems clear to me that more testing of the disfluency hypothesis is necessary before we're able to reach any firm data.

Slide 38: Slutsky type patterns

This is a study of letter shape and pattern done by a student, Deborah Slutsky.
I've been thinking a lot about patterns. The great challenge of typography is translating known speech patterns into visual patterns that fire signals at the retina and travel deep into the brains speech centers. We are pattern makers—which is good—because it turns out the brain loves patterns, and it loves them for two reasons. First, we love recognizable patterns—they are, in their way, pleasing. Have you ever had a song stuck in your head repeating, over and over, Jai Ho, Jai Ho? We seem to grab auditory patterns even if we don't want to. Our predisposition for visual pattern would come as no surprise in a culture as visually acute as India where pattern is a valued tradition and is literally everywhere you look. Pattern excites the eye. The second reason we love patterns is that even though we crave known or recognizable patterns, we also crave those moments that upset our expectations of how a pattern works. These are the dissonant places where we encounter something new, something unexpected. When this happens, and we like it, a message is sent to the amygdala in our brain and we get a nice little shot of dopamine as a reward to tell us "Hey, I liked that, that was delightful." And isn't delight one of those design outcomes we spend too little discussing with our students?

Slide 39: Medieval monk scribe

In this piece of manuscript by a medieval monk we see a quite old and similar investigation into repeat patterns with words. This is actual writing although its meaning is, well, meaningless. But the point is that 1000 years ago designers of text were already thinking about how graphic language is processed and the thresholds of readability.

Slide 40

This is an image of the famous Bible from the Doves Press, 1900., the opening page and a detail of the type. I love taking my students to see this book in our university rare book collection because it represents a reading experience that is almost entirely different from what they are used to today. Word spacing is minimal, and the setting of the justified type is perfect, not a river of white space on a single page. And all composed by hand in metal type. This is a visual pattern that was of the kind expected by a reader in 1900.

Slide 41

Stephen Mallarme's Un Coup de Des represents another kind of pattern, one that utilizes a wholly different approach to the page than was familiar at the time. Whether it was pleasing or not doesn't matter as much as that it was visually dissonant for readers of the time, it conformed to none of the expected patterns of readability, and it worked on systems of grouping by location and similarity that became popular some years later by proponents of Gestalt psychology.

I find that when teaching students about page and book design this pattern thinking is very useful, especially if it taps into other sensory categories of pattern recognition. I'd like to play snippets of recordings for you now, two recordings of the same piece of music from the musical The Sound of Music, the song My Favorite Things. I play this every semester for my students when we discuss patterns of recognition and dissonance in book design. The first recording is of the original version sung by Julie Andrews, as it was written in perfect ¾ waltz time. Listen.

The second is a recording of the same song by John Coltrane, one of the masters of American Jazz improvisation.

Coltrane's version is one of the most perfect lessons of book design I could ever imagine. There is the recognition of pattern and then there is upsetting the expectation. Theme and variation, expectation and dissonance. The written notes and the bent ones, and through it all a sense of timing that is magical.

Slide 42

We are in Mumbai, after all, so I wanted to conclude this talk by discussing a mode of visual communication distinctly Indian in nature, and although it's not typography, it does hold examples of ingenious forms of visible language, and some rather complex visual thinking. I have been documenting and writing about Indian signboards ever since my first visit to Ahmedabad 10 years ago. I was taken by the visual invention with letterform almost immediately, but it has been through the lens of visual perception that the true genius of these sign painters has surfaced for me, as well as a marvelous connection of two primary areas of my research, Indian design thinking, something I call "subtle technology" and visual perception.

It was this sign on a wall in the tiny village of Parvathagiri, Andhra Pradesh that captured my attention for its perceptual invention. When I saw this, I realized the masterful and manifold ways sign painters create 3-dimensionality on a 2D surface, by controlling a sophisticated graphic palette of visual illusion. The sign painters quite often shift implied light sources, perspectival references, and rendering styles within the same frame. The background of this sign is unusually spare, a concession to budget the painter told me. But it heightens the sense of lighting. I was struck by the massiveness of the green letters at top due to their extrusion and squared format, quite a departure from typical Telugu rendering below it, that to this foreign, non-reader always looks like a string of jalebis. I find these signs, with their shifting light sources and changes in between flatness and depth, are the very definition of visual ambiguity I spoke about earlier, that of "the ability to represent simultaneously on the same canvas not one but several truths, each of which has equal validity with the others."

Here are more signs that I have been collecting along the way. The skill I am considering in rendering 3D spatial constructs doesn't even consider the genius of the lettering itself. I urge you all to look at the wonderful work of Hanif Kureshi, in collecting and digitizing the great lettering styles of the painters at handpaintedtype.com.

Slide 43

We are only on the cusp of understanding the eye/brain perceptual pathways. I want to conclude with this slide, a drawing by Santiago Ramon y Cajal from 1901. Working from only dead tissue Cajal revolutionized neuroscience by imagining pathways as dynamic and directional, and communicating this by adding small arrows along the axons (B) carrying visual impulses to the brain from the retinal dendrytes (A). It's a brilliant piece of information design and communicates its assumption about this complex process through good graphic design. It is our ability to visualize that will expand our practice. Will it make better design? Well, that depends on what the criteria are for evaluating design's effectiveness, criteria that I believe are shifting as we speak. Understanding the science of visual perception doesn't automatically make one a better designer, but it will surely make a difference in our ability to serve diverse groups of users more effectively in the coming years.

The most important reason for teaching a curriculum based in principles of perception might be the (hoped for) outcome of having a student ask that one, big question— does everyone else see things the way I do?

Thank you.