Comp 388/441 - Human-Computer Interface Design

Week 2 - 28th January 2016

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Colour & Vision - I

Perception

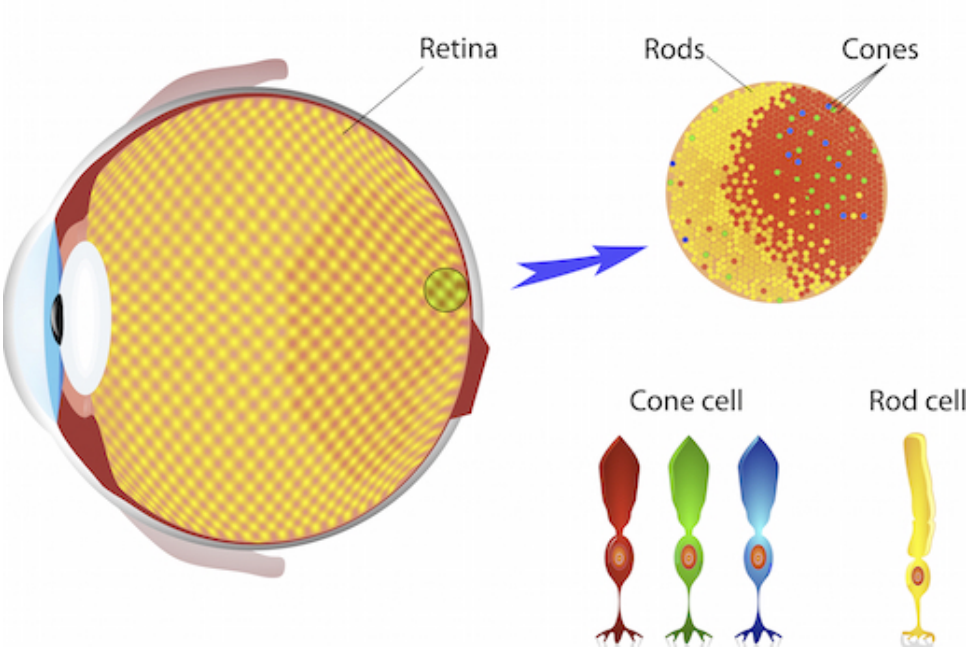
- colour perception in humans
    - *inherent strengths and weaknesses*
- a few limitations in everyday lives
- considerations as UI designers
    - *presentation of colours affects a user's ability to recognise and distinguish them*
    - *display influences a user's perception of colour*
        - eg: their monitor, screen or other viewing device
    - *user's vision optimal at detecting contrasts, edges*
        - not absolute brightness
    - *some users may have some degree of colour-blindness*

Colour & Vision - 2

Rods and Cones

- retina at the back of the eye is used for focusing images
- retina has two types of light receptor cells
    - *known as rods and cones*
- *rods* detect light levels, but not colours
- *cones* detect colours
    - *three types sensitive to red, green, and blue light*
    - *often compared to video cameras, monitors...*

Colour & Vision - 3



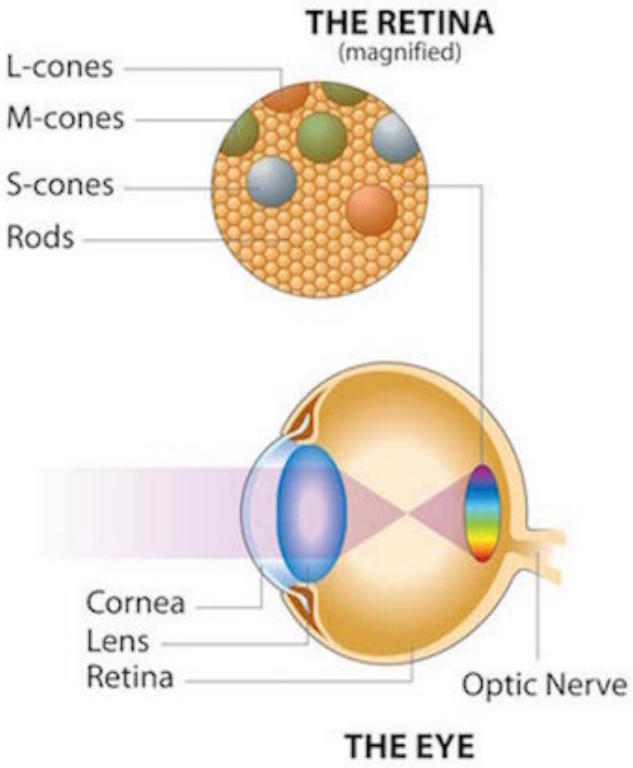
The Human Eye (source: DoveMed)

Colour & Vision - 4

Modern Environmental Influences

- we need to consider the effect of environmental conditions on human vision
    - *modern working and living spaces*
- rods are sensitive to the environment's overall brightness
- three types of cones sensitive to different frequencies of light
- bright artificial lights dramatically reduce the use of rods
    - *rods designed for low levels of light*
    - *navigating low-light environments*
- bright artificial lights max out our rods
    - *rods provide no real useful information*
- vision becomes reliant on input from cones

Colour & Vision - 5



The Human Eye (source: Verilux)

Colour & Vision - 6

Visible Light Spectrum (source: Wikimedia)

- S-cone = short-wavelength sensitivity
    - *sensitive to light over almost the entire range of visible light*
    - *most sensitive to the middle (yellow...) and low (red...) frequencies*

- M-cone = middle-wavelength sensitivity
    - *less sensitive than S-cones*
    - *sensitive to light ranging from high-frequency (blues...) through middle frequency (yellows & oranges...)*

- L-cone = long-wavelength sensitivity
    - *less sensitive than either S or M-cones*
    - *most sensitive to upper end of visible light spectrum (violets through blues...)*
    - *our eyes are less sensitive to violets through blues than other colours*

Colour & Vision - 7

Combinations in the brain

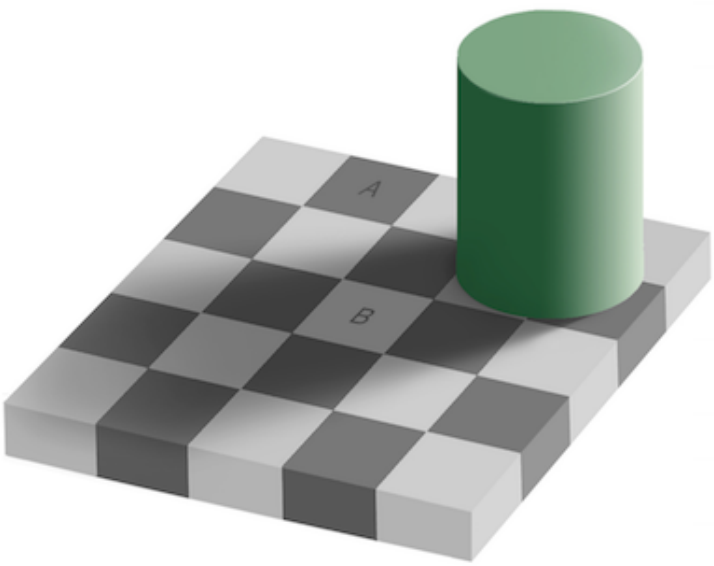
- our brain works on the principle of subtraction
- visual cortex at the back of our brain does the work
    - *neurons subtract signals coming along the optic nerves from S and M-cones*
    - *produces red-green difference signal channel*
    - *neurons subtract signals from L and S-cones*
    - *produces yellow-blue difference signal channel*
    - *third set of neurons as the signals from S and M-cones*
    - *produces an overall black-white, or luminance, channel*
- three channels known as *colour-opponent* channels

Vision & Contrast - 1

Sensitivity

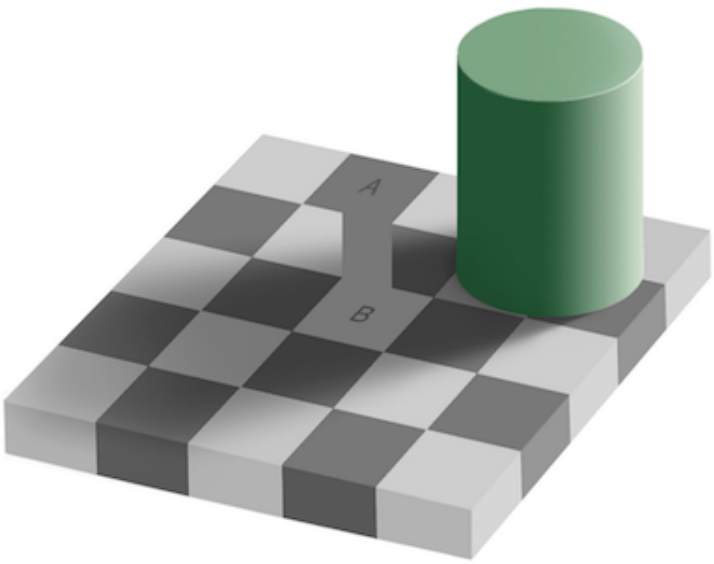
- our vision is now much more sensitive to differences in colour and brightness
    - *greater sensitivity to contrasting colours and edges*
    - *less sensitivity to absolute brightness levels*
- greater sensitivity to contrast is an advantage
    - *more easily discern objects in varied light*
- sensitivity to colour contrasts rather than absolute colours
    - *allows us to discern colour of an object in bright light or shade*

Vision & Contrast - 2



"Grey square optical illusion" - Edward H. Adelson (source: Wikipedia)

Vision & Contrast - 3



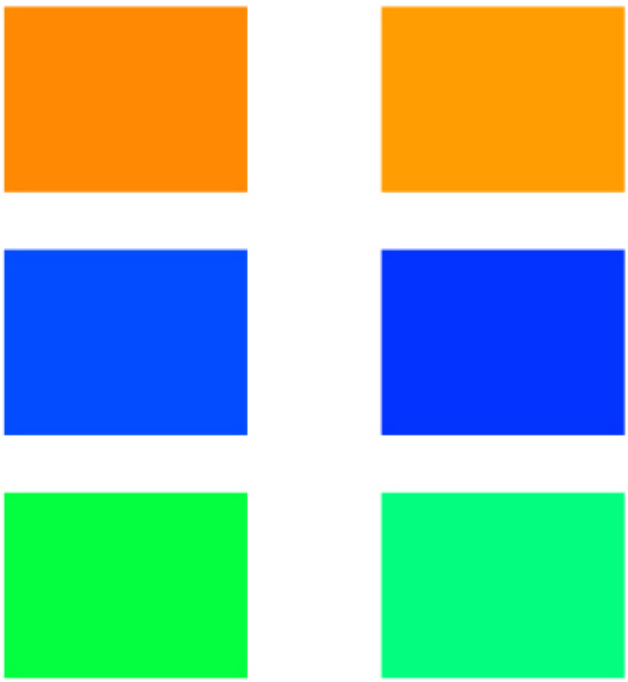
"Grey square optical illusion" - Edward H. Adelson (source: Wikipedia)

Vision & Contrast - 4

Incredible Shade Illusion!

Grey Square Optical Illusion - Source: YouTube

Vision & Contrast - 5



Colour Presentation (source: National Geographic - Modified)

Vision & Contrast - 6

A few things to avoid in images & graphics

- try to avoid overly pale colours
- avoid pale colours juxtaposed
- avoid pale colours for smaller blocks or zones
    - *often simply be lost in the noise of larger zones and blocks*
- carefully consider chosen colours for charts, graphs, infographics...

Vision Issues - I

Colour Blindness

- does not infer an inability to see colours
    - *a defect with one or more colour subtraction channel*
- makes it difficult to distinguish certain pairs of colours
- most common form of colour blindness is lack of red-green perception
- ~8% of men & ~0.5% of women suffer
    - *source: Wolfmaier, 1999*

Vision Issues - 2

Key

- left = normal human colour vision
- right = human Red-Green colour blindness

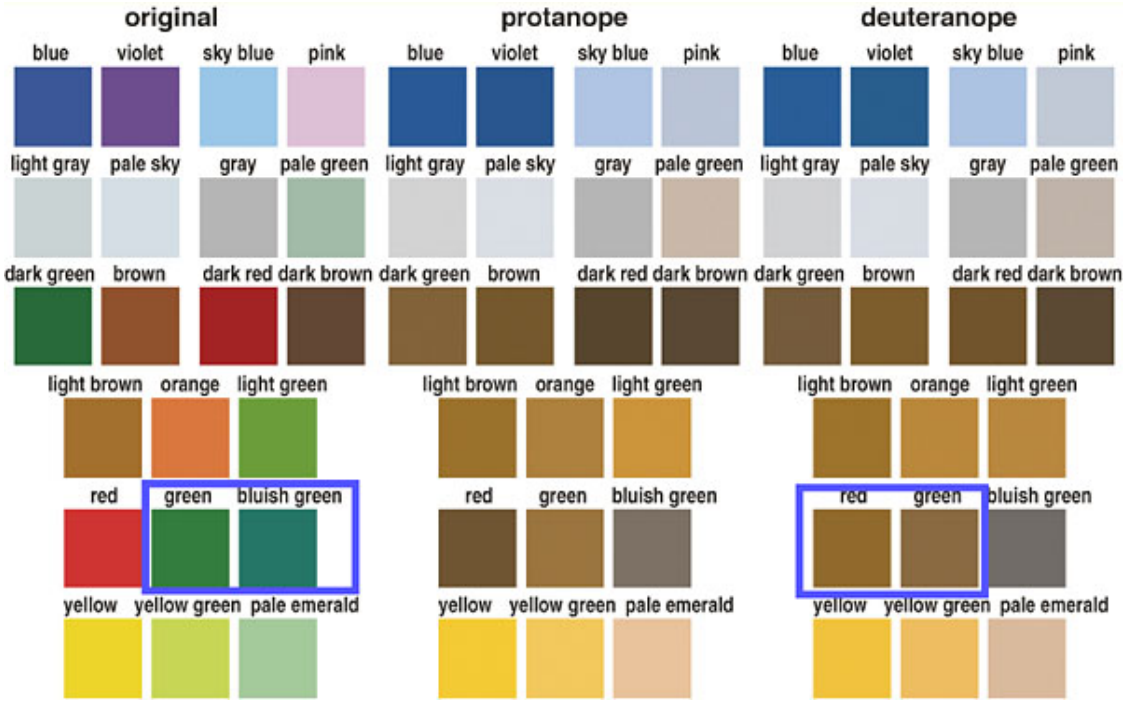
Colour Blindness - Red-Green (source: Ask a Mathematician / Ask a Physicist)

Vision Issues - 3

No Such Thing As Color - what it's like to be color blind

'No Such Thing as Color - what it's like to be color blind'
Source: YouTube

Vision Issues - 4



Colour perception (source: Okabe, M & Ito, K. 2008)

Vision Issues - 5

Other issues to consider...

- ambient lighting has a direct impact upon a user's display
    - *washed out, distorted colours*
    - *light and dark areas may persist*
    - *mobile & wearable considerations*
- display viewing angle affects a user's interpretation of colour
    - *cheaper, non-IPS displays offer poor viewing angles and colour shifting*
- mono or greyscale displays directly influence design choices
- variation in colour across competing display technologies
    - *deeper blacks, richer colours, varied viewing angles*

The Bible with Sources Revealed - Source: Amazon

Colour Suggestions

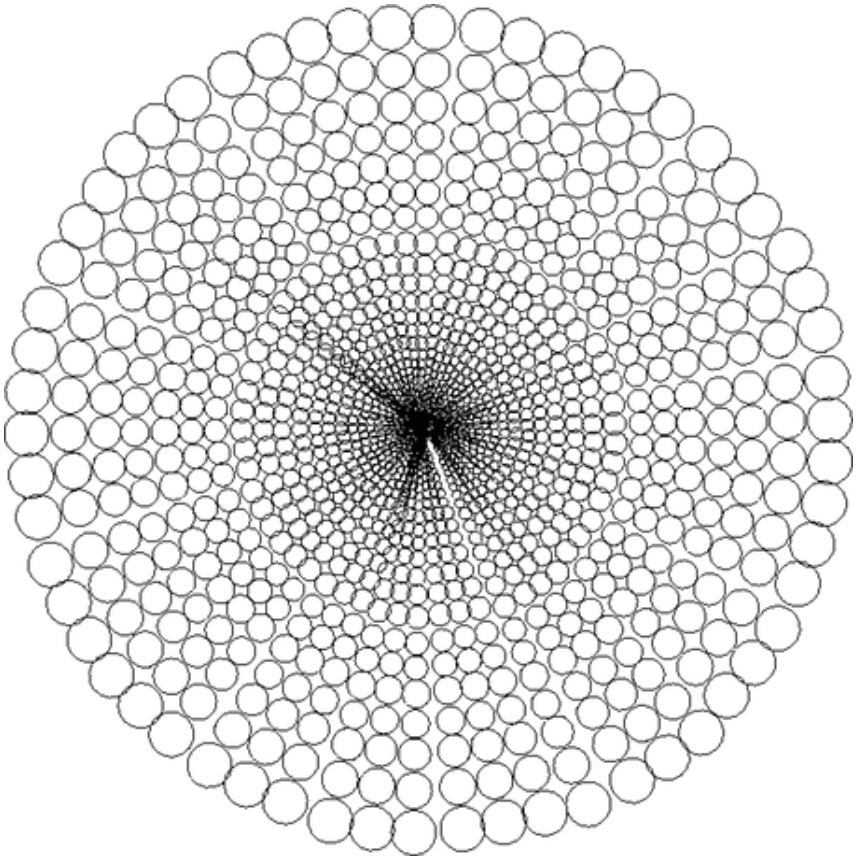
- subtle colour differences versus saturation, brightness, and hue
    - *test in monochrome to discern zones of coloured differences*
- distinctive colours aid a user's visual system in the combination of colours and visual recognition
    - *black, white, red, green, yellow, and blue*
- try to avoid colour pairs that colour blind people can't distinguish
    - *eg: dark red vs black, dark red vs dark green, blue vs purple, and light green vs white*
    - *try those colours against yellows and greens*
- try adding supporting recognition to colours within your interface
    - *eg: icons, keys, notes...*

Vision & Resolution I

Peripheral vision - consider spatial resolution in human vision

- spatial resolution drops greatly from the centre to the periphery
- three known reasons for this phenomenon
    - *data compression*
        - information compressed, associated data loss from visual periphery
    - *pixel density*
        - eye has ~ 6-7 million cone cells in the retina
        - cones densely packed in centre of vision, known as **fovea**
    - *processing*
        - fovea is ~ 1% of the retina
        - brain's visual cortex uses ~ 50% of its area for input from the fovea
        - remaining area for other 99%
- vision has much greater resolution in the centre than elsewhere
    - *Waloszek, G. 2005*

Vision & Resolution - 2



Foveal Image (source: Illustrated Dictionary of Computer Vision)

Vision & Resolution - 3

Is peripheral vision any use?

Three primary functions for peripheral vision:

- better vision in the dark
- detects motion
- guides the fovea, our centre of vision

Vision & Interfaces - 1

Application in User Interfaces

- one of the primary issues is a user's focal point relative to other interface elements
- error messages are an example of this issue
    - *user's focal point at button or clicked link...*
    - *messages often missed if presented within peripheral vision relative to link...*
    - *messages need to be obvious relative to focal point of fovea*
- other design considerations for peripheral vision
    - *standard design options*
    - *colour, font or icon size, relative positioning, opacity...*

Vision & Interfaces - 2

Make messages visible...

- use a user's focal point to our advantage as designers
    - *put the message at the focal point*
- user's tend to focus in a predictable manner with user interface interaction
- inherent predictability can be used to guide design
    - *western users tend to follow a pattern of movement for forms, panels etc*
    - *top left to bottom right*
    - *click a link and obtain focal point*
- mark an error prominently to help users
    - *normally place the message near the source of the error*
    - *or relocate to focal point if discrepancy in the user interface*

Vision & Interfaces - 3

Make messages visible...cont'd

- consider adding an error icon or symbol to the message output
  - *ensure icon or symbol is consistent throughout application, website...*
- reserve a single colour for error messages throughout the interface
  - *customarily red colour used for error and danger messages*
  - *consider red colour relative to company or brand image*
  - *red considered good luck, auspicious in Chinese culture*
    - often associated with death in Egypt...
  - *if necessary, change colour and add error icon etc to help reinforce different colour*

Vision & Interfaces - 4

Overt Interface Options

There are also more obvious options for attracting a user's attention.

- a message in an error dialog or modal box
    - *gets attention quickly and forces a user to interact before continuing*
    - *use with caution, can be very annoying if abused*
    - *carefully consider context before deploying modal options*
    - *traditional popups can be overridden in browser settings*
- use sound to reinforce an error message
    - *system beep or warning common tool for notifying users*
    - *notifies a user to check the interface for more information*
    - *consider as a support, reinforcement to visual messages*
    - *again, quickly becomes annoying if abused*
    - *environmental conditions important as well*
    - *vibrations an alternative for mobile apps...*

Vision & Interfaces - 5

Overt Interface Options...cont'd

- animated notifications work with our peripheral vision's motion tracking
    - *peripheral vision's ability to detect motion*
    - *detection causes reflexive eye movement towards the screen*
    - *animations often seen in interface menu selections*
        - menu blinks or flashes to indicate selection of option

Considerations

- these options should be used sparingly in a user interface design
- such visual options are often associated with annoying advertisements
- context is important
- consider advanced options to cancel or limit such interface options

Vision & Interfaces - 6

Positive Highlighting & Focus

- peripheral vision useful as a trigger for the fovea to focus
- moving, overt objects and triggers quickly draw the fovea's attention
- *searching* is another important role for our vision
    - *peripheral vision plays key role*
    - *dependent upon search target, style, colour, movement...*
- design can help our vision focus upon search target
    - *text decoration, highlighting, weight, emphasis...*
    - *bold that* ***pops***

Vision & Interfaces - 7

Test 1

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Vision & Interfaces - 8

Test 2

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Vision & Interfaces - 9

Test 3

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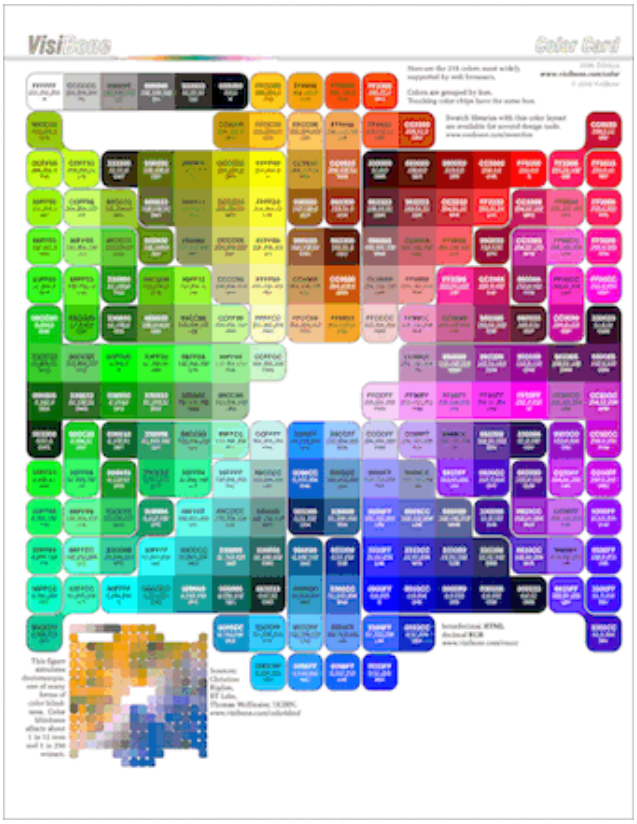
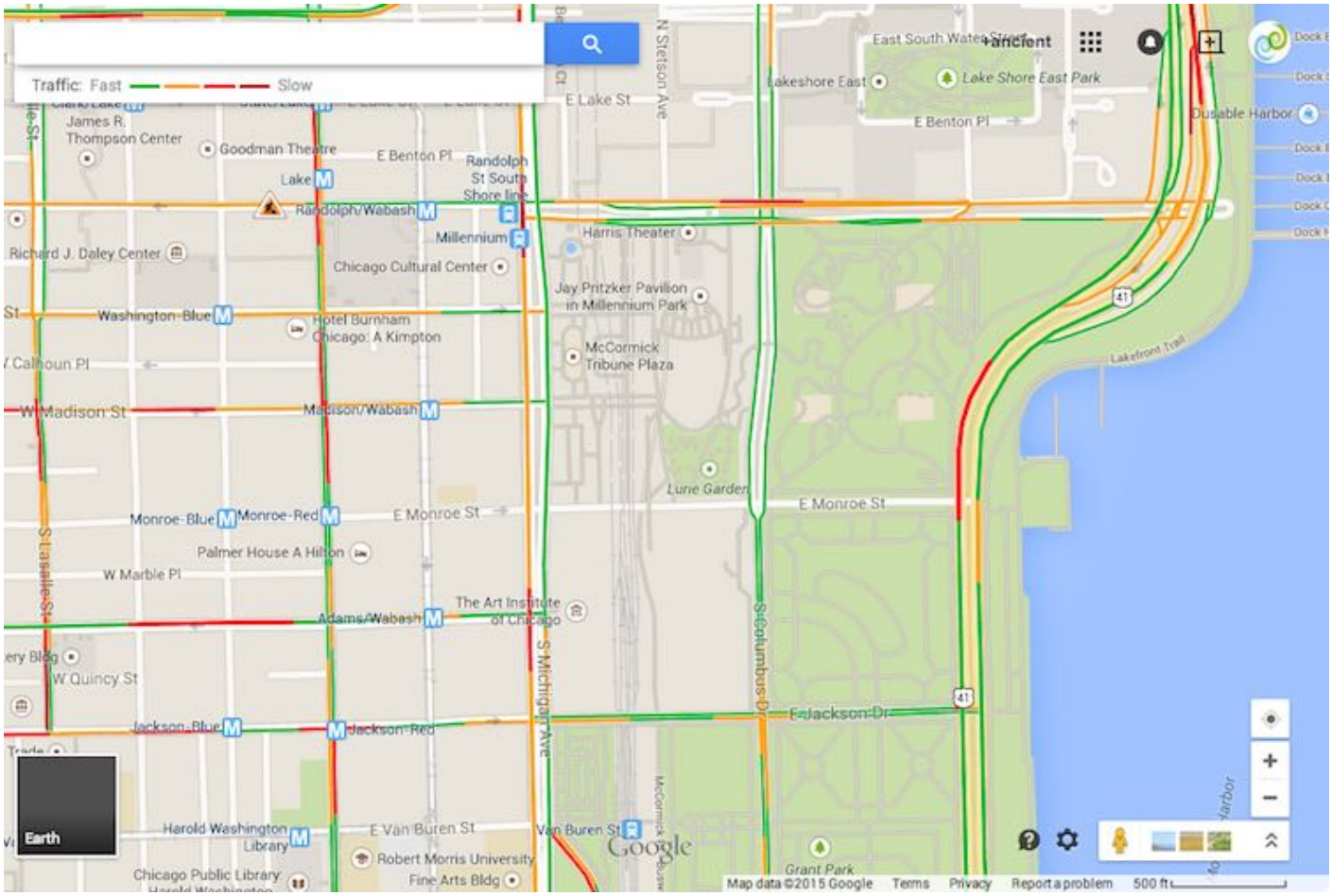
Vision & Interfaces - 10



Browser colours & colour blindness (source: VisiBone)



Traffic with Google Maps (source: Google Maps - Downtown Chicago)

Email Survey - (source: Art Institute Chicago)

References

- Okabe, M. & Ito, K. *Color Universal Design (CUD) - How to make figures and presentations that are friendly to Colorblind people.* J*Fly. 2008. http://jfly.iam.u-tokyo.ac.jp/color/.
- Waloszek, G. *Vision and visual disabilities: An introduction.* SAP Design Guild. 2005. http://www.sapdesignguild.org/editions/highlight_articles_01/vision_physiology.asp
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