

One might ask questions about QR codes in the same way one does about geographical maps. Indeed, is there some sort of parallel world of QR-cartography?

What alterations of a QR image do not destroy the embedded link to a website (or other)? Some of the answer to that question lies in the extent of embedded error correction within the underlying code. The greater the correction capability, the greater the surface pattern can be disrupted without loss of transmission capability. Nonetheless, are there certain geometric styles of pattern disruption that are permitted? Figure 1 shows simple pattern destruction that still permits code transmission.



Figure 1. Source: http://en.wikipedia.org/wiki/File:QR_Code_Damaged.jpg

It is important to understand what sorts of alterations of QR code pattern will still permit decoding of the image. From an aesthetic viewpoint, it is important to be able to make attractive QR codes to encourage their use. From a marketing viewpoint, it is important to be able to make QR codes clearly linked to a business. And, from a municipal viewpoint, it is important to be able to make QR codes as parts of official documents that will withstand handling by multiple parties, as in the case of the recent adoption of a requirement by the City Council of the City of New York, that every city agency that has inspection, permit, license, or registration information online post a QR code linking to it (Pereira, 2012).

Geometric Alterations within the Plane

Color Change

Perhaps the simplest alteration is color change. The contrast between dark and light needs to be sufficient for the scanner to make suitable distinctions, but beyond that, color is irrelevant. Black and white is no different from color. Changing color may slightly improve design appearance. As with a map, four colors suffice. Too many colors create visual clutter. The images in Figure 2 offer some ideas involving color change; all should decode by going to the same url. The interested reader can find any number of color (and other) variations created by folks all across the Internet: [link](#).



Figure 2a. QR code leading to IMAge home page.

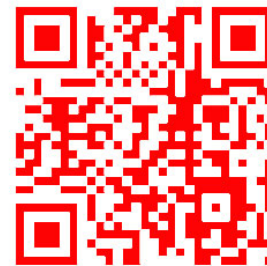


Figure 2b. Image in Figure 2a with single color replacement.

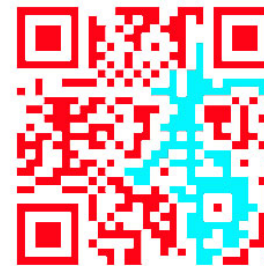


Figure 2c. Image in Figure 2a with more than single color replacement.

Distortion

Image creation software, such as Adobe Photoshop, may be used to soften the edges of images and introduce a host of filters. Some of these introduce distortion that is slight enough not to alter code transmission. The user is engaging in a balancing act with the level of error correction built into the code on one side and the level of power of image alteration on the other. Figure 3 offers a set of examples of image alteration through artistic distortion. Many others are available online ([Beautiful Pixels](#), 1010, for example). These distortions involve alteration of the pattern within a given canvas.



Figure 3a. Base figure worked with for much of this document.



Figure 3b. Straightforward use of several filters in Photoshop leaves the pattern clearly recognizable.



Figure 3c. Shearing the pattern creates an interesting effect. How much shearing is permitted?

More generally, one might wonder how the aspect ratio itself might be altered and still preserve code. Figure 4 offers a set of examples of image alteration through aspect ratio distortion (again, the level to which one can perform such distortion will be tied to error correction capability). In Figures 4a and 4b the decoding is swift. In Figure 4c, one scanner could not decode it while another could do so. Clearly there are limits to this sort of distortion but determining them is based on a variety of software, hardware, and error correction factors. What is important to note is that in fact there are limits beyond which aspect ratio distortion yields the code unusable. This fact might come into play if one were to consider tattoos on growing humans, etching QR codes into the bark of growing trees, and no doubt a variety of other possibilities involving a time or stretching of a surface factor.



Figure 4a. Based on Figure 3a: A 50% increase in height dimension while keeping width the same.



Figure 4b. Based on Figure 3a: A 70% increase in height dimension while keeping the width the same.



Figure 4c. Based on Figure 3a: An 80% increase in height dimension while keeping the width the same.

Interruption and Opacity

The shearing in Figure 3c interrupted the image (much as a cut in the ocean, as in a Goode's homolosine projection might interrupt a map). Screen savers often interrupt an image; in fact, that is the idea. Figure 5 shows an image of a QR code that remains readable despite being covered with a set of semi-opaque "bubbles" from a screen saver.



Figure 5. Bubble screen saver does not interrupt capability to decode pattern.

Figure 5 prompts questioning the extent to which one image may be slid (translated) across a QR code with opacity adjusted. Figure 6 shows a sequence of such codes. Again, the answer is a matter of balance. In Figure 6a, the hexagonal overlay is 100% opaque. The image does not scan. In Figure 6b, the overlay is 60% opaque and the image scans but it does not scan when set to 65%. In Figure 6c, the two overlays are set at 36% each. The image scans despite the opacity of the interior hexagon being greater than 36%. Clearly location of semi-opaque elements matters and leads to asking questions about where materials might be successfully embedded within a given QR code.



Figure 6a. Hexagon is 100% opaque.



Figure 6b. Hexagon is 60% opaque.



Figure 6c. Each hexagon is 36% opaque.

Embedding

As translation is considered, what logos or other images in fully opaque form may be inserted within the QR code? The [linked](#) file explains the process. Figure 7 shows one existing example; there are many others.



Figure 7. QR code with embedded logo.

One can also turn the idea around and consider how to embed QR codes (altered or not) into existing art (as in Figures 8 and 9) or into art created with the QR code deliberately incorporated as an element of the art. A number of forward-looking original pieces of art, designed to have an embedded QR code are present in a variety of locales: one that seemed particularly attractive to this author were the examples present in the extensive PATH network linking underground downtown Toronto, Ontario locations.



Figure 8. Seurat, 1884. Pointillism. *A Sunday on La Grande Jatte*. Look for the QR code (from Figure 2a) embedded in Seurat's pointillist approach. There is sufficient contrast that most scanners should be able to decode the image, when viewed on a screen with high resolution, that has had the white background removed and replaced with transparency.

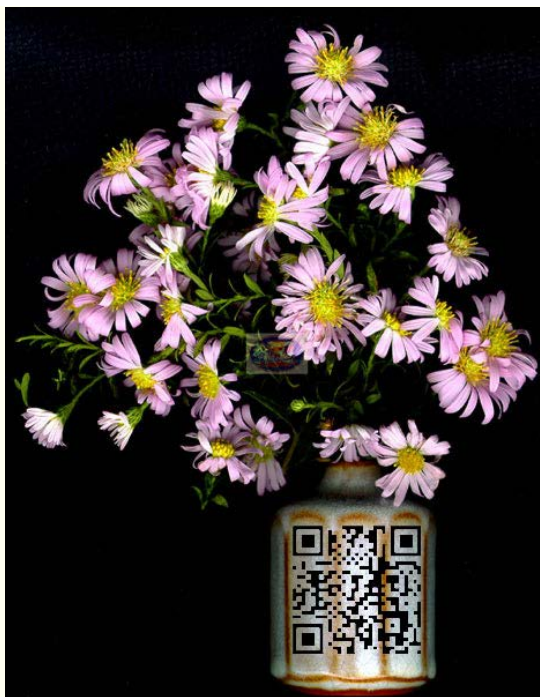


Figure 9. Lach, Alma. 1998. Wild Daisies. Here the QR code appears on the vase, superimposed as part of the design of the vase.
<http://www.almalach.com/>

Geometric Alterations beyond the Plane

Warping

QR codes are often presented on flat paper. That is the source of their greatest utility, currently. They also work well when displayed on a flat screen TV panel. Do they work when bent...as on the surface of an old-fashioned television screen? Inserting a QR code on the somewhat curved and bumpy surface of Google Earth might offer directions for analysis.

Animation

One way to go beyond layering and the limits it has in terms of successful QR code decoding, is to animate the QR code. The successive frames of the animation function as individual layers. Figure 10 illustrates a single example. While from an abstract standpoint this strategy overcomes a variety of difficulties, it is really only useful on a computer or TV screen. Thus, it might not see the same set of practical utility (except perhaps in a store window on a wide screen flat TV panel) as the static QR code does in the contemporary printed document. It is, however, an exciting prospect to consider.



Figure 10. Animation of QR codes. Do the intermediate "tweening" frames resolve correctly?

Layers

One way to create interesting visual effects is to layer images. The extent to which it is possible to layer images of varying opacity, shape, size, and position on an existing QR code is again a matter of balance. It is a straightforward matter, for example, to embed a QR code on the Google Earth globe. Layers of roads superimposed on the QR code might not interfere with decoding (Figure 11a). The QR code here is laid down as a mat around Buckingham Fountain in Grant Park on Chicago's beautiful lakefront. The facade of tall buildings along Michigan Avenue serves as an edge to the code.

It is tempting to want to tip the image so that the 3D buildings stand out more clearly. Doing so, however, interferes with decoding the QR code. In Figure 11b, the QR code has been elevated above many of the tall buildings to enhance its ability to be decoded--as a sort of "QR cloud."

Zooming in on the cloud (Figure 11c), from below, suggests attempting to read the QR code from underneath. Future experiments might involve aspects of flipping (reflecting) QR codes in order to do so. They might involve putting QR codes inside bubbles in Street Views or on billboards (to avoid warping inside a spherical or cylindrical bubble). In the meantime, the interested reader might work with the [attached file](#) in Google Earth.



Figure 11a. QR code covers Grant Park, Chicago Illinois. The code should scan properly.



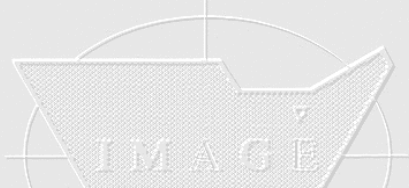
Figure 11b. Code is adjusted so that it serves now as a cloud over the tall buildings which would otherwise interfere with proper scanning.

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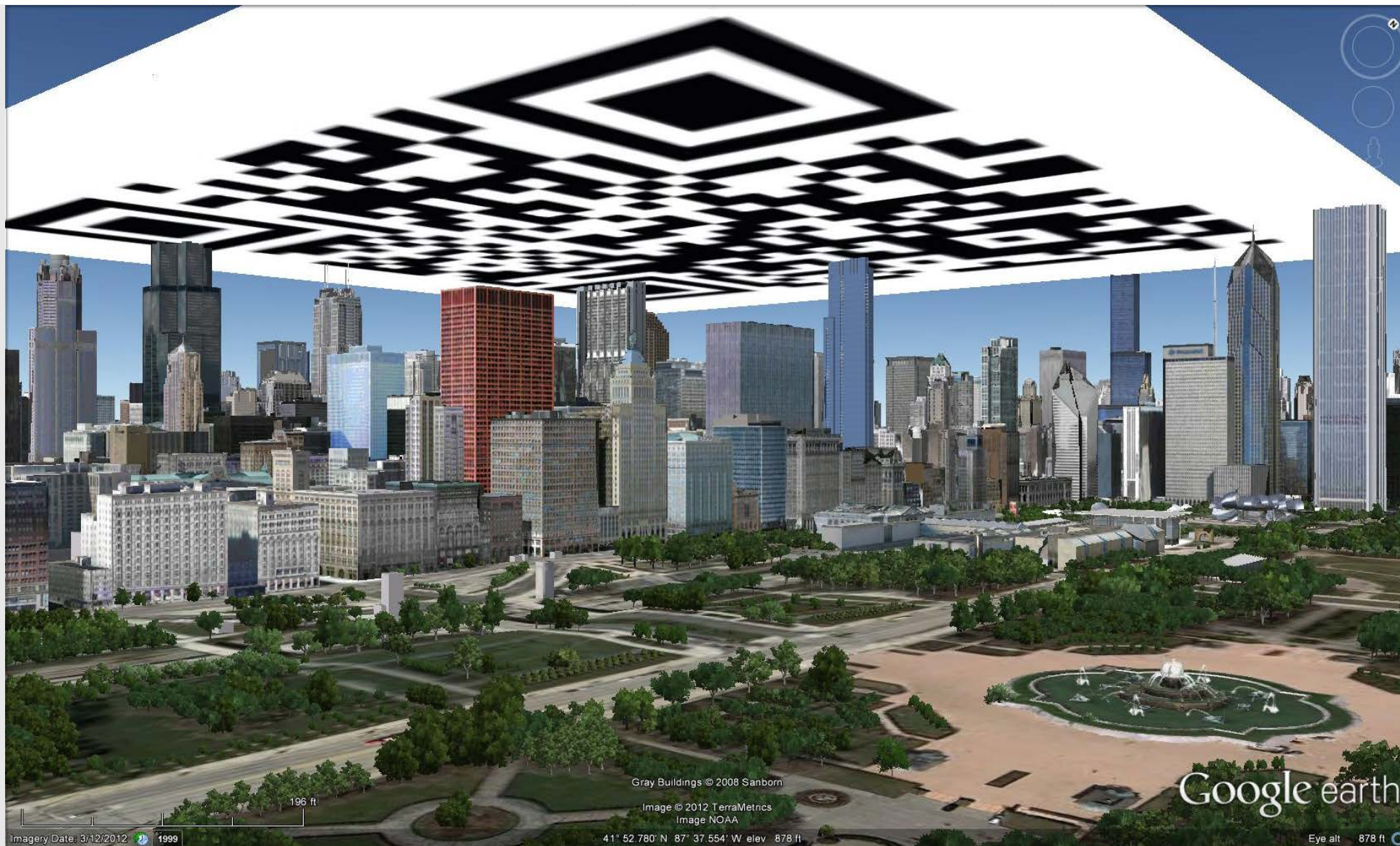


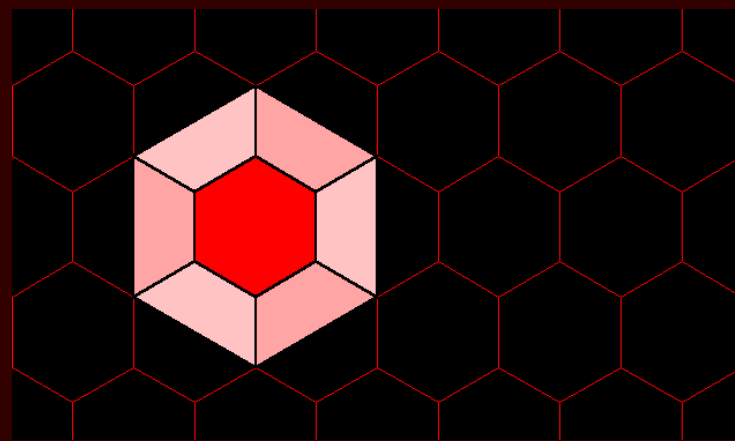
Figure 11c. Wave of the future...combine elements to create codes that scan from below...to scan the QR Cloud from the Earth!

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• **Wikipedia:**

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1. ARCHIVE

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1.



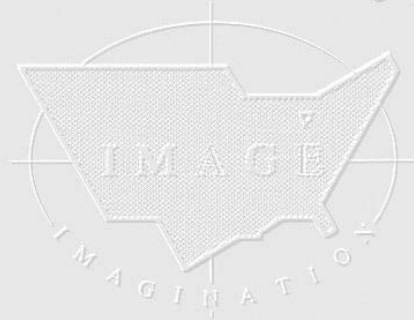
2.



3.



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Solstice was a **Pirelli** INTERNETional Award Semi-Finalist, 2001 (top 80 out of over 1000 entries worldwide)

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Congratulations to all *Solstice* contributors.

Remembering those who are gone now but who contributed in various ways to *Solstice* or to IMaGe projects, directly or indirectly, during the first 25 years of IMaGe:

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1964 Boulder Drive,
Ann Arbor, MI 48104
734.975.0246
<http://deepblue.lib.umich.edu/handle/2027.42/58219>
sarhaus@umich.edu