The N-Dimensional Geometry and Kinaesthetic Space of the Internet

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INTRODUCTION

What does the space created by the Internet look like? One answer to this question is to say that, because this space exists "virtually", it cannot be represented. The idea of things that cannot be visually represented has a long history, ranging from the romantic sublime to the Jewish God. A second, more prosaic, answer to the question of what cyberspace looks like is to imagine it as a diagram-like web. This is how it is represented in "maps" of the Internet. It appears as a mix of cross-hatching, lattice-like web figures, and hub-and-spoke patterns of intersecting lines.

This latter representation, though, tells us little more than that the Internet is a computer-mediated network of data traffic, and that this traffic is concentrated in a handful of global cities and metropolitan centres. A third answer to our question is to say that Internet space looks like its representations in graphical user interfaces (GUIs). Yet GUIs, like all graphical designs, are conventions. Such conventions leave us with the puzzle: are they adequate representations of the nature of the Net and its deep structures?

Let us suppose that Internet space can be visually represented, but that diagrams of network traffic are too naïve in nature to illustrate much more than patterns of data flow, and that GUI conventions may make misleading assumptions about Internet space, the question remains: what does the structure of this space actually look like? This question asks us to consider the intrinsic nature, and not just the representation, of the spatial qualities of the Internet. One powerful way of conceptualising this nature is via the concept of hyperspace.

The term hyperspace came into use about a hundred years before the Internet (Greene, 1999; Kaku, 1995; Kline, 1953; Rucker, 1984; Rucker, 1977; Stewart, 1995; Wertheim, 1999). In the course of the following century, a number of powerful visual schemas were developed, in both science and art, to depict it. These schemas were developed to represent the nature of four-dimensional geometry and tactile-kinetic motion—both central to the distinctive time-space of twentieth-century physics and art. When we speak of the Internet as hyperspace, this is not just a flip appropriation of an established scientific or artistic term. The qualities of higher-dimensional geometry and tactile-kinetic space that were crucial to key advances in modern art and science are replicated in the nature and structure of space that is browsed or navigated by Internet users. Notions of higher-dimensional geometry and tactile-kinetic space provide a tacit, but nonetheless powerful, way of conceptualising the multimedia and search technologies that grew up in connection with networked computing in the 1970s to 1990s.

BACKGROUND

The most common form of motion in computer-mediated space is via links between two-dimensional representations of "pages". Ted Nelson, a Chicago-born New Yorker, introduced to the computer world the idea of linking pages (Nelson, 1992). In 1965 he envisaged a global library of information based on hypertext connections. Creating navigable information structures by hyper-linking documents was a way of storing contemporary work for future generations. Nelson's concept owed something to Vannevar Bush's 1945 idea of creating information trails linking microfilm documents (Bush, 1945). The makers of HyperCard and various CD-Rom stand-alone computer multimedia experiments took up the hypertext idea in the 1980s. Nelson's concept realized its full potential with Berners-Lee's design for the "World Wide Web" (Berners-Lee, 1999). Berners-Lee worked out the simple, non-proprietary protocols required to effectively fuse hyper-linking with self-organized computer networking. The result was hyper-linking between documents stored on any Web server anywhere in the world.

The hyper-linking of information-objects (documents, images, sound files, etc.) permitted kinetic-tactile movement in a virtual space. This is a space—an information space—that we can "walk through" or navigate around, using the motor and tactile devices of keyboards and cursors, and motion-sensitive design cues (buttons, arrows, links, frames, and navigation bars). It includes two-dimensional and three-dimensional images that we can move and manipulate. This space has many of the same characteristics that late nineteenth century post-Euclidean mathematicians had identified algebraically, and that early 20th-century architects and painters set out to represent visually.

The term hyperspace came into use at the end of the 19th century to describe a new kind of geometry. This geometry took leave of a number of assumptions of classical or Euclidean geometry. Euclid's geometry assumed space with flat surfaces. Nicholas Lobatchevsky and Bernhard Riemann invented a geometry for curved space. In that space Euclid's axiom on parallels no longer applied. In 1908, Hermann Minkowski observed that a planet's position in space was determined not only by its x, y, z coordinates but also by the time it occupied that position. The planetary body moved through space in time. Einstein later wedded Minkowski's hyperspace notion of space-time to the idea that the geometry of planetary space was curved (Greene, 1999; Hollingdale, 1991; Kline, 1953).

Discussion of hyperspace and related geometric ideas signalled a return to the visualization of geometry (Kline, 1953). Ancient Greeks thought of geometry in visual terms. This was commonplace until Descartes' development of algebra-based geometry in the 17th century. Euclidean geometry depicted solids in their three dimensions of height, width, and breadth. The 17th century coordinate geometry of René Descartes and Pierre Fermat rendered the visual intuitions of Euclid's classical geometry into equations—that is, they translated the height, depth, and breadth of the x, y, z axes of a three-dimensional object into algebra. In contrast, in the 20th century, it was often found that the best way of explaining post-Euclidean geometry was to visually illustrate it.

This "will to illustrate" was a reminder of the traditionally close relationship between science and art. Mathematics was common to both. It is not surprising then that post-Euclidean geometry was central not only to the new physics of Einstein and Minkowski but also to the modern art of Cézanne, Braque, and Picasso (Henderson, 1983). In turn, the visualised geometry of this new art and science laid the basis for the spatial intuitions that regulate movement and perception in Internet-connected multimedia environments. In geometric terms, such environments are "four dimensional". In aesthetic terms, such environments have a "cubist" type of architecture.

Technologies that made possible the navigable medium of the Internet—such as the mouse, the cursor, and the hypertext link—all intuitively suppose the spatial concepts and higher dimensional geometries that typify Cézanne-Picasso's multi-perspective space and Einstein-Minkowski's space-time. The central innovation in these closely related concepts of space was the notion that space was not merely visual, but that the visual qualities of space were also tactile and kinetic. Space that is tactile and kinetic is fundamentally connected to motion, and motion occurs in time. Space and time are united in a continuum. The most fundamental fact about Internet or virtual space is that it is not simply space for viewing. It is not just "space observed through a window". It is also space that is continually touched—thanks to the technology of the mouse and cursor. It is also space that is continually moved through—as users "point-and-click" from link to link, and from page to page. Consistent with the origins of the term, the hyperspace of the Internet is a form of space-time: a type of space defined and shaped by movement in time—specifically by the motions of touching and clicking.

CRITICAL ISSUES

When we look at the world, we do so in various ways. We can stand still, and look at scenes that either move across our visual field or are motionless. When we do this, we behave as though we were "looking through a window". The window is one of the most powerful ways we have for defining our visual representations. The aperture of a camera is like a window. When we take a picture, the window-like image is frozen in time. The frame of a painting functions in the same way. Whether the scene depicted obeys the laws of