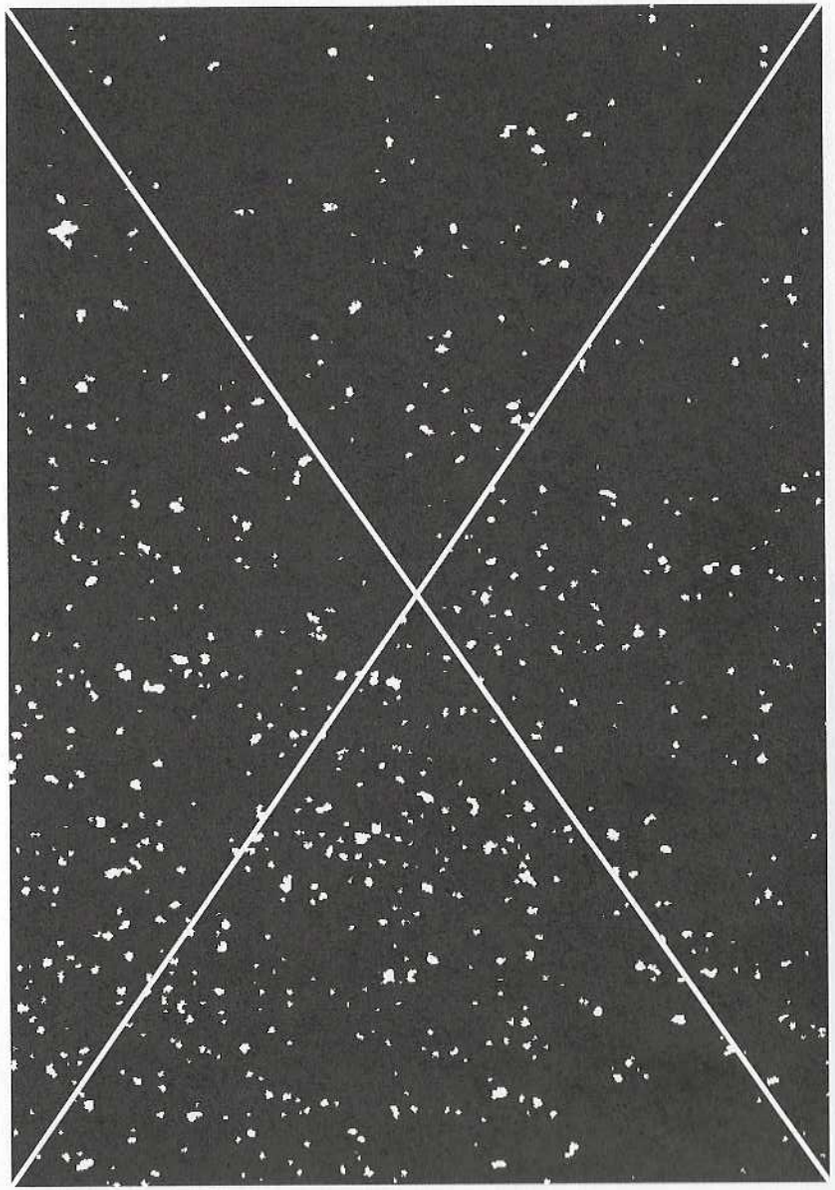
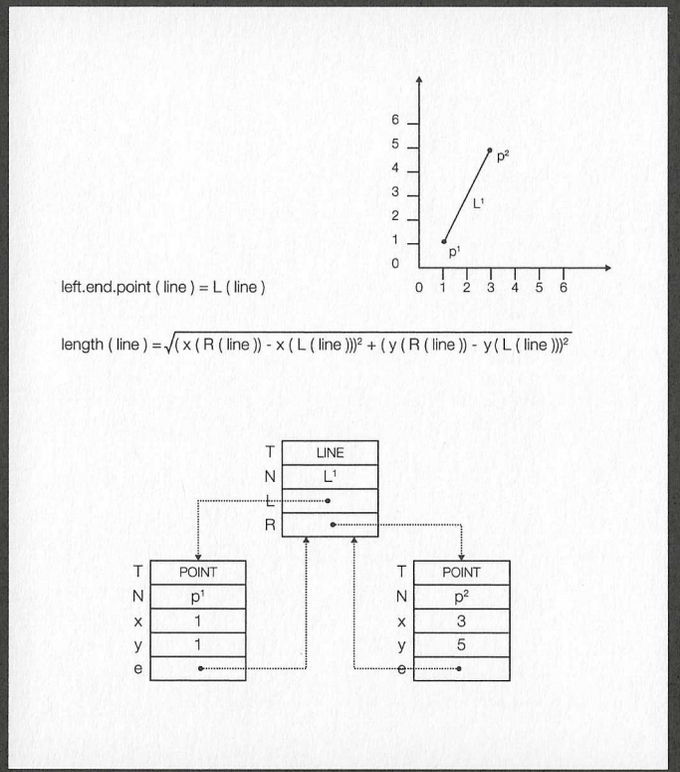


NOTES ON HASHTAG ARCHITECTURE



1. Drawing logic of Ivan Sutherland's Sketchpad software.

NOTE 1

The Internet is no longer an ephemeral, opt-in playground for the dissemination of information, but rather our primary progenitor and distributor of data including imagery, narratives, and political positions. This warrants new modes of conceptualizing the "space" of the web that can push through the outdated skeuomorphic representations established early in its history. From an architectural point of view, Internet space (meaning browsers and screens) could be understood as an infinitely deep three-dimensional space through which users move orthographically. In other words, using architectural analogs, we can extend our understanding of the abstract nature of Internet space: the architecture of the hashtag.

NOTE 2

The Internet relies on more than merely data and code. Users manipulate virtual objects through a variety of gestures. These gestures, consisting of tracking pointers, touching screens, typing shortcuts, are manifestations of a new consciousness engendered by ubiquitous computing. Not only do these gestures constitute an extension of the self into the space of the screen, but they also relate to spatial analogies with their own lineages, such as Ivan Sutherland's concept of "rubberbanding."[1] In order to expose the architectonic qualities of Internet space, these gestures must be closely examined.

NOTE 3

Because the Internet creates (close to) real-time links between people and objects across vast distances, it could be understood as a cosmic entity: a vast, complex, ever-expanding universe. Seen in this light, Internet space could be associated with an emerging form of mysticism similar to that of the Russian Suprematists. Suprematism and its attendant themes (irrational space, non-figuration, infinite depth) can therefore serve as precedents for an examination of the abstract, virtual void that is Internet space.

COMPUTING METAPHORS

Computer programmers love to use architecture to describe their code. A simple online search for "software architecture" yields thousands of images of flow charts synthesising the logics of assembled code, nodes, and behaviors. Books with titles like *Computer Architecture, Computer Organization & Architecture, Assembly Programming and Computer Architecture for Software Engineers* litter desks in Comp-Sci labs in Universities worldwide.[2]

The reason for this is fairly straightforward: programmers need to be structured and organized, and what field better exemplifies both themes than the design of the built environment? Molly Wright Steenson describes this as a natural cross-disciplinary dialogue. "Architecture structures and scaffolds complex entities," Steenson observes. "It is no surprise that engineers, computer scientists, and digital designers reach out to architectural concepts when they want to express the complexity of their work."[3] In other words, because architecture often serves as an apt metaphor for structure, order, and function, it can be easily co-opted by other fields.

But programming and metaphors also have their own complex history. When researchers were developing the first computer desktop, they relied on skeuomorphic representations of objects to communicate their functions. The skeuomorph, a kind of visual metaphor, would allude to traditional mid-century office protocols, such as filing folders or throwing away paper into a recycling bin. These became the icons of desktop computing. Susan Kare's pixelated icons—the floppy disk for "save," the monitor for "computer"—on the Macintosh Operating System, for instance, still resonate in the cultural imaginary (and it would be difficult for anyone who grew up with Microsoft Windows to forget her canonical *Solitaire* graphics).

Before skeuomorphic icons, however, the pioneers of computer-aided drafting (CAD) software drew their metaphors from elsewhere. This is particularly evident in Ivan Sutherland's development of Sketchpad, ostensibly the first CAD program. In 1963, Sutherland completed his doctoral dissertation at MIT, a drafting program that ran on a mainframe computer. Though it was built on a complex series of components to which many of his colleagues contributed, Sutherland is largely credited with inventing the functional logic of the system.[4] Comprised of a screen, a light pen, a control pad, and computer referred to as the TX-2, Sketchpad enabled a user to draw, for the first time, a line on a cathode ray tube (CRT) screen. A perfectly *straight* line.

But drawing straight lines on a screen was just the beginning. Sketchpad also allowed the points constituting the drawn line to "snap" and stick to other points, enabling lines to connect and produce polygonal shapes. At a time when straight lines were still facilitated by paraline tools on drafting desks, the notion that one could instantly connect points to generate figures was revolutionary. But perhaps more relevant to our conversation on metaphors was how Sutherland conceived these drawing gestures. Today we understand snapping and line constraints as givens in drawing software, but in 1963 programmers had to design these simple gestures from scratch. For this, they turned to mathematics and metaphors.

Much like hand-drafting established a set of disciplinary techniques and gestures in its inception, CAD required new interpretations of drawing as an act. Rather than dragging a residue such as graphite to outline a path, Sutherland suggested that users could achieve more precision by connecting points and receiving real-time visual feedback of their lines. In his description of Sketchpad, Sutherland notes, "the computer will construct a straight line segment which stretches like a rubber band from the initial to the present location of the pen."[5] This "rubberbanding" effect was for Sutherland the key to understanding human-computer interaction and feedback. The user did not simply connect dots on a screen to create a polygon, but would first establish an origin point, a line would then stretch in real-time to the current position of the pen, and allow the user to visually see the temporary line before committing to the next point. Once the line was established, the drawing itself could take on a wide array of qualities, perspectival or orthographic. Circles and arcs could be made the same way. Using simple geometric distance formulas and trigonometry, curved figures could be defined by a center point, radius, and clipping points.

In addition to rubberbanding, Sketchpad required another conceptualization of the drawing itself. Sutherland insisted that his invention was more than just a virtual drafting table. Because these lines were built out of data, "the constituent elements of objects were programmed to possess an understanding of their relationship to the object as a whole."[6] In other words, Sketchpad drawings contained much more information about the drawing than pencil lines: "[i]nformation about how the drawing is tied together...as well as the information which gives the drawing its particular appearance."[7] This epiphany, as Stephen Turk has noted, exists as the primordial origins of "electronic object description," or what

today we might call Building Information Modeling: the embedding of information into a visual representation of an object.[8]

As Sutherland's mechanisms became less metaphorical and more abstract, from rubber bands to coded objects, they also paved the way for the translation of perspectival and orthographic three-dimensional drawing conventions into virtual space. Today, Sketchpad's gestural functions are ingrained in most drawing and 3D-modeling software.[9] But so are the disciplinary conventions of parallel and perspective projection.[10] These modes of representation rely primarily on the concept of the picture plane, which exists as a flat screen onto which lines, representing a scene or objects, are projected. While these two-dimensional planes have existed formally since the Renaissance, digital picture planes today are mutating—thanks to Sutherland's sticky, stretchy, screen—into more dynamic, animated, and warped voids, warranting other models of description.[11] These nascent spatial representation mediums, often referred to as "realities" (both virtual and augmented) are actively distorting the previously planar and static conception of projection in general. However, in order to examine the critical potential of these dynamic picture planes, we must first take a detour through an unlikely historical movement: Russian Suprematism.

SUPREMATIST SPACE

Suprematism stands as a unique instance in the history of the picture plane. An art movement founded by Kazimir Malevich, it concerned itself largely with cosmic relationships and abstract thought. "To the Suprematist," Malevich wrote, "the visual phenomena of the objective world are, in themselves, meaningless; the significant thing is feeling." And these feelings, to the Suprematists, were represented best as geometric compositions on a canvas.[12]

Although it is generally accepted that Malevich's contribution to the legacy of avant-garde art were the aesthetic and visual theories of Suprematism, the fickler concepts underlying those theories, such as cosmic relationships and what he called "objectlessness" are quite timeless. They provide terms for understanding the picture plane as a representation of infinite, abstract space.

Malevich famously defined Suprematism as art that is "liberated from objectness;" that doesn't examine the world, but rather senses and feels it.[13] For him the movement was a way of resetting painting to a tabula rasa condition, or a "degree zero" as his colleague, El Lissitzky, put it.[14]

This would allow painting to cease its mimetic dependence on object representation and start to depict "objectlessness" through painterly effects. Lissitzky would also take Malevich's argument further, and state that Suprematist space is not only non-representational, but in fact, infinitely deep and dynamic.

In his essay, "A. and Pangeometry," Lissitzky describes a concept called *irrational* space, a positional system that stands in direct opposition to perspectival space. He states, "Suprematist space may be formed not only forward from the plane but also backward in depth. If we indicate the flat surface of the picture as 0, we can describe the direction in depth by - (negative) and the forward direction by + (positive), or the other way around. We see that Suprematism has swept away from the plane the illusions of two-dimensional planimetric space, the illusions of three-dimensional perspective space, and has created the ultimate illusion of irrational space, with its infinite extensibility into the background and foreground."[15] Anna Neimark's piece, "On White on White," is a recent example of an investigation that extends a potential reading of this "ultimate illusion" onto architectural imagery. Neimark suggests that Suprematist works imply an ambiguous relationship between objects and their shadows, an indeterminate depth resulting from the clash of geometry and color, foreground and background.

Axonometry became for Lissitzky the most appropriate mode of representing infinite space as it allowed elements to show depth without succumbing to the distortion of vanishing points. It was this relationship between non-converging lines and the lack of a single viewpoint that made his space irrational and ambiguous. This ambiguity would then "force the spectator to make constant decisions about how to interpret what he or she sees."[16] In a way, it established an artistic proto-interface between the viewer and the space of the canvas. The indeterminacy of background and foreground elements gave compositions a conceptual dynamism unachievable through perspectival means, which always represented the literal. As a result of Suprematism, abstraction as a means to represent that which is hard to represent (objectlessness, feelings, infinity) was codified and tied to the projective picture plane.

BROWSER SPACE

The Internet browser is a contemporary, dynamic picture plane. Though its history parallels the rise of the skeuomorphic icon and its equally metaphoric language, the browser of today has the capacity to render

animations, video, 3D models, as well as text and images. This makes the Internet browser perhaps the most accessible picture plane available to the public. It is part of every operating system, from desktop to laptop to smartphone, and is powerful enough to host a slew of web-based software. The browser's history, however, is fraught with metaphors and descriptions which have become outdated. Like Sutherland's use of the rubberbanding analogy, the Internet was first described as something users "surf," or as a large spider "web." But today, rarely do users describe themselves as "surfing the net," or riding the "information superhighway." Instead, the Internet is regarded as an almost-infinite universal or cosmic entity. Contemporary descriptors are more nebulous than, for instance, Senator Ted Stevens's "series of tubes."[17] Servers are clouds and protocols and switches are addresses. It follows that Internet browsers operate as interfaces that rectify this otherwise incomprehensible amount of information, coded instructions, and data. By translating code into visual media, browsers constitute a new dynamic picture plane that collapses time and distance into a set of manageable flat layers through which we scroll, swipe, tap, click.

Unlike its predecessors—painting, photography, film—browsers as picture planes are so novel that little critical scholarship exists that places them alongside a lineage of spatial representation mediums. Most critical theories of the Internet refer to the medium's social or cognitive effects. While it is certainly important to reflect on the Internet's levels of instantiation, notions of authorship, and other complexities, the Internet also enables a new platform for experimental spatial representation. It can therefore serve as another site for abstraction.

In "Lessons of the Russian Avant-Garde," historian Catherine Cooke critiques the architectural Deconstructionist movement for its purely visual reading and appropriation of Suprematist compositions. Deconstruction was, of course, the proto-digital movement concerned with visual instability that branded itself as a metonymic offspring of deconstructionist literary theory and constructivist art. But in her critique, Cooke points out that much of the architectural work missed the underlying themes of the Russian avant-garde: mysticism, infinity, dematerialization, and objectlessness. Had architects studied the movements closer, they would have realized that, "[Suprematism's] very otherness...provides a paradigm of a space-time universe, which is, naturally and logically, appropriate to the new perceptions of how the cognitive and phenomenal world of the late 20th century is operating."[18] And so for Cooke, the lessons that should be taken away from the Russian avant-garde are therefore not primarily visual at all, but rather deeply cosmological.

If we extend Cooke's thesis to the digital world, arguably a cosmos in itself, we can recognize similar immaterial properties in the ubiquitous computing environments that surround us; not necessarily as graphic visual elements, but as gestures and instincts tied to software interactions. Software's pervasiveness has engendered a new consciousness, which blurs the distinction between virtual and physical objects, and creates a tension similar to that of *White on White*'s off-white and pure-white; or what Anna Neimark refers to as the real-time oscillation of figure-ground, figure-figure, and ground-ground.[19]

The Internet, as an ambiguous space in which an endless variety of media exist, can be further exemplified by Lissitzky's concept of *irrational space*. As we've seen, Lissitzky proposed this abstraction of space as an evolution of Malevich's work on the painterly surface, pushing for Suprematist space to be "formed not only forward from the plane but also backward in depth."[20] Much like Malevich rejected the literal object in favor of the abstracted object, Lissitzky saw perspective as a metaphor, whereas axonometry enabled one to "reflect on infinity."[21]

Because of the infinite extensibility of depth and indirect experience of the passage of time, *irrational* space is perhaps the most appropriate description of today's Internet browser space. Michael Rock, for instance, has noted that software windows are akin to meta-universes: "If the multitasking window becomes the norm of interface design—each screen a panoply of more screens—browsing is miniaturized: the negotiation of windows mirrors the negotiation of space...The smallest screen is at once an element of the world while encapsulating the universe."[22] In short, both browser windows and Suprematist compositions tackle the subject of an "unrepresentable infinity."[23] Moreover, the gestures we use to browse Internet space—swiping, scrolling, bringing to the front, sending to the back—constitute new orthographic behaviors linking human and screen. The space of the browser screen then operates quite similarly to Lissitzky's axonometry: the forward and backward buttons move one in the positive and negative directions, scroll bars move orthographically (and infinitely in some cases), and content is stacked on a Cascading Style Sheet canvas.

Furthermore, since the development of HTML5 and Javascript, programming languages for the web, browsers now have an increased level of interaction. This is exemplified in websites that have infinite scrolling mechanisms, parallax illusions, drawing tools, and 3D effects. In the web drawing app designed by myself and Jose Canizares, *Malevi.ch*, for example,

the browser acts as irrational space and the canvas on which the geometric objects are drawn resembles Malevich's examinations of the second and fourth dimensions, planimetry and time. [24] Drawn objects in the app can interact with other objects according to forces and time but cannot rotate in three dimensions nor extend outside the canvas. *Irrational space* here is not a literal translation of an infinite void, but more of a way to reconcile the difference between the space of the browser and the space of the app itself. For example, one can have multiple instances of *Malevi.ch* open on the browser as layered tabs, but those tabs each create an infinite plane within each instance. One is free to navigate through the tabs, keeping in mind that although the interface is infinitely extendable and corresponds to the same code read from the same web server, each instance of *Malevi.ch* constitutes its own independent world.

Alexander Galloway describes this phenomenon as the "metaphysico-Planotic logic of object-oriented [programming] systems." In this type of programming, "objects are instances of classes, they are created in the image of a class, they persist for finite amounts of time and eventually are destroyed." [25] In other words, when using object-oriented languages, objects on the screen are always temporary instances of a larger-order being. This temporality, again, addresses Malevich's 4th dimension: time. We can therefore say that in *Malevi.ch* Suprematist themes surround not only its appearance, but also the abstract relationships between its users and objects. For generating objects physically, *Malevi.ch* uses the previously described "rubberbanding" mechanism invented by Ivan Sutherland. While Sutherland developed this elastic motion for linking two points together on a screen without a mouse, the stretchy gesture is pervasive in all current CAD and vector-graphics software. The act of defining a starting point and stretching to the next point with an imaginary line is now an ingrained part of our digital consciousness. Unsurprisingly, *Malevi.ch* uses this instinct to define all of its shapes. Rather than defining the boundaries of an object, the software relies solely on Sutherland's elastic method coupled with a few distance-defining formulas for creating objects. Circles and triangles are defined as a center and a radius, and rectangles are defined as a center and a corner.

Though *Malevi.ch* explicitly references Suprematist compositions and geometric abstraction, more importantly, it also distills a set of common digital behaviors in order to cast them back onto the user. Like Lissitzky's irrational space, its stark blankness and minimal interface creates a space for users to reflect on immaterial themes, such as time, movement, or gravity. Once shapes are defined on *Malevi.ch*'s canvas, a user may interact with these objects in two ways: by toggling on or off a vertical force (gravity) or simply by selecting and dragging the shapes around. If no gravity is activated, the shapes will still collide and bounce off the canvas' boundary or other shapes when they are moved. In the default mode, the canvas hosts physical interactions without a directional force, allowing users to generate Suprematist compositions by moving and colliding objects. If gravity is activated, all objects on the canvas will immediately fall to the bottom of the browser. This shifts the composition from plan to elevation, once again recalling the ambiguity of Suprematist space. In this mode users can also move and generate shapes, but they will immediately fall to the ground after the mouse or finger is released. Gravity may be toggled on and off at any points affecting all objects currently on the canvas.

At a broader scale, the Internet, host of the *Malevi.ch* app, functions as a cosmic entity that assembles and disassembles code in real-time according to user requests. It creates links between people and objects across vast distances and as we have seen, the interface for those links operates primarily orthographically. In the early days of graphical user interfaces, software developers relied on metaphors and skeuomorphic representations to convey the spatiality of the web. [26] But the analogies of surfing and the literal transposition of a physical desktop into an icon no longer hold any meaning besides being kitsch retro fantasies of a more naive era. The Internet has evolved into a much more complex and metaphysical environment, which warrants new spatial conceptions. It has enabled a new digital consciousness that manifests itself as an extension of ourselves either through physical gestures that manipulate virtual things or psychological reactions to those virtual objects. We see this when our hand muscles type shortcuts autonomously or when we develop inside jokes about programs or when we feel a rush of euphoria at the discovery of a new tool. At a larger scale, it has also engendered a kind of mysticism in which we find ourselves praying to Google to keep our data safe or to software engineers as we attempt to recover a corrupt file or as we mourn dead pixels. Under these new circumstances we can understand infinite voids, abstract environments, and geometric behaviors as terms related to software and computing, but also as Suprematist modes of depicting space put forth by Malevich and El Lissitzky. Bringing in the mysticism of the Suprematists and conceiving of screen space as an ever-changing, infinitely deep orthographic space can be a productive way to advance our perception of these virtual realities.

NOTES

1 See page 139.

2 John L. Hennessy and David A. Patterson, *Computer Architecture: A Quantitative Approach* (Burlington, MA: Morgan Kaufmann, 2017). William Stallings, *Computer Organization and Architecture*, 10th Ed. (New York: Pearson, 2016). Brian R. Hall and Kevin J. Slonka, *Assembly Programming and Computer Architecture for Software Engineers* (Burlington, VT: Prospect Press, 2018).

3 Molly Wright Steenson, *Architectural Intelligence: How Designers and Architects Created the Digital Landscape* (Cambridge: MIT Press, 2017).

4 Daniel Cardoso Llach, *Builders of the Vision* (New York: Routledge, 2015) 49.

5 Ivan Sutherland, "Sketchpad, A Man-Machine Graphical Communication System" (PhD Dissertation, Department of Electrical Engineering, MIT, 1963), 3.

6 Stephen Turk, "Computer Graphics: Tracing Cybernetic Flows," *Performance Research*, 11:1, 64-74 (2006).

7 Sutherland, "Sketchpad."

8 Turk, "Computer Graphics," 66.

9 Llach, *Builders of the Vision*, 49.

10 In fact, Llach covers the process by which engineers translated a German tome on perspective drawing. "For his doctoral thesis, [Larry G.] Roberts developed a computer program able to interpret a three-dimensional shape from a photograph of a planar solid. Unable to find a precedent, Roberts found a solution by combining two separate bodies of literature: mathematical methods for perspective geometry from German textbooks from the 1800s, and matrices." See *Builders of the Vision,* 68.

11 For example, virtual reality, augmented reality, etc.

12 In fact, Suprematism has also become a topic of renewed interest in contemporary discourse. From re-readings of White on White, to a new translation of The Non-Objective World titled The World as Objectlessness as well as a recent collection of his writings, Malevich's ideas are being reworked for the digital age, warranting more scrutiny of the intricacies of Suprematism and Constructivism. See Anna Neimark, "On White on White" in *Log* 31 eds. Cynthia Davidson, Dora Epstein Jones, Bryony Roberts (New York: Anyone Corporation, 2014); and Kazimir Malevich, *The World as Objectlessness*, ed. Britta Tanja Dumpelmann (Basel: Hatje Cantz Verlag, 2014). See also Kazimir Malevich, *Malevich Writes: A Theory of Creativity Cubism to Suprematism,* ed. Patricia Railing (Artists Bookworks, 2018).

13 Malevich, *The World as Objectlessness*, 188.

14 Neimark, "On White on White," 64.

15 El Lissitzky, "A. and Pangeometry," in *Art in Theory 1900-1990, An Anthology of Changing Ideas,* eds. Charles Harrison and Paul Wood (Cambridge: Wiley Blackwell, 1993), 303.

NOTES

16 Yve-Alain Bois, "El Lissitzky: Radical Reversibility," *Art in America* Vol. 76, No. 4 (April 1988), 172.

17 Senator Ted Stevens in a statement to the Senate Commerce Committee: "the Internet is not something that you just dump something on. It's not a big truck. It's a series of tubes. And if you don't understand, those tubes can be filled and if they are filled, when you put your message in, it gets in line and it's going to be delayed by anyone that puts into that tube enormous amounts of material." See "Your Own Personal Internet," accessed March 10, 2018, https://www.wired.com/2006/06/your-own-person/.

18 Catherine Cooke, "The Lessons of the Russian Avant-Garde," *Architectural Design* Vol 58 no. 3/4 (1988), 12.

19 Neimark describes these conditions as "not important," which I have chosen to interpret as simultaneously important. It does not matter which the viewer sees, because all exist at the same time. "On White on White," 63.

20 Yve-Alain Bois, "El Lissitzky," 172.

21 Ibid.

22 Michael Rock, "Notes for a Lecture Titled: Empire of Screens" in *Multiple Signatures: On Designers, Authors, Readers, and Users* (New York: Rizzoli, 2013), 324.

23 "Unrepresentable infinity" is used by Bois to describe Lissitzky's preference of axonometry over perspective.

24 Bois also points out that Malevich was primarily concerned with 2D and 4D representations, or "everything but the third dimension."

25 Alexander Galloway, *The Interface Effect* (Malden, MA: Polity Press, 2012), 21.

26 See Curtis Roth. "Computation and the Spatial Myth." *Thresholds* 45 (2017), 211-221.