International Journal of Design Sciences & Technology

Volume 25
N°2

2023

ISSN 1630 - 7267

International Journal of Design Sciences and Technology
Design Sciences, Advanced Technologies and Design Innovations
Towards a better, stronger and sustainable built environment

ISSN 1630 - 7267

15, avenue de Ségur,
75007 Paris, France.
Tel (Fr) 01 45 51 26 07 - (Int.) +33 1 45 51 26 07
Fax (Fr) 01 45 51 26 32- (Int.) +33 1 45 51 26 32
E-mail: ijdst@europia.org
http://www.europia.org/ijdst

International Journal of

Design Sciences and Technology

Volume 25
N° 2

ISSN 1630 - 7267

International Journal of Design Sciences and Technology
Design Sciences, Advanced Technologies and Design Innovations
Towards a better, stronger and sustainable built environment

The Indefinite Idea Plane Artistically Considered

Mark Bernstein[1]
[1] Eastgate Systems, bernstein@eastgate.com

Some computational tools intended to educate, illuminate, persuade, or to facilitate scholarship create diagrammatic representations of concepts and ideas. This abstraction, which I call the "indefinite idea plane," often consist of boxes and arrows. Alternative approaches that have been neglected may be found in art and architecture. If an office building "must be every inch a proud and soaring thing," what should we expect of an idea plane unfettered by material physics?

Keywords: diagrams, computational tools, visualisation.

1. The Indefinite Idea Plane

Diagrammatic representations of notes, concepts, and ideas are often constructed by computational tools intended to facilitate scholarship. Though many different visualizations have been created, most of these diagrams share a common approach to visualization. Textual atoms (described variously as nodes, pages, documents, lexia, writing spaces, blocks, or cards, and which I will call *notes*) are drawn as rectangles on a visual plane that is infinite in extent, or that grows to whatever dimension is needed to hold the work at hand. Links between documents are represented as lines or curves [1]. Illustration of various sorts may be present, and additional annotations may sometimes be added. The placement of notes and the routing of links may be either manual, computer-generated, or some combination of both.

Although there was once lively research into other ways to visualize information spaces — for example as a cityscape [2] or a flyway [3] — this sort of work seldom or never appears at contemporary research venues. Diagrams of this sort have many names: map view, document examiner, concept map, Mind Map®, and many others. Here, I will denote the generalization of all views of this type as the "idea plane". Figure 1 shows a detail of one contemporary idea plane.

Any idea plane might be a work of art: it is a visual representation seeking to convey an idea. Some ideas may be contained in small details, while others are conveyed only by examining the whole plane, or even by contemplating how the plane might evolve as new things are added, or considering what has been excluded. This is not to say that any particular diagram is worthy of praise or that it belongs in a museum, but rather that it is doing the sort of work that (say) paintings do, using the means that paintings use. We can (and should) talk and think about the idea plane in the way that we talk and think about painting, sculpture, architecture, and dance.

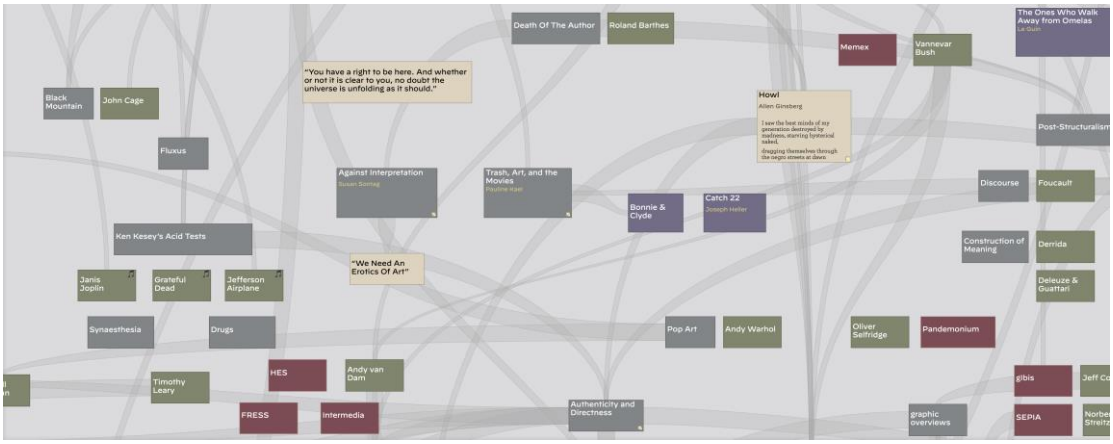

Figure 1: A small portion of an idea plane, presented in Tinderbox. Typical examples contain from a few dozen to a few thousand notes. Credit: an excerpt from the author's Tinderbox notes for this paper.

The point of the idea plane is to record ideas and relationships among ideas, and to suggest to us additional ideas and relationships that emerge during our research. We are not greatly concerned here with the decorative qualities of the idea plane, whether it is pretty, whether novices can use it without instruction.

Current representations of the idea plane draw from a very limited range of visual traditions. Those traditions are steeped in their own ideological, political, and aesthetic concerns, and though their concerns need not be our own, it is useful to understand them and the shadows they cast. If an office building "must be every inch a proud and soaring thing, rising in sheer exultation so that from bottom to top it is a unit without a single dissenting line" [4], what should we expect of an idea plane unfettered by material physics?

I will have occasion to refer both to traditional research literature, which I cite in the usual way [5], and to paintings and other work, which I cite using letters [A]. I have linked each art citation to an image the pertinent work and urge the reader to use those links. Many are worth seeing again.

2. Boxes and Arrows

Graphic diagrams of web sites, web applications, and hypertextual knowledge tools have been ubiquitous from the start of the Web and, indeed, from its prehistory. Vannevar Bush wrote of trails between reference that researchers discover, trails that do not fade [6]. John Brunner envisioned the trailmaker as a corporate influencer [7], and Isaac Asimov described a research institute whose formal knowledge map could not fit onto a page or a wall, but was studied in a pan-zoom interface on a planetarium dome [8]. Early hypertext systems such as *FRESS* [5], *Intermedia* [9], *Symbolics Document Examiner* [10], and *Storyspace* [11] offered maps of various sorts, and an early review article proposed that a map might be a definitive, constitutive requirement for hypertext systems [12]. Site maps were prominent in the early web (for which see [13]). These interactive diagrams seek to aid both comprehension and navigation, and they remain prominent features of contemporary knowledge management tools such as Roam Research, Obsidian, Tinderbox, and Twine.

The idea plane need not be computational, and some anticipations in older media include:

- Note-taking on index cards, organized and arranged in card boxes or *zettelkasten* or on a large table or the floor. [14] [15]

- Chalkboards — often quite large — for teaching, especially in mathematics and the physical sciences. [16]

- Walls or windows of sticky notes, often as part of an exercise in collaborative brainstorming.

- Sculptural or pictorial sequences of substantial scale, such as the Parthenon frieze. [A]

- Large and/or intricate images depicting numerous people doing numerous things. [B] [C]

- Cycloramas — 360° immersive paintings of battles or distant lands. [17]

3. Classical and Gothic

Today's visualizations of the idea plane tend to be classical or classicizing, which his to say that they are concerned with symmetry and regularity. Things in a line align precisely, and things that have the same role have the same appearance. If a paper (symbolized by a gray rectangle) has authors (one or more adjacent green rectangles), then every paper should be arranged that way [18] unless you have a good reason for an exception. As Vitruvius claimed that a good farmhouse ought to have "firmness, commodity and delight", it is now generally believed that a good visualization ought to be clear, concise, and sincere (see [19]).

Ruskin crystallized opposition to the classical impulse, arguing for a Gothic architecture characterized by savageness, changefulness, naturalism, grotesqueness, rigidity and redundance [20]. The classical-revival architect Palladio had cared a lot about symmetrical elevations, but Ruskin liked a palace where they put a window wherever one was needed. The classical world was drawn to consistency precisely it had been so difficult to achieve [21], but Ruskin recognized that machine production had made consistency easy and therefore meaningless. Ruskin acknowledged, too, that much of the labor required to achieve perfect finishes had always been slave labor, and even contemporary artisans who were made to endlessly duplicate another's designed were performing "slave's work, unredeem'd." To oppose this, Ruskin calls attention to the Gothic propensity to "savageness": where each Greek capital is alike, every Gothic capital is likely to be different. If all those repeated Doric entablatures expressed the unity of a community as a state and its common purpose [A], Ruskin thought unique Gothic capitals reflected the opinionated cussedness of individual stoneworkers doing their best to praise God and their Prince as they thought best.

Most considerations of the idea plane have been inclined to classicism and treat savageness as a mistake. Bernstein's rhetoric of spatial hypertext [22] is fundamentally Palladian in its emphasis on symmetry, mirror planes and forms of balance. Its embrace of curves and naturalistic forms injects a baroque note, but that represents sophistication, not savageness. The spatial parser introduced in VIKI [23] presents itself to the user as a sort of extended spelling checker, offering to fix misalignments and to formalize implicit lists.

A savage and changeful idea plane is not hard to imagine. Lars Spuybroek, in "The Digital Nature Of Gothic," [24] identifies the essence of the digital not in its binaryness or its technology, but in its propensity to generate endless design variation. To try out a thousand small adjustments would be tedious for us, but our slaves of steel have nothing better to do. Random variation opens the door to good fortune. Indeed, it hard been argued [25] that the moderate irregularity of hand-sketched notes is superior to the deceptive polish of familiar diagrams, and for this purpose "sketchnote" fonts have been developed that model both the irregular form and the random inconsistency of hand lettering.

A principle of this tradition of spatial hypertext has been stability: things stay where you put them [26]. We might instead imagine a system that moved things gradually, noting when we have seen and accepted the change (and so authorized it) or when we have corrected the computer's speculation.

4. Figure and Ground

If we look at Signac's *The Pink Cloud, Antibes* from across the room, we see a painterly image of a cloud above a calm bay as evening approaches [D]. Close up, we see thousands of horizontal bricks of flat color. These two views of a single canvas reflect the pointillist's paired concerns: the way adjacent colors affect each other, and the way they affect us. But these disparate views also reflect the dual ambitions of the large idea canvas: to elucidate connections among clusters of notes, most of which are close together, and to represent emergent structure that is much larger in scale and that reflects a growing holistic understanding of the domain.

The brushstrokes that form this painting are visible and distinct. We could easily envision notes in the idea plane working together in this way. We might have a lake of references: reddish notes that represent journal

articles, interspersed with blue notes that represent textbooks and monographs. A shimmer of white notes represents our commentary and observations, as well as critical responses to the papers and monographs we have cited. Individual notes remain focused, yet over time the lake expands and shifts to reflect the development of the domain and your own insights.

The meaning of a note, like the meaning of a brushstroke, does not depend solely on what is inside it. Notes in the idea canvas gain meaning from their neighbors, and from notes to which they are linked, much as our perception of a spot of color depends on the colors that surround it [27] Multivalence is not a vice [28]: it is the way notes are, because it is the way ideas are.

The idea plane is filled with notes, but little attention has been paid to the parts of the idea plane that are empty, the negative space where notes are absent. Marshall does point out that consistent spatial rhythms naturally bring attention (perhaps ours, perhaps the machine's) to missing notes, to data that ought to be represented but that has not yet been added to the plane [29]. Much more might be attempted. Empty space can be eloquent: Sebastian Smee, for example, understands Giacometti's emaciated sculptures [J] as emphasizing the unbridgeable gap between artist and subject, and also the existentialist's dilemma in facing of the catastrophe of the war [30].

5. Collage and Montage

Film is usually composed by pasting together a series of *shots*, often quite brief, that describe larger scenes. We don't see what happens between the shots, but instead we infer what took place and what that means. In *Casablanca,* we see café-owner Rick Blaine nod, and then we see a band strike up *La Marseillaise:* we infer cause and effect. Juxtaposition of two things gives rise to a third idea that is contained in neither. If the juxtaposition occurs in time, this is *montage.* In space, (pace [31]), it is *collage.*

Collage is frequently the way the idea plane makes meaning. Let's take, for example, a note about Leonard Bernstein (1918-1990): conductor of the New York Philharmonic, composer of *West Side Story,* and New York celebrity. Finding two notes grouped together

Leonard Bernstein Dmitri Shostakovich

we might reflect on a tradition of modernism in classical music. Other pairs lead in different directions.

Leonard Bernstein Stephen Sondheim

Leonard Bernstein Norman Mailer

Leonard Bernstein Marilyn Monroe

Idea maps often group related or similar things together, and much research has focused on helping to find related notes and bringing all of them together, often in the service of making them easier to find later. That is useful, but placing dissimilar notes together can be powerful, just as occasional dots of cream and blue enliven Signac's pink cloud. Unexpected pairs of notes may still give rise to third ideas — sometimes surprisingly vivid.

Pierre Salinger J. D. Salinger

Jane Austen Woody Allen

Jackson Pollock Richard M. Stallman

This, of course, is among the chief charms of literary hypertext. Hypertext offers authors an opportunity to put the same passage in two (or more) different places in a story. Narratives do not generally unfold in sequence. They jump in time and leap over space, not only to make things interesting, expressive, or artistic, but also to make them clear. *Ocean State* [32] begins at the end: "When I was in eight grade my sister

helped kill another girl." Its author did not do this to be artistic, to defy formal convention, or to upset the bourgeoise: he did it because it tells us what we will be talking about.

6. Process: The Trout and The Milk

Thoreau observed that "Some circumstantial evidence is very strong, as when you find a trout in the milk." [33] One might find a trout in various places, but if you find it on your plate with spinach and cream sauce, you can be fairly confident that someone arranged to make it for you. The prepared trout calls attention to process, not to result alone. The process is often the interesting part.

For the most part, the idea plane has ignored its own past and process; we see its current state and perhaps imagine what we want to add, but we seldom can see how we got where we are. One exception is Shipman's VKB [34], which preserved its undo stack not only within a single session but indefinitely. VKB allowed you to rewind the document to its origin and to see how it was created. Yet still, arriving at the current state, you would see a product with scant evidence of how it was made.

A contrasting visualization might begin with Jackson Pollock's drip paintings, perhaps "Lavender Mist" [E]. A useful way of understanding the drip paintings is to consider the painting as the product of the physical activity that created them. Mondrian's rectangles suggest underlying truths about vision, geometry, and the world. No symbolic verity underlies the drip paintings: Lavender Mist is all about the messy, organic physicality of their making. [35]

This seldom-discussed approach could be a singularly powerful way to think about the idea plane. Most students and scholars hope that, though at the outset their understanding of a topic or problem may be inadequate, order and insight will emerge over time. The tangle of the famous Intermedia "web view" was be seen as a failure: either the technology cannot represent the domain correctly (which is to say, elegantly), or the user has created a mess, letting the garden grow untended until it becomes unsightly or impassible. Alternatively, we might conclude that the ideas themselves have failed, that the structure we sought cannot be found and does not exist, and that in fact there is neither certitude, nor peace, nor help for pain — at least not on this topic. Yet, perhaps the tangled mess is not to be seen as failure, but as the record of a journey to (or towards) understanding. Long ago, we set out to study something. Some promising areas turned out to be unproductive: very well, but we learned *something* on those topics and that learning is bound to benefit us. Some assumptions turned out to be wrong: that, too, is a lesson, and better to preserve the record of those bad assumptions and to be reminded of them from time to time than to erase them.

If we take a close look at a small section of *Lavender Mist*, we see how some bits of color seem to be pooled, poured, or puddled. Others above them are splashed or thrown — not arbitrarily, perhaps with intent, but perhaps also without control. There is energy here, turbulence and complexity. It is not pretty, or if it is, its prettiness is the nature of things, not a contrivance. We can see what was thrown on top of another color, and perhaps why it is that way. One interesting approach to the layered idea plane would be, simply, to let each element leave an indelible trace where it is placed, or one that fades only very slowly. We might decide to shift the element elsewhere, but its former position remains marked with a stain or a shadow to remind us of what once was here. These stains might fade over time or, more interestingly, they might spread and flow toward other nearby stains, mixing like watercolor inks or swirling like colored inks of marbled paper.

7. Biomorphic Forms

The great intellectual enterprise of the early and mid-20th century was the effort to find, in disparate fields, systematic underlying structures of the sort that had proven so useful in 19th-century chemistry and physics [36]. One facet of this program sought to examine the mathematics of abstract machines, and this gave rise to the core ideas of computer science long before researchers imagined that such machines might be useful or profitable to build [37]. Related efforts sought to identify structural patterns that might govern history [38], narrative [39], and sociology [40]. For a time, it seemed that essentially linguistic oppositions — for example, the opposition between the raw and the cooked — explained a lot. This intuition underlies many early ideas about information spaces, and indeed Nelson's Zig-Zag might be viewed as a technological realization of structuralist ideas [41]. A subsequent reaction against the constraints of structuralism shaped

the early rhetoric of hypertext theory and web studies [42] [43]. Everything is intertwingled [44]: the world is deeply complicated, if only because it is peopled and people are deeply complicated.

Current visualizations of the idea plane adopt a style consistent with structuralist thinking, a style well suited to representing oppositions and a design language adopted from the vocabulary of high modernism. Our lines and arrows stand in neat rows and columns. They do not overlap; they seldom seem to recognize their neighbors.

Other approaches might be worth exploring. Consider, for example, Pollock's *Mural* [F] and imagine that it represents an elaborate idea plane, perhaps one annotated in a language you cannot read. Forms are notes or concepts. They bend toward, entwine with, or merge with other notes. The flexibility and complexity of these *biomorphic* forms reflects our understanding of the contingency and variability of ideas as we know them. The complexity of *Mural* might seem daunting, but large idea planes require capacity; other approaches might be suggested by the work of Wassily Kandinsky [G], Fernand Léger [H], or El Lissitzky [I].

American graphic artist Mark Lombardi's *Gerry Bull* [K] is an interesting example of a large (1.5m × 1.8m) idea map created as fine art. Lombardi's approach has inspired a number of algorithms that replace the boxes and arrows with continuously looping lines [45].

8. Borders and Darkness

Though we no longer hope to uncover simple structures everywhere with the confidence of the early 20th century, most scientists and engineers are nonetheless convinced that elegance and simplicity may be found in nature and in reason. We know that this faith can be neither unreasonable nor unconstrained: Gödel, Turing, and Heisenberg are all facts. Things that are true might not be provable; something that is *here* might also be *there.* Indeterminacy is unsettling, and I would suggest that current renditions of the idea plane attempt to be excessively legible, making things distinct that are, in reality, inclined to shade into or entangle each other.

This is, in fact, a familiar artistic impulse. Francis Picabia, in his late figurative painting from the 1940s, draws outlines around faces and features that make them into symbols [L] in a sometimes-creepy emulation of Fascist art. Earlier, Egon Schiele had used outlined figures [M] to heighten their emotional intensity. Julian Opie's figures are almost entirely outline, unemotional yet imbued with personality [N].

Still, these outlined figures represent distortions, making dim and ambiguous images more clear than they can really be. The world we see — say, Sargent's *Daughters of Edward Darley Boit* [O] — is replete with dimness and darkness, lost edges, with faces turned away from us or hidden from sight. Many of the demarcations and boundaries in our idea planes might not be needed and removing them might well let us see the rest more clearly. Non-Euclidean geometries warp and transform the plane unexpected ways; in particular, the hyperbolic space of the Poincaré disk neatly accommodates the combinatoric explosion to which taxonomies and tree structures are so often inclined.

9. The Problem of Evaluation

How are we, having adopted any of these approaches, to determine whether the new visualization offers capabilities that boxes and arrows lack? We might, for example, let some students use the new visualization and ask their opinion. We could contrive some tasks and see whether the students succeeded more quickly or more often when using the new visualization. This approach to evaluation is currently ubiquitous, and it is not without value, but it fails to measure the central purpose of the indefinite idea plane: to convey new insight and to facilitate the discovery of new ideas. Our tools for measuring significant albeit infrequent outcomes are not plentiful, but these are precisely the outcomes we are seeking.

Yet, the outlook is not entirely bleak. First, the Hawthorne Effect works in our favor: a modest change in a familiar visualization is likely to improve productivity because novelty helps focus attention. Second, reflective practice and representational talkback can inform any users judgment of the efficacy of a visualization. Indeed, reflection is inherent to the use of the idea plane: the ideas, after all, are our ideas.

Studies of computer-human interaction have come to be dominated by questions of usability and throughput, measured in clinical settings through statistical observation. Yet, this is not the only merit nor even, for us, the traditional or dominant metric. After all, the inventions of complex numbers and the discovery of non-Euclidean geometries met stern resistance: these were not very usable and they were certainly unpopular, but nonetheless they let people understand things (differential geometry, general relativity) that they could not understand otherwise [46]. In the generation since the start of the Web, we have seen both the victory of post-structuralism and its own overthrow. We share a core belief in the order and stability of ideas, but we now understand that — even if some things are true, not everything that is true can be proven, and not every truth — not even every provable truth — has a simple or elegant representation. Perhaps our systems ought to reflect our current views, not those of a past world with its discredited vision of divine, universal order.

Acknowledgments

I thank many colleagues for helpful discussions on these topics, most especially Rigas Arvanitis, David A. Bayer, and George P. Landow.

Artworks

[A] **Alma-Tadema, Lawrence**. Phidias Showing the Frieze of the Parthenon to his Friends. 1868. Birmingham Museums Trust.

[B] **Raphael**, The School of Athens, 1511, The Vatican.

[C] **Couture, Thomas**, Romains de la décadence, 1846.

[D] **Signac, Paul**. The Pink Cloud, Antibes 1916. Museum of Fine Arts Boston.

[E] **Pollock, Jackson**. Lavender Mist, 1950. National Gallery, Washington DC

[F] **Pollock, Jackson**. Mural, 1943. Stanley Museum of Art, Iowa City.

[G] **Kandinsky, Wassily**. Untiled. 1922. Museo Nacional Thyssen-Bornemisza, Madrid

[H] **Léger, Fernand**. Mechanical Forms (Formes mécaniques). Guggenheim Museum, New York.

[I] **Lissitzky, El**. Proun 12E. 1923. Busch-Reisinger Museum, Cambridge.

[J] **Giacometti, Alberto**. Man Pointing. 1947. Tate Gallery, London.

[K] **Lombardi, Mark**, *Gerry Bull, Space Research Corporation and Armscor of Pretoria, South Africa, c. 1972–80 (5th Version)*, 1999. Museum of Modern Art, New York.

[L] **Picabia, Francis**. Portrait of a Couple. 1942-1943. Museum of Modern Art, New York.

[M] **Schielem Egon**. Seated Woman with Raised Knee. (1917), National Gallery, Prague.

[N] **Opie, Julian**. Lynsdey, student. 3. 2004. Private Collection.

[O] **Sargent, John Singer**. *The Daughters of Edward Darley Boit.* 1882. Museum of Fine Art, Boston.

References

[1] **Streitz, N., Haake, J., Hanneman, J., Lemke, A., Schuler, W., Schutt, H., & Thüring, M.** (1992). SEPIA: A cooperative Hypermedia Authoring Environment. In, Milano: ACM, 11-22.

[2] **Dieberger, A.** (1994). Navigation in Textual Virtual Environments using a City Metaphor [Doctor of Technical Sciences]. Vienna University of Technology. https://smg.media.mit.edu/library/dieberger1994.html

[3] **Fairchild, K. M., Poltrock, S. E., & Furnas, G. W.** (1988). SemNet: three-dimensional graphic representation of large knowledge bases. In R. Guinon (Ed.), Cognitive Science and its Applications for Human-Computer Interaction, Lawrence Erlbaum, 201-233..

[4] **Sullivan, L. H.** (1896). The Tall Office Building Artistically Considered. Lippincott's Magazine, 403-408.

[5] **Carmody, S., Gross, W., Nelson, T. H., Rice, D., & van Dam, A.** (1969). A hypertext editing system for the /360. In M. F. A. J. Nievergelt (Ed.), Pertinent concepts in computer graphics University of Illinois, 291-330.

[6] [**Bush, V.** (1945). As we may think. Atlantic Monthly, July 1945, 101-108.

[7] **Brunner, J.** (1968). Stand on Zanzibar. ([1st ed.] ed.). Doubleday.

[8] **Asimov, I.** (1953). Second foundation. ([1st ed. ed.). Gnome Press.

[9] **Yankelovich, N., Haan, B. J., Meyrowitz, N. K., & Drucker, S. M.** (1988). Intermedia: The Concept and the Construction of a Seamless Information Environment. IEEE Computer, 21(1), 81-96.

[10] **Walker, J. H**. (1987). Document Examiner: delivery interface for hypertext documents. Proceedings of the ACM conference on Hypertext, 307-323.

[11] **Bolter, J. D., & Joyce, M.** (1987). Hypertext and Creative Writing. In (pp. 41-50). Chapel Hill: ACM.

[12] **Conklin, J.** (1987). Hypertext: An Introduction and Survey. IEEE Computer, 1987(September), 17-41.

[13] **Kahn, P., & Lenk, K.** (2001). Mapping Websites: Digital Media Design. Rotovision.

[14] **McPhee, J.** (2017). Draft no. 4 : on the writing process (First edition. ed.). Farrar, Straus and Giroux.

[15] **Ahrens, S.** (2022). How to Take Smart Notes: One Simple Technique to Boost Writing, Learning and Thinking. http://books.google.com/books?id=wzv9zgEACAAJ&hl=&source=gbs_api

[16] **Wynne, J.** (2021). Do not erase : mathematicians and their chalkboards. Princeton University Press.

[17] **Lambourne, L.** (1999). Victorian painting. Phaidon Press.

[18] **Marshall, C. C., & Shipman, I. I. I., Frank M.** (1997). Spatial hypertext and the practice of information triage. In, Southampton, United Kingdom New York, NY, USA: ACM, 124-133.

[19] **Lanham, R. A.** (1993). The Electronic Word: Democracy, Technology, and the Arts. University of Chicago Press.

[20] **Ruskin, J.** (1873). The Stones of Venice. Smith, Elder & Co.

[21] **Mayor, A.** (2018). Gods and robots : myths, machines, and ancient dreams of technology. Princeton University Press.

[22] **Bernstein, M.** (2011). Can We Talk About Spatial Hypertext? In, NY: ACM, 103-112.

[23] **Marshall, C. C., III, F. M. S., & Coombs, J. H.** (1994). VIKI: Spatial Hypertext Supporting Emergent Structure. ECHT'94, 13-23.

[24] **Spuybroek, L.** (2011). Sympathy of things : Ruskin and the ecology of design. V2 Publishing : NAi Publishing Available in North, South and Central America through D.A.P./Distributed Art Publishers Inc.

[25] **Rohde, M.** (2013). The sketchnote handbook : the illustrated guide to visual note taking. Peachpit Press.

[26] **Kaplan, N., & Moulthrop, S.** (1994). Where No Mind Has Gone Before: Ontological Design for Virtual Spaces. ECHT'94, 206-216.

[27] **Albers, J.** (1963). Interaction of color. Yale University Press.

[28] **Bernstein, M., Joyce, M., & Levine, D. B.** (1992). Contours of Constructive Hypertext. In Milano: Asssociation for Computing Machinery, 161.

[29] **Marshall, C. C., & Shipman, F. M.** (1995). Spatial Hypertext: Designing for Change. Communications of the ACM, 38(8), 88-97.

[30] **Smee, S.** (2022). America may finally be ready for Alberto Giacometti's uncompromising art – The Washington Post. Retrieved 2023-05-12

[31] **Bernstein, M.** (2003). Collage, composites, construction. In, Nottingham, UK New York, NY, USA: ACM, 122-123.

[32] **O'Nan, S.** (2022). Ocean state (First Grove Atlantic hardcover edition. ed.). Atlantic Monthly Press.

[33] **Amory, H.** (1986). The trout and the milk: An ethnobibliographical talk. Harvard Library Bulletin, 7(1), 50-65.

[34] **Shipman, F., Hsieh, H., Airhart, R., Maloor, P., & Moore, J. M.** (2001). The Visual Knowledge Builder: A Second Generation Spatial Hypertext. In Y. D. Hugh Davis, and David G. Durand Århus, Denmark: ACM, 113-122.

[35] **Menand, L.** (2021). The free world : art and thought in the Cold War (First edition. ed.). Farrar, Straus and Giroux.

[36] **Bernstein, M.** (2023). Knowledge Machines: a Complex Web of History and Technology. In L. R. M. Wiebke Keim, Rigas Arvanitis (Ed.), Handbook of Academic Knowledge Circulation. Routledge.

[37] **Bernstein, M.** (2022). On The Origins Of Hypertext In The Disasters Of The Short 20th Century. Proceedings of the ACM Web Conference 2022, 3450—3457.

[38] **Spengler, O., Werner, H., Helps, A., & Atkinson, C. F.** (2006). The decline of the West (Abridged ed. ed.). Vintage Books. http://www.loc.gov/catdir/enhancements/fy0634/2006273914-b.html

[39] **Propp, V. A.** (1968). Morphology of the folktale (2d ed. ed. Vol. Publications of the American Folklore Society. Bibliographical and special series; v. 9). University of Texas Press. http://www.loc.gov/catdir/description/texas041/68065567.html

[40] **Lévi-Strauss, C.** (1966). The savage mind (La pensée sauvage). Weidenfeld & Nicolson.

[41] **Nelson, T. H.** (2004). A Cosmology for a Different Computer Universe: Data Model, Mechanisms, Virtual Machine and Visualization Infrastructure. Journal of Digital Information, 5(1), Article 129. https://jodi-ojs-tdl.tdl.org/jodi/article/view/jodi-129

[42] **Landow, G. P.** (1992). Hypertext : the convergence of contemporary critical theory and technology. Johns Hopkins University Press. http://www.loc.gov/catdir/description/jhu051/91020068.html

[43] **Joyce, M.** (1994). Of Two Minds:Hypertext Pedagogy and Poetics. University of Michigan Press.

[44] **Nelson, T. H.** (1974). Computer Lib/Dream Machines. Ted Nelson.

[45] **Roman Chernobelskiy, K. C., and Stephen G. Kobourov** (2011). Force-Directed Lombardi-Style Graph Drawing. In, 79-90.

[46] **Needham, T.** (2022). Visual complex analysis. Oxford University Press.