The Heart of Connection: *Hypermedia Unifiedby Transclusion*

Theodor Holm Nelson

I can imagine few honors greater than a facing page to Douglas Engelbart's; he is one of the great men of our century and I love him dearly. Like Doug I have had a unified vision, of which today's popular attainments are only centerless shadows of the edge. But I have till now had little basis for conversation with the computer mainstream. Coining words has hardly helped (e.g., hypertext, hypermedia, transclusion).

Let me begin again, for few have understood.

After college, wishing to work alone as rogue philosopher and film-maker, I was troubled about distribution for self-publishing and how to manage notes and threads for many projects. Then I took a computer course. Philosophically, I saw that the computer was a clockwork of arbitrary abstractions designable any which way; cinematically, I saw it would become the theater of all media turned interactive. These two angles fused into a stereo perspective pointing far beyond.

What would be the best underlying abstractions for this ultimate union and generalization of literature and movies? Personally, I wanted a system for massively parallel creative work and study; more grandly, I sought to design the rightful literature and art canvas of the future, creating a technical, legal and commercial basis for a worldwide populist and participatory electronic literature of freely weaving screen transmedia—republishable and quotable without restriction—to the betterment of human understanding and freedom of expression and access [2]. What better dream at 23? And still a good idea.

By the end of 1960 I had a design paradigm centering around deep intercomparison. The resulting system design (called since 1967 "Xanadu"™) has always been a unified scalable concept, both for personal work environments

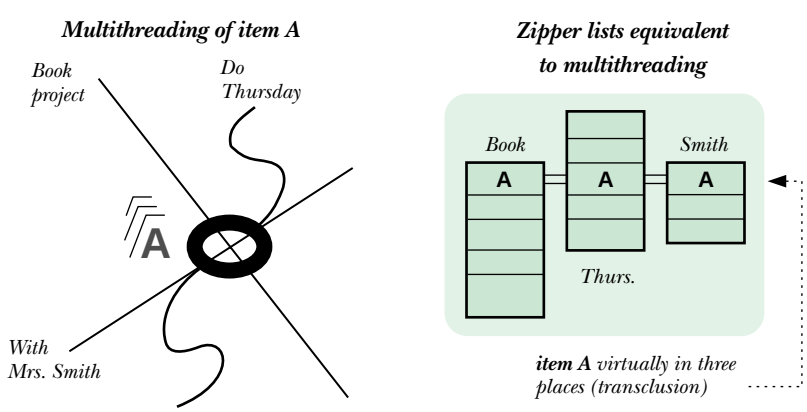

Figure 1. Deep Intercomparison Viewing—Transclusion through Zipper Lists: Zipper lists are a data structure and viewing method for multithreaded items. Figure 1a shows item A's logical existence in three contexts. The user would view this as 1b's equivalent zipper lists, with equality-bands indicating item A's transclusion (virtual presence) in the three contexts side-by-side.

(managing private versions) and for hypermedia publishing— that is, all publishing.

The central idea has always been what I now call transclusion, or reuse with original context available, through embedded shared instancing (rather than duplicate bytes). Thus the user may intercompare contexts of what is re-used, both for personal work (keeping track of reuse) and publication (for deep comprehension and study).[1] Transclusion brings to electronic publishing a copyright method that makes republication fair and clean: Each user buys each quotation from its own publisher, assuring proper payment (and encouraging exploration of the original).

Contexts of transclusions must be visually comparable on screen as shown in Figures 1 and 2. (Unfortunately, today's windowing systems do not yet allow arrows and bands to cross frame boundaries.)

Such intercomparative use at the center of all digital function meant building a new kind of file system. It would be hyperarchical, permitting the same material to be organized into simultaneous alternative structures—hierarchies, sequences, hyperplexes. It could permit no embedded codes, would make all changes by optional additions and structural

Figure 2. Deep Intercomparison Viewing—Transclusion and Link Display through Transpointing Frames: Equality-bands indicate the transclusion of text across window frames in two contexts. Arrows show links across window frames.

Caesar, J., *The Conquest of Gaul.*

All Gaul is divided into three parts.

Snerd, I., *Rome As I See It.*

When Caesar said, "All Gaul is divided into three parts," he referred, first, to Trans-Alpine Gaul, which we now know as southern France; secondly, to Cis-Al-Alpine Gaul, now called part of Italy; and third, much to the confusion of

overlay. As a deep revision server and project tracker for writers, scholars and programmers, it would manage reuse and instance comparison in all projects and publications. Users trying many possible organizational strategies could maintain all of them to express the unified fullness of their exact ideas. And this single-user console would scale up directly to groupware and a mighty on-line publishing server for tomorrow's transclusive all-media interactive literature.

Since then, colleagues and I have implemented (in varying degrees) half a dozen server designs, improving granularity (especially editability of embedded instances), mechanisms of transclusion, mechanisms of versioning, and transvisibility (the ability to reach different instance portions from one another) [3]. Substantial funding was provided for a time by Autodesk, Inc. [5]

Of late I have rethought the system's core, which had always seemed irreducible. I now discern layers: project tracker engine, change manager, networking this and that, publication server, sale method, legal basis, among others. Separable specifications will help everyone to build systems of this class on a mix-or-match basis. I already have elucidated the copyright method—actually an open permission system—in a separate paper [1].

Like Doug Engelbart, I slog on with ideals held high above the mud. Ironically, Doug and I started from completely opposite premises: he to empower work groups and make them smarter, I to free the individual from group obtuseness and impediment. That we have converged on common ideas to any degree is astonishing, and shows, I think, their correctness and generality.

References

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Best known for coining the words "hypertext" and "hypermedia" in the early 1960s, ***Ted Nelson*** *considers his to be the third school of computer thought (after hierarchicalism and AI but preceding Xerox PARC by years). Nelson's theory of Virtuality subsumes software under cinema as the design of seeming.*

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[1] For sequences of discrete chunks, transclusion is isomorphic to multi-threading items (see Figure 1 and [4]).