INTENSIONAL HYPERTEXT

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To become a meaningful medium that will enhance and support online interaction between Authors and actual or virtual Users, the Web must be intensional. This is a different emphasis for the Web than that defined by Ted Nelson when he coined the terms *hypertext* and *hypermedia* in 1965. Since Nelson's view of hypermedia is often received as the definition from which the Web takes shape, this paper will consider Nelson's vision to demonstrate that, despite its hyperlinking, Nelson's project presents a unipolar, extensional vision of hypermedia. We explore the limits of such an extensional web and redefine the web through an intensional model (ConTexts and Intensional Communities). We also present this model's possibilities for future growth in creating machine-assisted, networked communications and communities.

1 Introduction

The work in intensional versioning of Web documents undertaken at the University at Victoria [1,2,3,4,5] has clearly shown the utility of versioning for the development of hypertext systems. In all of these works, it has been assumed that documents are entities that vary according to the context in which they are placed and, furthermore, that the very structure of the document may change as the context changes.

In addition to a number of small but powerful examples that have been developed to show the strength of the technology, there have also been some large-scale examples that show the real-world usability of the ideas. For instance, schraefel and Driessen [6] have written chapters of an intensional textbook on Digital Signal Processing; the project demonstrates versions of information that can be rendered along dimensions of expertise and detail.

Nevertheless, we wish to further elaborate the notion of "intensional hypertext", as currently embodied in IHTML, ConTexts and ISE. In particular, we wish to better understand the concepts of *document*, *version*, *author* and *reader*. A clear understanding of these concepts, as well as how they are evolv-

ing, is crucial to the development of future large-scale, networked, hypertext systems. In particular, are documents atomic objects, or, as intensional hypertext suggests, can they have fuzzy boundaries? If so, then the other three concepts potentially become more complicated, and possibly more powerful as well.

We will consider the notion of fuzziness below. To begin, though, let us consider Ted Nelson's vision of hypertext. Nelson is the best known visionary of hypertext — the man who coined the term itself. He has written substantially on the subject.[7] It has often been stated that Nelson wanted to create the World Wide Web, but failed. He refutes that statement, claiming that "the World Wide Web is precisely what we were trying to prevent." In particular, he focuses on the fact that the Web is a "widespread hypertext universe with ever-breaking one-way links" that has "no version management, no rights management, no parallel intercomparison and no principled re-use of content materials".[8]

Reading statements such as these, one might surmise that Nelson thinks intensionally. This tendency is reinforced by paragraphs such as this one in *Dream Machines* [9] (page 66):

> Thousand-track branching recordings are imaginable. It is as though the listener could wander in an orchestra, first hanging out near the brasses, then the violins. But carry it further: New sections, themes and melodies could be accessible. This new genre could be like wandering through a forest of music — music that never stops, but that changes with every movement of the listener through a fantic space. Whole new themes are just over a hill. And the beginnings of other sounds beckon the listener ever onward.

Although the dream is intensional, the planned product has always been otherwise. In this article, we will demonstrate that the Web and Nelson's Xanadu [10] share an *extensional* view of hypertext. This view restricts the power of future hypertext systems, and retains a number of features that can only be called retrograde, in the sense that they just perpetuate how printed works have been produced since the advent of Gutenberg's printing press. Essentially, Nelson views a document as a *dead* entity. His versions are only collections of hyperlinked, independent extensions; they are not intensional renderings of a set of possible versions that can create a document. The author, in the extensional case, is simply a *road worker*, whose work only receives form and meaning from the user, who acts as a *manager*.

The critique will draw heavily on Nelson's *Literary Machines*,[10] — *LM* in the rest of the text — which presents the famed Xanadu project, as well

as on the ideas presented in his Web page. In our opinion, these references summarize well his views.

Demystifying Nelson will assist us further in developing our own vision of Intensional Hypertext: we may draw on certain particular points of Nelson, but the philosophical core and principles clearly diverge. Addressing the myth of Nelson allows us to make these principles explicit; in addition the critique gives us a road map for future research.

2 A critique of Nelson

In his Web page about parallel documents,[7] Nelson presents a picture of what he calls *Transpointing Windows.*[a] In this scene, two texts appear, each in a window, side-by-side on a computer screen, and a user has created links relating individual points in one text to individual points in the other text. Nelson claims that this example illustrates his understanding that one of the fundamental problems of hypertext is *being able to see connections side by side* and that this is *the most fundamental tool of human thought.*

At first glance, Nelson's argument seems potent. After all, it is true that by placing two (or more) related entities together, and examining their commonalities and differences, we can infer new knowledge, which can be expressed in the form of commentaries, links or annotations.

In addition, history has shown that this general approach has allowed important works to be produced. For example the King James Bible, the first authorized English translation, was the result of integrating passages from other translations as well as creating new translated passages.[12]

Another example comes from the area of geomatics. Several images are produced of a given area — from multiple passes or wavelengths — and the results are *fused* together through a combination of automatic and manual means, to form a single map of the region. A situation similar to the King James Bible example occurs when an existing geographical information system is to be updated with more recent *in situ* or remotely-sensed data.

Nelson's view of parallel documents is also consistent with, say, the compilation of the sometimes multiple versions of Shakespeare's plays to create the Oxford Shakespeare.[13] In some cases where variants of the plays cannot be resolved into a single, non-contradictory text, Wells, the chief editor of the Oxford edition, refuses the tradition of presenting the illusion of a single play. Instead he presents the variant readings themselves. The reader must

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[a] The open source code for the Xanadu project, under the name Udanax, has been recently released.[11]

decide how to deal with the ambiguity of multiple versions. In this respect, this version of Shakespeare is more Nelson-esque than the King James Bible, which would be loath to present more than one version of a sacred text to the lay reader.

Nonetheless, each of these examples show that Nelson's view of parallel documents is consistent with the scholastic tradition, whose primary aim has usually been seen as a search for the deep truth, typically defined in a religious — read *idealist* — manner.

Being consistent with tradition, Nelson does not think in terms of documents themselves as versions. That is, his work is neither intensional, nor interactive. By interactive, we mean that the emphasis on documents is not *always* and *only* to prepare a midrash of commentary on a given extensional text, but where the text itself frequently becomes a document rendered from possible versions; a document that can exist entirely as an extension of requests to render components of that document space in a particular way.

Nelson's parallel versions correspond to the presentation of pre-existing extensional documents that are to be the passive recipients of the objectifying gaze of the subject, the reader. The hypermedia power of Nelson's user is to make their own links between representations of pre-existing documents. *The documents themselves are static.* This assertion is sustained by a diagram appearing in *LM*, page 2/62: a person gazes at a screen, with interacting windows, giving form to a mishmash of documents randomly lying about on the ground.

It appears then, that for Nelson, all is extensional. As he states:

> *Parallel versions.* My working definition of a document is this: a document is an arbitrary collection of versions having the same name (and possibly under control of the same owner), whose cross-connections and commonalities may be important. These are parallel.[7]

But is a document *ever* an arbitrary collection of versions having the same name? Few meaningful collections of anything are "arbitrary". Indeed "arbitrary collection" seems to be an oxymoron. Consider the papers in this volume, called *Intensional Programming II*. The individual papers' "cross-connections and commonalities" have been constructed through the subject of the book itself, or by each "having the same name" as a marker: whether implicitly or explicitly, each paper has something to do with the further development of intensional programming. Thus, this collection is not arbitrary but constructed, where we would also say that the collection as a whole, as well as any component of that collection, is a document itself.

We are not suggesting that this is an intensional view of the term document. Indeed, it is entirely traditional. We do suggest therefore that Nelson's parallel views is equally traditional, extensional.

His notions of elements in collections are also based on notions of linking pre-existing whole documents together (a paper to a collection, for instance), and this is where Nelson is clearly extensional in his approach to hypertext.

In general, Nelson seems to take pride in wanting to perpetuate traditional forms of literature (*LM*, page 1/10):

> And this world, this new literature, will be built from the "document" as we have long known it, the "author" as we have long known him or her, and an extended form of "writing" as we have long done it and read it — rather than what some people, such as McLuhan and the video freaks and the CAI folk, have been telling us would be anonymous, collective, scrambled, psychometric, and/or Boolean.

Nevertheless, his definition for document is rather loose:

> *"The Carol Burnett Show" archive.* It was recently announced that 284 episodes of "The Carol Burnett Show", and all the associated documents (some 350,000 pages) will be donated to the UCLA library. We may think of this as being 284 parallel documents (a set for each show — notes, scripts, and the recorded show itself); or we may think of the whole collection as a single, fairly large-scale parallel document.[7]

Such a "parallel document" would be not much other than what a database today could render. Attributes are Sets, Shows, Scripts, Video. Search criteria return the relevant information to be viewed simultaneously.

This kind of viewing can very well be valuable, and there is a literature that considers a database as document, and databases do render versions of demand-driven documents, as any search of `amazon.com` or `altavista.com` demonstrates. However, these documents are first, rigidly structured (the document structure only presents a single view of the data) and second are not versionable within themselves. The viewing of comparable data objects, side by side, relies on the pre-existence of a complete object/document structure.

In the early development of IHTML (1996), Wadge and Yildirim envisioned parallel documents similar to Nelson's Parallel Universe. In the first version of IHTML, we could have the same document in French or English or Turkish, blue or white, graphics or no graphics, and thereby we could render an incredible number of possible documents with very little effort, but these were still,

effectively, direct translations of some core set of data with the same document structure per page.

Where these documents surpass Nelson's vision is their willingness to muck about with the document as artifact itself. Any attribute of these IHTML documents could be changed at any time. The document could shift from blue background to red at any time. Graphics could be added or stripped away.

By contrast, in Nelson's example, above, the Window only makes available multiple views of pre-existing documents. The 1967 episode 22 against the 1972 episode 22. This is not versioning, just parallel views of similar kinds of data.

And while simultaneous viewing of similar documents may be indeed truly rewarding, simply viewing two documents in a polar way does not harness the processing power of the computer. Such viewing, however, is modeled on the notion of the data being static and the user being the only active component of the system.

This type of hypermedia, where the user contributes the connections between the views, may be hyper in some sense, but it is not interactive. That is, the document is only a body on which users inscribe their meaning; the document does not contribute to the process of creating the associations for the user. There is no interaction, only reception of the user's claims.

Nelson dreams his own dream of hyperactive media, of manipulating and cross connecting parallel documents. It is the old solopsistic fantasy of the master builder that sees liberation through giving us all the tools to be master builders. The Xanadu project itself liberally allows anyone the license to be such a creator.

In the ConText paradigm, we are particularly interested in documents that are the result of interactive engagement, rather than only as passive collections to be acted upon, or gazed upon, or clicked to. We are interested in facilitating real interaction between the users (or readers) and authors, using computers and networks as vehicles. In fact, our intuition is that the boundary between users and authors will diminish as systems become interactive.

3   ConTexts are different

As stated, Nelson's vision of hypermedia, while hyper, is not interactive. The work over the past several years on Intensional HTML in general and on the ConText paradigm in particular demonstrates that the intensional programming community is well ahead of the curve in modeling non-linear, intensional, truly interactive digital documents.

In the intensional community's work on versioning of documents, the user

is not simply The Document Master, where the computer makes multiple views of data available. The user is typically an investigator, seeking not just information *à la* typical web search for news, stock quotes and merchandise information. The intensional user can also seek for knowledge, the putting together of information into a meaningful context that a user can develop interactively *with* the system. And we have found that often the best way to gain this kind of knowledge is to build a system that can present associative interactions, like good conversations.

The development of the IHTML extensions was informed by schraefel's research into gendered communication strategies, in particular, consideration of online interactive strategies.[14] It became apparent that onscreen communication is at its best, most involving, when it is interactive, when the source *reacts* to the user's queries. This can be seen in virtual conversations, such as chat room spaces, emails, and newsgroup postings, especially those among women, where conversational give and take is more — though not always — the norm than argument, and where one user can pose questions, have another user respond, and then pose a question, and respond, and hear responses. In other words, there is a high degree of apparent *listening* and responding to questions. The text that results from this conversation is one that evolves intensionally. Extensional posturing is more often the site for flaming, not knowledge making.

Intensional documents promote such associative, non-linear interaction within a document space. These documents allow the user to say when they want more information on a point, or less; to hear the discussion at a more expert or novice level; to start at any point and still get to the desired destination; to create the document through one's navigation of it; where the document to be navigated is not a pre-existing thing, but a version rendered on demand by the user in response to the user's interactive requests of that moment.

This is what sets intensional ConTexts, for instance, apart from Nelson's parallel versions. Nelson envisions data as the passive recipient of the Document Master's gaze in the Making of Meaning. ConTexts imagine that knowledge can derive from a conversational exchange between the ConText itself and the user:

I'd like more information on this point (CLICK: there's more)... but I don't know what that term means (CLICK: the term's definition flows into the text)... OK, could you summarize the next few sections (CLICK)... ah, I see! that relates to the earlier point; now I can go

back to that (CLICK)... [b]

Indeed, Conversational Texts, unlike Nelson's extensional world, also, perhaps especially, make room for the contextual nature of data: that it is as much where and how data is situated that contributes to meaning, as it is what that data is. Learning, conversation, the making of meaning is intensional. Let the system of delivery of the data reflect that.

In this respect, we may finally be able to bring the power of the computer and the network to document rendering. That is, in most cases, data/documents available online are still largely shovelware: pre-existing documents made available for online perusal. This is the case whether one accesses course notes or a catalogue. So far, the only thing hypermedia has brought to these documents is the hyperlink. A user can click to be led from one extensional thing to another. This is not putting the computational muscle of the network into document development.

By building intensional documents, we allow for intensional infrastructures that can contribute to the document space. This can mean the system could contribute calculation results, smart aggregation of non-local components that enhance the locally available components, or agent interaction within the intensional field to render what may be missing components. The possibilities of such collaborative interactions among the system and its users are legion.

How does a vision of the Intensional Document relate to the practical engineering of intensional systems? *Nothing* is innocent. All structures are informed by the particular biases of those who support or develop a given technology. [c]

In essence, we have suggested above that Nelson's efforts are informed by patriarchal privilege, and codify patriarchal ways of interacting with the world. That is, the traditional, modern Eurocentric notion of writing and transmitting text is not challenged by Nelson; Xanadu presents, rather, a new way of looking at the same old stuff. The Text, the document, even as a collection of documents (of Carol Burnett scripts, for instance) contains pre-existing, untouched, unchanging documents. Meaning is to be derived from comparing sacred texts rather than by generating new texts through call and response.

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[b] This scenario sounds like what Nelson might say in one of his writings, so we should insist on the fact that the information or texts being displayed may well be generated automatically using complex version structures, where the system itself can contribute to the generation of document components on demand. But this is not possible in Nelson's system, since it "does not permit the running of user programs" (*LM*, page 3/7).

[c] See, for example, Ursala Franklin's writings. [15]

By identifying and critiquing these biases, we allow ourselves ways to define better systems. ConTexts, as one example, is a *much* better system, and that for several reasons. First, because it is based not on one man's vision, but on research into actual strategies of user interaction with information; second, it is intensional, and third — perhaps best of all — it works; users can create ConTexts now. (At the time of writing, Xanadu did not exist as an implementation.)

So the crux of the problem is that *Nelson dreams of versions, but thinks only extensionally.*

With Intensional HTML, there is not only an Extensional document, or series of extensional documents. There are versions available to be rendered as instances of the version space.

Leading up to the second revision of IHTML in 1998, in 1997, schrae-fel refined the notion of intensional HTML documents by postulating three extensions to IHTML. These extensions were degree of detail, depth, and aggregation.[16]

These extensions allow intensional documents to be rendered not only by parallel content (the same content in French, English or Turkish), but by structure as well: the one page executive summary version or the several page Full Bore Detail Version of the same topic.[d]

Individual elements within a document can be versioned as well. For instance, one component of a document topic can be rendered at Expert level, while another component on the page can be set to Novice.

The aggregation extension of IHTML also allows for the on-the-fly collecting of appropriate components for a given version. For instance a bibliography can be rendered according to criteria such as "most important for summary" or "best introductory texts for this topic".

In a ConText space, the goal is to produce a document for the user that will allow users to gain the knowledge they seek. So far, this has meant that a ConText facilitates a way for the user to interact with a document in an ongoing way.

ConTexts can support this ongoing interaction because they are intensional, and are not dominated by a phallocentric paradigm of pre-existing complete objects (the document as homonculus); quite the opposite, they deliberately make room for heterogeneous interaction, rather than presuppose a desire for homogenizing synthesis, at the root of Nelson's proposal. Both points, intensionality and real-time heterogeneity, are important in terms of

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[d]This flexible structure also sets intensional text apart from database derived pages since, unlike the necessarily fixed structure of a database, intensional structures are themselves dynamic.

the continued development of ConTexts as a paradigm, not only for digital
document rendering but for virtual community support: this system seeks
to support diversity and diverse communities rather than impose the "every-
thing is neutral in cyberspace" homogeneity of current media representations
of Internet-based interactions. Intensionality supports independent entities
and communal communication without squishing either into a single proto-
col, defined by who knows whom, for interaction.

4 Intensional Hypertext

One way to summarize Nelson's apparent view of hypermedia is that he wishes
to relate two *extensions*, while we wish to relate two *intensions*. This means
that a link between two intensions may well lead to thousands, millions or
even more links between potentially generatable extensions.

The implication of this insight is that links themselves must be inten-
sional, i.e. links vary according to their own specific dimensionalities as well
as according to the dimensionalities of the documents they relate.

Furthermore, links should be of a richer nature. Interactions should be
allowed on contents (form, literal words, . . . — the Xanadu approach), on
depth (summary, expanded version, . . . — the ConTexts approach), but also
on concepts, history and document history, as well as with respect to related
documents and topics. Some of these links can be inserted manually, using
current Web technology, but are indistinguishable from one another. Links
as seen today do not lead to new data, conclusions or knowledge. This leaves
room for the introduction of *versioned links*, links that can create tables, fused
text and/or graphics, that is, new data just to name a few.

Links could also, *on the fly*, lead to multiple other documents that point
to the current document, or to the current section of the current document.
Clearly, it would be a rare situation in which one wanted *all* of the documents
that point to the current document; rather, one would want to use selection
criteria to restrict the numbers.

With respect to the bringing together of multiple versions of a document,
it should be clear that there is nothing special about the number *two*. Any
number of relevant extensions should be presented, as needed, i.e. when a
particular version is requested, the *aggregate* of *all* of the relevant versions
should be provided.[e]

But how should aggregate versions be presented? Quite simply, by ver-
sioning the presentation. Depending on what is required, presentations might

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[e] This approach was first proposed in schraefel's Ph.D. thesis, *Talking with Antigone*.[2]

be textual, graphical, audio, video, etc., or some combination of these. The members of the aggregate might be presented "side-by-side", or might be superimposed (layers), or might be fused into a single extension, etc.

However, to be able to have versioned presentation, it is likely that access to the internal structure of the extensions will be necessary. This is not currently possible with the basic object-oriented paradigm that forms the basis of the Web, where boundaries are fixed, not fuzzy. That is, they are not able to function within multiple contexts. The standard model in object-oriented programming assumes that objects are hard-shelled unopenable entities that interact one-on-one. In reality, most object-oriented systems suppose a shared context, including networking infrastructure, in which all the objects are immersed. The *intensional communities* of Plaice and Kropf [17] *assume* that objects are themselves versionable, i.e. can express themselves differently in different contexts, and that different shared contexts can be created explicitly, populated by multiple objects, thereby allowing a very rich development environment, with its own implicit and explicit rules.

In these communities, which can be very small or huge, there can be all sorts of free-floating material, similar to messenger RNA and proteins hanging around in a biological cell. The objects can pick up as needed the free-floating material, pithy passages that are useful for epigraphs, what have you.

The rules within a community can be radically different. For example, we could have a medieval style writing community, where people are allowed to grab quotes from here and there, with no referencing or verification of authenticity, in whatever form.

At the other extreme, we could have the vertically integrated late twentieth century business model, *à la* ISO9000, in which there is a never ending (electronic) paper trail of who did what, etc.

A third community might support scientific work, which would retain some of the freedom of the medieval community, but also some of the rigor of the business community.

In each case, fuzzy objects from one community could interact with those of another, adapting on-demand to the protocols of those entities.

5 Moving Forward: an Intensional Author

In a recent talk given by schraefel,[f] it was observed that ConTextual texts make readers authors; that situation was perceived as a "good thing". In order

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[f] "The ConText Paradigm", 12 April 1999, Department of Computer Science, University of Toronto, Toronto, Canada.

to grasp the potential for the intensional web more fully, we need to consider the role of the author as author of document components and the reader as author of document versions.

Now Nelson has also written about authorship, and proposes that it correspond to filling-in-the-blanks in an n-dimensional space:

> LUSTR, or Level of Universal Structure, is a proposed definition language for highly-interactive, multidimensional flying objects. The author begins by carving n-space into the structures that make sense, then painting text, colors and textures onto surfaces in that space. "Text formatting" becomes a spatial structure in this surface mapping — rather than the gnarly system of embedded codes used by HTML and its parent SGML.[18]

These things are possible with IHTML, but much more. The key is the ability of the document editor, of the *component author* to define versioned links — particularly the *relative* versioned links — that allow different links to be followed depending on the currently rendered context. It is not just a question of "stretch-text", nor of moving up and down a few levers on a mixing machine. As these levers move, the entire structure may change....

There is another key aspect that is implicit in the aggregation of ConTexts: the possibility for multiple-source input, for the document to be *alive*, in the sense that new authors may be continually adding to the corpus of text that makes up the complete set of versions of the entire document. It is not just the reader/listener who is interacting, it is also the document and those creating it.

And finally, the reader-as-author renders a particular path/version of the document that is rendered just for them, where their path of associations, their map of hyper-connections within the version they create, becomes a special document in and of itself.

This document map could then also be shared as a document with other users, as it becomes itself another dimension for navigating the document version space.

6   Conclusion

It has often been stated that the invention of the Web is akin to the introduction of the printing press into Europe by Gutenberg in terms of its long-term implications, as it allows for the collaborative creation of new works. However, we argue that the Web in its current status does not allow for truly interactive, collaborative hypermedia, and, more importantly, *nor does Nelson's vision.*

But the power of networked computing and of hypertext means that we now have a medium where many people can collectively build new understanding, hence new knowledge, without there ever being a statement that, *Yeah verily, we have reached absolute truth* or that *This is the Sole Authoritative Text on this subject.* Our experience of intensionality shows that for any non-trivial subject, there will always be more ways to delve into that subject, and a hypertext document will continue to grow, even if the original authors are long dead: the document is *living*; the versions as numerous and effective as the users.

Ironically, one might suggest that even the above discussion of the intensional presupposes that really, there is one Truth; just many paths to get to that Truth, and intensional documents only at best support such multiple paths. This would be a good observation, but does not bear out in practice. The examples above have only discussed types of documents where there may only be one final, ultimate answer: Tanner's address is fixed, whether it is given in English or Turkish or arrived at through numerological renderings or a phonebook query.

There are other types of documents, though, which lend themselves to the prism of intensional perspectives where Truth, to use such a term, is multiple. It is a truism to state that reality is often perceived quite differently depending on the perspective.

Intensional documents, however, allow users to interact with those multiple perspectives interactively, immediately. The consequences for knowledge making of such interactions have not yet been formally tested, but our suppositions, stemming from work in actual conversation, and from initial observation of interaction with itexts, are full of promise for surpassing the interactions between paper-based representations of the same material as discrete entities.

Consider a document about a book: suppose the same topic is engaged from a Feminist Theory perspective, using lay language; from a Post Modern approach, for an expert reader; or from a Marxist view. Where is the resolution? Where are the points of contact? Is it possible to engage the same point from these perspectives or does something other emerge each time the glass shifts focus around this particular valence? Intensional representations of data, structure and view support such interactive querying.

We are increasingly becoming a digital culture. To support an effective model of exchange; to enhance in the digital what cannot be represented in the physical, in other words, to make this massive shift to the digital meaningful, the paradigm needs to shift from extensionally rendered entities to intensional infrastructures.

Hypertext, if it is to be meaningful, can only mean *intensional hypertext.*

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