Glass, Paper, Scissors: Investigating the Metaphors of the Glass Cast Through Paper Prototyping

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Abstract
This article reflects on the importance of user feedback in early stages of the design process of Glass Cast. A 3-D interface, Glass Cast is intended for the visualization of knowledge networks, including parameters such as authorship, time, subject, discipline, and connections between documents in a corpus. The name Glass Cast refers to the working metaphor of the prototype, which is a cast sculpture in which the object of representation appears as negative space in a glass block. The participants in this study, graduate students and faculty in the humanities and social sciences, provided feedback on a low-fidelity paper prototype in the context of interviews. Their feedback is organized following the taxonomy of user-interface metaphors.

Keywords
Interface design; Visualization; Prototyping; Interface metaphors; 3-D model

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Introduction

This article reports on the current stage of the development and study of the Glass Cast prototype. A 3-D interface in development, Glass Cast is intended for the visualization of knowledge networks, including parameters such as authorship, time, subject, discipline, and connections between documents in a corpus. At present, this interface exists in the form of conceptual wireframes (see Figure 1 and Figure 2). The production will be completed in Unity and Blender, but it is anticipated that the ultimate platform for the interface will be three.js. The data to be visualized once the interface is operational in three.js will be acquired from standalone open source

Figure 1: Application of design premises – default 2-D view of the interface with both views: "network" and "timeline"

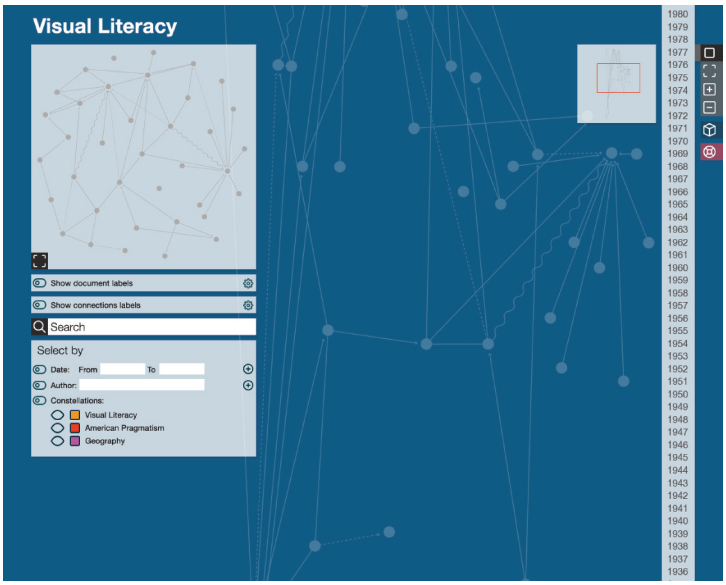
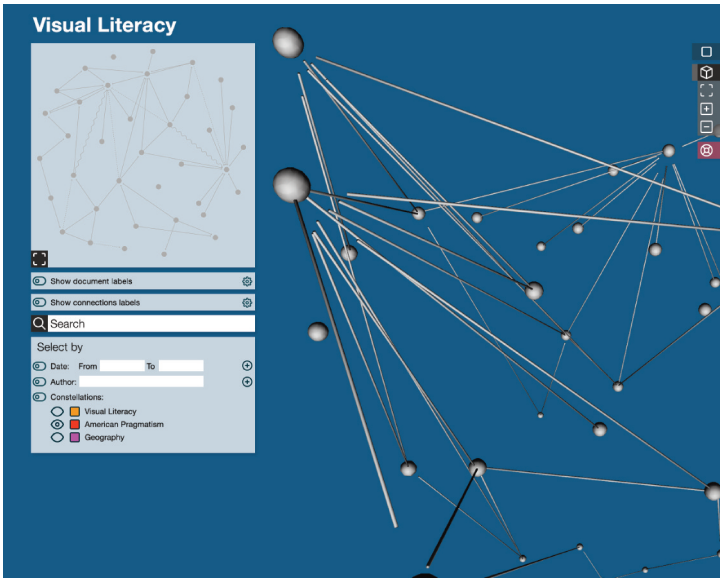


Figure 2: Application of design premises – default 3-D view of the interface



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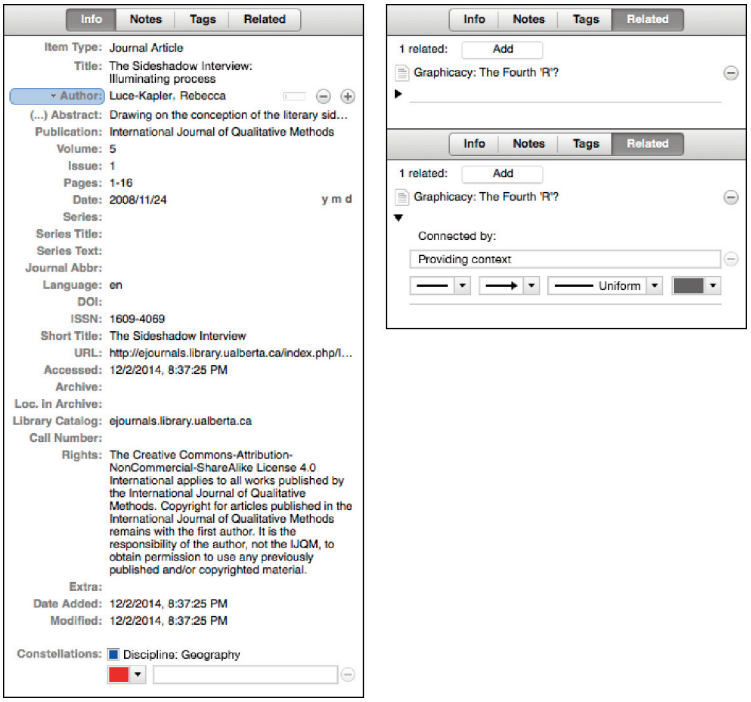
citation managers (e.g., Zotero), through the addition of a plugin to be developed for this purpose. This approach has already been used for projects such as Paper Machines (Mullen, 2012). This plugin will harvest information that is typical of a citation item (author, year, place of publication, etc.). It will also increase the default input fields to enable the addition of relevant categories, such as discipline or any other sort of professional affiliation. Finally, the plugin will allow for the expression of relationships between documents; users will also be able to specify the nature of these connections and their directionality (see Figure 3).

The data acquired using this plugin can be populated into the Glass Cast interface, which will then visualize the relationships a user has specified. Within the display of a knowledge network consisting primarily of scholarly citations, for example, a top view might present connections between citations, while a side view might present the citations in chronological order (see Figure 4). This distribution would allow users to visualize the connections between the documents based on authorship and date of publication.

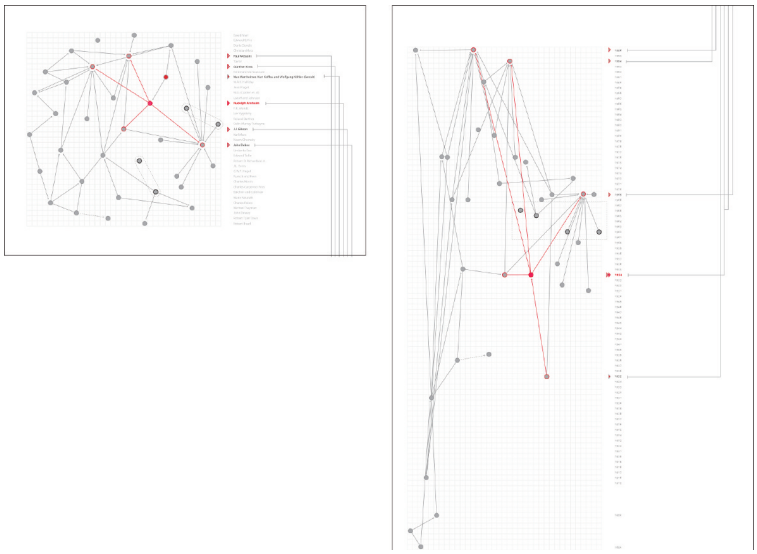
Figure 3: On the left is a mock-up of the additions to the default input fields in Zotero ("Constellations"). On the right are additions to Zotero's default documents relations fields. These additions will inform the character of the relations between the documents and the directionality of these relations (e.g., who cites whom).



Understanding the metaphoric entailments of the Glass Cast prototype

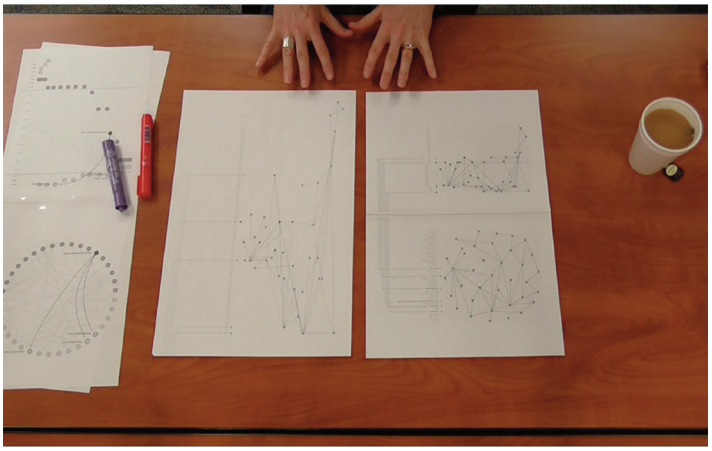
As intimated above, Glass Cast is currently in the low-fidelity prototyping stage. To gauge the effectiveness of the interface metaphor before developing a working prototype, we conducted a study with ten participants: five PhD students and five faculty members. Two participants were in literary studies and the arts, respectively, while the remaining eight were in the social sciences. All participants had backgrounds in literature, language acquisition, and linguistics. Participants provided feedback on our low-fidelity paper prototype (see Figure 5) in the context of a side-shadowing interview, "a think-aloud approach in which interviewer and participant engage in natural dialogue during the session towards negotiated interpretation" (Dobson, Brown, & Peña, 2014) (e.g., Luce-Kapler, 2008). During each interview, we asked a series of specific

Figure 4: The views offered to the participants in the study. The image on the left displays the top or network view and the one on the right shows the side or timeline view.



questions aimed first at gaining an understanding of the semiotic resources the participants used to make sense of the prototype, particularly in relation to their use of metaphors. Second, our questions sought to elicit design premises that might be applicable to the next stage of prototype development. Some of these questions included the following: What does the prototype remind you of? What do you think the interface is for and why do you think this? Can you circle those parts you find more appealing (interesting/confusing/striking)? What name would you give this prototype? Which of these prototypes do you find more appealing/effective in regards to communicative purpose and why?

Figure 5: The arrangement of the interview for this study



Participants were provided with a paper model of the prototype intentionally lacking in key information, such as the nature of the relations between items or the purpose of the interface, to prompt observations in the form of guesses and assumptions. Participants were also provided with a marker and asked to enhance their verbal descriptions and insights by making visible traces and marks on the paper prototypes. Two views of the prototype were offered: top view (network) and side view (timeline) (see Figure 4). The interactions of the participants with the prototype were video recorded, and the marked prototypes were also analyzed as data (see Figure 5).

Metaphors elicited during the interviews were categorized as orientational, ontological, or structural, according to Pippin Barr, Robert Biddle, and James Noble's (2002) taxonomy of user-interface metaphors, which is heavily informed by the work of Jakob Nielsen (1994) and George Lakoff and Mark Johnson (1980). According to Barr et. al., orientational metaphors explain concepts "in terms of space" (p. 26) as in *up*loading or *down*loading; ontological metaphors explain concepts in terms of "objects and substances" (p. 26) as in *files* and *folders*; and structural metaphors explain concepts in terms of a logical system as in the *office environment* depending on the kind of mental references from which the metaphors are derived.

Design implications: Orientational metaphors

Orientational metaphors provided by participants followed two broad patterns: the exploration of the interface in terms of 1) "starting point" or "origin," or 2) in terms of "foundations." However, even in instances in which the terms "starting point" and "origin" appear to be semantically related, participants' responses connoted an implicit difference between the "starting point" of the interface – as in, for example, its "landing page" – and the "origin," as related to the model's narrative affordances. Assessments of the interface's orientations appeared to respond to the distribution of information within the paper prototypes, whereas discussions of its narrative affordances seemed to be motivated by the timeline, one of the few explicit pieces of information provided in both prototypes, as recognized by every single participant. For example, in one

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interview, the difference between the orientation of the model and the visual or operational entry point of the interface was made explicit:

> … I am going to make an assumption that this [participant points to the low part of the timeline view] is sort of [the] *origin of route*, and other things come out of it … [which] makes me think that these are either a top view or a *general view* [referring to the top view]. (Participant 0228, emphasis added)

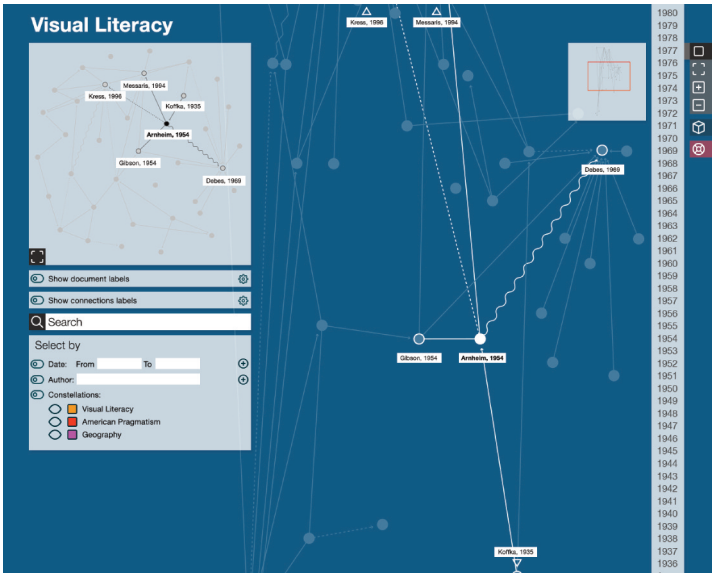
From these comments we inferred the need to try to match the orientation of both the model and the interface by placing the network or general view at the bottom of the timeline view, where the participants located the "foundations" or "origins," even if this conflicted with the orientation pattern that places the new information at the top, or "closer" to the viewer. Doing so, or providing a toggle that would allow viewers to change the view to suit their conceptual frameworks, will not present a problem in regards to the general aspect of the interface, as the bottom and top views of the model will be essentially identical (see Figure 1).

Another issue in regards to orientation arose out of discussions of the direction of the arrows that indicate whether a document influences or is influenced by another. In the prototype, the direction of the vectors moves from the influencing document (tail) to the influenced (head). This makes sense in the general overview of the timeline, as every vector is pointing either up or sideways. This orientation reflects the phrasing "*A* is referenced by *B*" (A→B). However, the direction of the arrows could be confusing to participants who understood the orientation according to the phrasing "*B* refers to *A*" (A←B). During our study, at least one such case arose:

> … I am thinking this document references that document because it is going that way, but let me think about it the opposite way… so this document is referencing that, is looking back at … yeah, I can't quite get my head around that. (Participant 1020)

In regard to the emerging design premises, we could argue that in the network view, adopting the "*B* refers to *A*" phrasing would have no major effect, but it would be counterintuitive in the timeline view where the arrows would be pointing "back" in time. A possible solution might be to remove the arrows from the timeline view, as time itself suggests directionality. However, in the case of documents published the same year, the directionality would have to be expressed explicitly (see Figure 6). Another solution could be to create a tutorial for the interface that might include a simple explanation of the directionality of the arrows.

Figure 6: Application of design premises – arrows represented by default. Hovering over an individual item would highlight nodes and connecting arrows (items outside of the main view are signalled by an triangle).



Design implications: Ontological metaphors

According to Lakoff and Johnson (1980), ontological metaphors mediate reality in terms of objects and substances. Of the various ontological metaphors supplied by participants, two stood out for their frequency of reference throughout our interviews. First, there were numerous references to the model as being a sort of "map," or of "mapping information" being its intended purpose. For example, as one participant mused, "this will be like a map that shows me – oh, you know – Gunther Kress is really a big name," and, "I am studying applied linguistics and I am curious about where I am" (Participant 0217).

Figure 7: Application of design premises – selection of a single item by clicking it, omitting labels

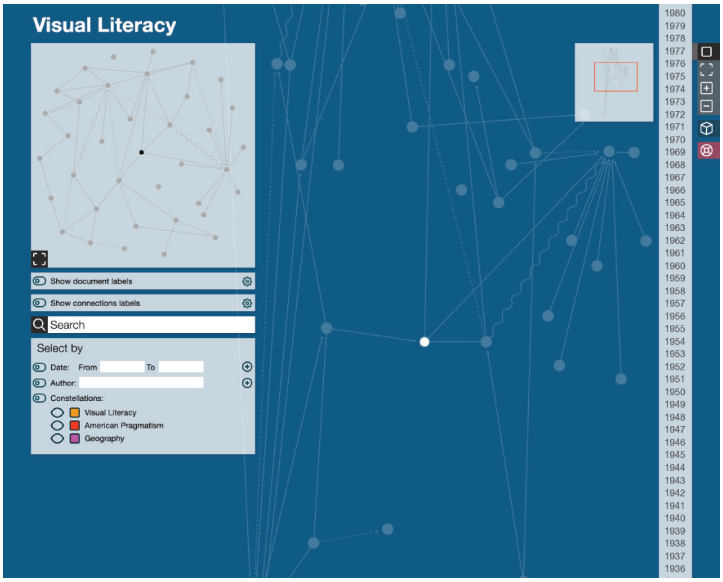


Figure 8: Application of design premises – selection of two items by clicking them, showing document labels, controlled from the labels pane

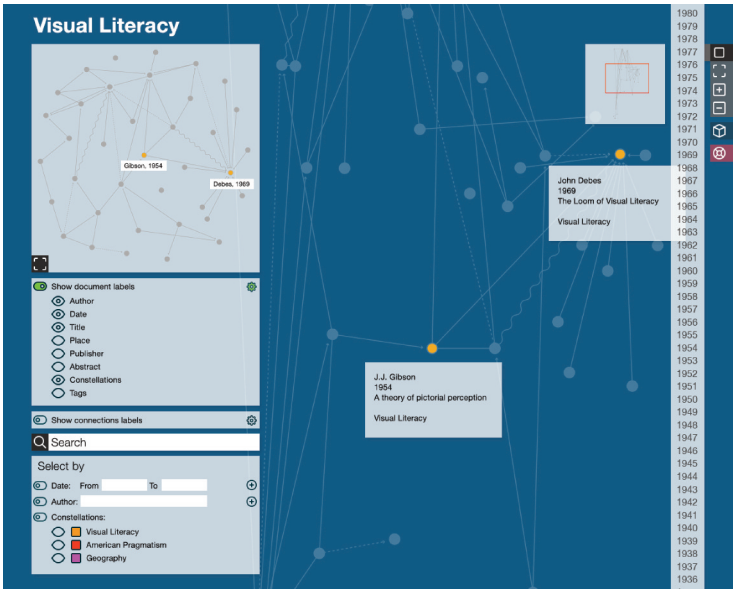


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Figure 9: Application of design premises – selection of two items by clicking them, showing document and connection labels, controlled from the connections pane

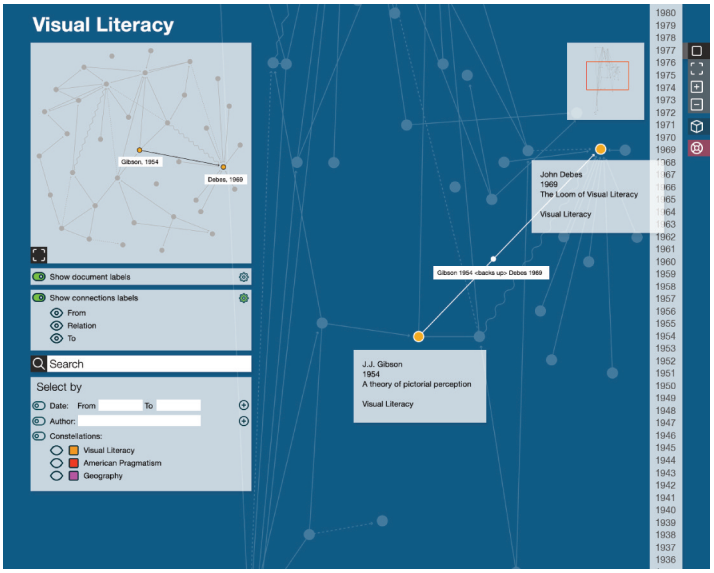
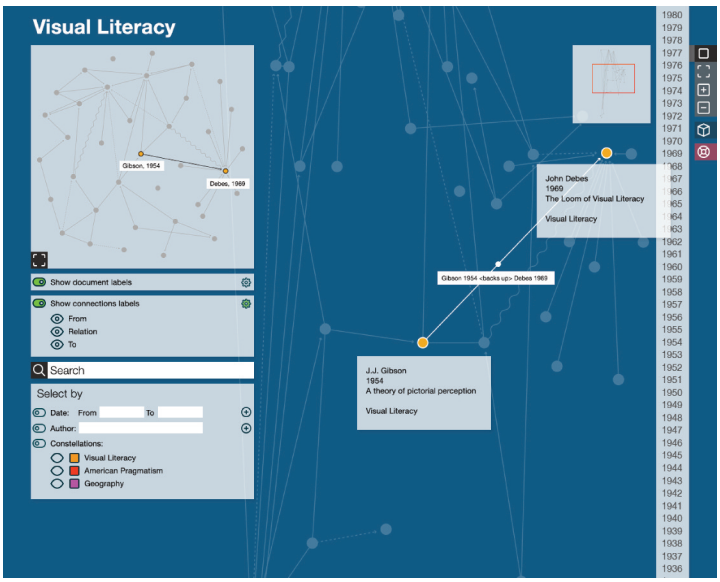


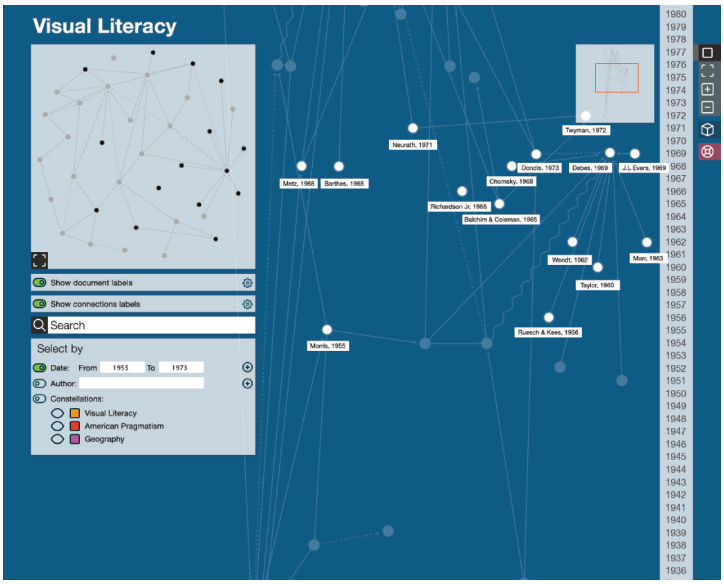
Figure 10: Application of design premises – selection by constellations, omitting document labels, controlled from the constellations pane



Second, participants frequently described aspects of the prototype as "constellations." Twice both metaphors ("maps" and "constellations") were employed in the same utterance. Consider this example: "I think of maps of the night sky, but other than that, certainly the lines connecting the dots is how we depict constellations" (Participant 0212). We would argue that these two metaphors should not be assessed in the same way, even when they appear together, because of distinct differences in the uses and/or entailments of these metaphors. As our analysis revealed, references to maps, or mapping, were often casual and spontaneous. Conversely, every mention of constellations was prompted by the question, "What does [the prototype] remind you of?"

Further, references to constellations both explicitly and implicitly supplied a structural metaphor for the interface as a whole, whereas references to maps and mapping instead suggested perceptions of the prototype's purpose; at least seven out of ten participants used the metaphor of maps in this way.

Figure 11: Application of design premises – selection by date, showing document labels, controlled by date pane



Embracing the map metaphor has resulted in specific design premises for Glass Cast. For example, the affordances of the objects of these two primary ontological metaphors – constellations and maps – suggest the introduction of additional functions, such as the ability to search for item, author, time, or term, or the ability to isolate or highlight particular clusters of documents, or "temporal zones," within a visualization so they can be analyzed as such (see Figures 7, 8, 9, 10, & 11). These functions will require the addition of operation panes with search fields and visibility options.

Design implications: Structural metaphors

Barr et. al. (2002) define structural metaphors as implicit comparisons between the structures of two different objects. We believed participants would be less likely to invoke structural metaphors in their comments on the Glass Cast prototype. This is because we assumed that identified metaphors would only become a system after conscious efforts of conceptualization and adaptation of the features of the interface within a general logic. Such metaphoric entailments were purposefully hindered because we did not provide participants with the name of the prototype or its function.

However, the ontological metaphor of the prototype as a constellation also provided a meaningful reference point for the conceptual elaboration of a system. This reference point led us to a new structural metaphor, one that could accommodate both the orientational and ontological metaphors: namely, the interface as an observatory. This new metaphor does not, however, refer to an actual computerized observatory control pad since such interfaces are not familiar enough to be helpful in scaffolding the design of the prototype presented here. Instead, the metaphor of the prototype as an observatory employs a map visualization interface, which is more familiar and will accommodate the ontological metaphor proposed by the participants.

According to the system of logic implied by the Glass Cast as observatory, the network view could be the general view and the starting point (see Figure 1). It will also be conceptually positioned at the bottom of the timeline view, as this is the view from the eyepiece of a telescope, usually positioned at the bottom. This view (formerly the "network view") will be known as "the viewer." The side view (formerly the timeline view"), a two-dimensional representation of the connections between documents over time, will be known as "the explorer." This view will provide other sorts

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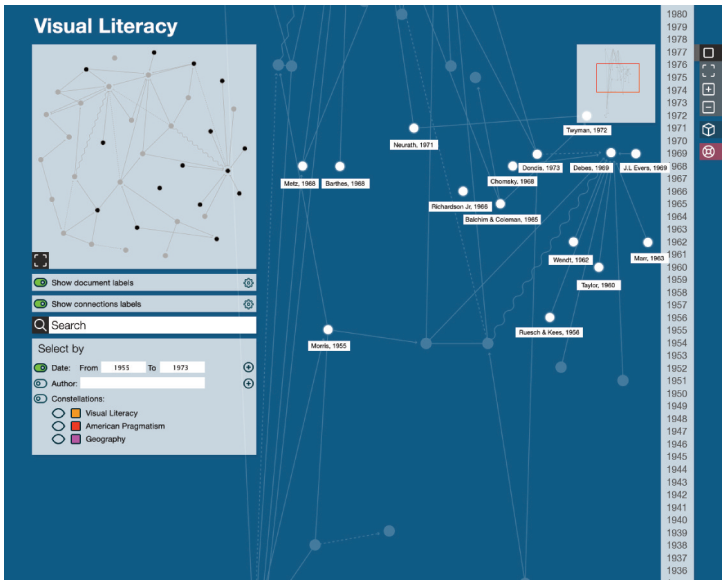
of information, such as a heat map, to indicate years of increased knowledge-network activity.

Finally, a third view, called "the model," will provide a three-dimensional view of the visualization (see Figure 12). Compared to other views, the affordances of this view might be limited as some documents could occlude others. Users will be able to switch between "the explorer" and "the model." There will be a main pane that will provide information and selection options. Documents can be selected from the explorer; selections will then also be shown in the general view. From there, users will have the ability to define criteria in order to create "constellations" of documents based on keywords related to discipline, theoretical approach, place of origin of a publication, or any other relevant information. The connections between documents might indicate the kind of relations they have through a legend and colour codes. These relations will be determined according to the criteria of the researcher, but there will be general visual cues based on the aspect of the interconnecting lines.

Figure 12: Application of design premises – default 3-D view of the interface, also known as "the model"



Conclusion

This study demonstrates the importance of user feedback early in the design process. One of the challenges of using metaphors for the design of interfaces is that the choice of these metaphors is usually in the hands of the designer or the design team before users engage the interface. In the realm of usability studies it has been repeatedly pointed out that the criteria of the producers is not necessarily compatible with that of the users (e. g., Gócza, 2014). We had the opportunity to witness this when users described metaphoric entailments (e.g., "constellations") that had previously gone unnoticed by the design/research team. As described above, we will incorporate the metaphoric entailments provided by participants in the next stage of development of the prototype.

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Unity, https://unity3d.com/

Zotero, https://www.zotero.org/

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