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Designing a *Madison Commons* Visualization

**Background on *Madison Commons***

*Madison Commons* is a hyper-local news site focusing (as the name implies) on Madison, Wisconsin. Initiated by faculty in the UW-Madison School of Journalism and Mass Communication, the project is a collaboration among citizens and community-based organizations, like the Morgridge Center for Public Service and Community Shares of Wisconsin. The central purpose of *Madison Commons* is filling gaps in news coverage of local issues. The site is dedicated to covering issues that are important to community members but often do not receive coverage from the more prominent, traditional local news outfits.

Specifically, citizen input has guided the *Commons* to focus on the areas of local food, education, and transportation. Coverage of these areas emphasizes citizen engagement with their communities. The stories published by *Madison Commons* aim to get citizens involved in local problem-solving and decision-making processes.

Along with this goal of promoting citizen engagement, the *Commons* seeks to localize the issues it covers. The implication here is that societal problems can seem overwhelming and unsolvable when viewed at an aggregate level. The staff of *Madison Commons* believes that localizing issues gives problems more specificity and in turn makes them more manageable. The hyper-local nature of coverage positions issues, problems, and solutions within the framework of local neighborhoods (as opposed to state or national frameworks). *Madison Commons* coverage encourages citizens to get involved in problem-solving and decision-making within their hyper-local communities. Such coverage promotes citizen engagement that is more easily initiated and more sustainable than problematization frameworks that would require large effort and extensive coordination at state or national levels.

The underlying mission of *Madison Commons* is civic engagement, and coverage accordingly emphasizes ways that citizens can easily get involved in improving their communities, starting at the hyper-local level. A key aspect of encouraging community involvement is educating citizens of the impacts of their and others’ actions. The *Commons* seeks to inform citizens of the effects of government policies, business decisions, and community efforts. In the case of benefits to the community, *Madison Commons* aims to show citizens how they can support and/or extend the benefits. In the case of detriments to the community, the *Commons* aims to show citizens how they can correct and/or solve the problems.

The goal of the visualization project discussed in the remainder of this essay is to augment the education function of the *Madison Commons* mission. The final objective is to create a visualization that helps citizens explore the content published by *Madison Commons*. Most significantly, I want to design a visualization that encourages citizens to learn more about local issues. One of the key design objectives is creating a visualization that builds on a citizen’s prior interests, using those interests to highlight relevant/related issues. Based on my review of the literature, there are two components of such a visualization design: (1) designing a visualization for engagement and insight, and (2) designing a network visualization for organizing and displaying content. In the following section, I survey some visualization research that highlights the differences between visualization design, on the one hand, for efficiency and accuracy and, on the other, for engagement and insight. I then survey research related to network displays, focusing particularly on visualizations that create networks from literature/article datasets. In doing so, I apply principles from prior research to the *Madison Commons* dataset, integrating this research into design guidelines for a *Madison Commons* visualization.

**Designing for Engagement and Insight**

Visualization research has frequently revolved around the efficient communication of information and its accurate interpretation. Kostelnick (2008) observed that the influences of the cognitive-perceptual research paradigm have resulted in visualization design being dominated by a ‘rhetoric of clarity’. This rhetoric of clarity produces visualizations that embody the values of rationality, objectivity, and minimalism, building from foundations in the scientific method and Modernism (Kostelnick, 2008). However, Kostelnick (2008) pointed to digitization and the transition from print to computer screen as prompting a corresponding change in the rhetoric of visualization. Whereas the rhetoric of clarity placed the burden of knowing the audience and the context entirely on the designer, interactive visualizations have democratized the design process: “Online data design shifts the user’s interpretive act from a passive to an active, participatory role. Clarity becomes a moving, self-adjusting target whereby users shape (and reshape) data displays according to their needs and preferences” (Kostelnick, 2008, p. 123).

Kostelnick is not alone in asserting that the rhetoric of visualization has evolved beyond clarity. Segel and Heer (2010), for example, examined the trend of narrative visualization—visualizations that tell stories, as opposed to objectively presenting data via minimalist displays. Like Kostelnick (2008), Segel and Heer (2010) noted the differing values of author-driven and reader-driven approaches to visualization. An author-driven approach corresponds to the rhetoric of clarity and is most appropriate for the task of efficient communication, while a reader-driven approach “supports tasks such as data diagnostics, pattern discovery, and hypothesis formation” (Segel & Heer, 2008, p. 1146) through interactivity and flexibility.

Hullman, Adar, and Shah (2011) also noted that a focus on clarity does not always support comprehension. They argued that through decoding information, assimilating information with prior knowledge, and drawing inferences, greater interaction with a visualization enhances learning (Hullman et al., 2011). As such, they argued against the rhetoric of clarity and promoted the use of ‘visual difficulties’. As noted above, the rhetoric of clarity results in passive processing by the audience. Hullman et al. (2011) explained that visual difficulties induce greater engagement with visualizations, thereby prompting active processing of information, which in turn produces better long-term memory and greater comprehension.

Working from a similar perspective, Saraiya, North, and Duca (2005a) developed an ‘insight-based methodology’ for evaluating visualizations. Juxtaposed to traditional evaluation metrics that emphasize accuracy and efficiency, Saraiya et al. (2005a) noted that beyond accurate and efficient communication of information, “a primary purpose of visualization is to generate *insight*” (p. 443). They defined an *insight* as “an individual observation about the data by the participant, a unit of discovery” (Saraiya et al., 2005a, p. 444). They evaluated insights based on factors like how long it took to arrive at the insight; how much domain value the insight had; whether or not the insight led to new hypotheses; whether an insight was directed by a prior question or was gained unexpectedly; and how much detail/depth the insight had (Saraiya et al., 2005a). Although the specifics of that study are not relevant to the task at hand, their approach reinforces the notion that greater clarity in visualization does not necessarily correspond to greater comprehension.

**A Network Visualization for *Madison Commons***

Using the set of *Madison Commons* articles as the dataset to be displayed, I settled on a network visualization as the basic design. A network display seems an ideal way to build from a user’s interests, pointing them toward articles within those interests while simultaneously suggesting paths to explore for related but unfamiliar content. In what follows, I glean network visualization principles from prior research and suggest how these principles might be applied to the *Madison Commons* dataset.

Based on the research discussed above, I want to incorporate some level of interactivity in order to encourage engagement and exploration of the visualization. But how much should users be able to interact with the network display?

Saraiya, North, and Duca (2005b) found that users of network visualizations preferred premade pathways for their interests to constructing their own arrangements from scratch. Similarly, Dwyer, Lee, Fisher, Quinn, Isenberg, Robertson, and North (2009) found that participants asked to construct network layouts found the task very difficult. These results point to the need for the *Madison Commons* visualization to involve network presets of some sort, to provide a starting point for users. Currently, each article is tagged based on content and location. The content tags include topics like food, education, and transportation; the location tags consist of the neighborhood and/or region (Isthmus and Campus, North Madison, Near East Madison, South Central Madison, etc.) Accordingly, having preset networks based on these tags seems like a good beginning display. Two presets seems appropriate: one preset network where articles are clustered by content tag, and one preset network where articles are clustered by location tag.

Although users prefer automatically-generated network displays to those they have to construct themselves, interaction is very important to network visualizations. Saraiya, North, and Duca (2006) found that participants felt the network displays generated by PathwayAssist (which uses a natural language processing algorithm) contained too much information. They concluded that having some mechanism of filtering data is very important for network visualizations (Saraiya et al., 2006). But that study dealt with bioinformatic visualization techniques, so the conclusions may not translate to the *Madison Commons* case.

However, Gove, Dunne, Shneiderman, Klavans, and Dorr (2011) studied network visualizations of literature networks, which is extraordinarily similar to the goal of visualizing *Madison Commons* articles. In creating their Action Science Explorer (ASE) tool, they also found filtering to be very important. Users found ‘attribute ranking’ a particularly useful method of filtering (Gove et al., 2011). Although the method of attribute ranking ASE employs is based on scholarly citations and therefore cannot be applied to the *Madison Commons* data, a similar ranking mechanism can easily be constructed for *Madison Commons*. Again, articles could be ranked based on content and location tags. They could also be ranked by date of publication and/or popularity.

Altering attribute weightings would simultaneously serve the purposes of interaction and filtering. Obviously, choosing how to weight attributes involves interaction, but it also fulfills the important function of filtering out articles the user is not interested in. As noted above, filtering is especially important to network visualizations. It also fits with the common visualization ‘drill-down’ structure. Segel and Heer (2010) noted that the drill-down structure embodies a more reader-driven approach, which suits my goal of user engagement.

Ultimately, the *Madison Commons* visualization serves as a tool to direct users to read specific articles, so the visualization needs to embody a drill-down structure. Users need to be able to use the network structure to find articles of interest (and filter out irrelevant articles), and then drill-down to reading individual articles. This points to the importance of details-on-demand. Gove et al. (2011) also found that details on demand were an important feature of their literature network visualizations. For the *Madison Commons* data, this is another area of interaction. Users should be able to hover over or select an article node and receive more information about it. Because many articles will need to be displayed, each node should probably only contain the article name. But users should be able to get other details (like tags, publication date, popularity, author, the lead paragraph) on demand. Ultimately, they will need to navigate to a separate page to read the entire article, but it is important to have some details available on demand within the visualization.

Altering attribute rankings and details on demand are two forms of interaction to be incorporated. The final form of interaction I would like to incorporate into the *Madison Commons* visualization is node manipulation. Saraiya et al. (2005b) found that users of network visualization tools wanted to be able to create their own links among nodes. Endert, Fiaux, and North (2012) developed a mechanism called ‘semantic interaction’ to address this concern. Semantic interaction builds on the advantages of ‘foraging tools’ and ‘synthesis tools’ to better augment cognitive processes through visualization. Foraging tools are statistical models that transform complex data into a two-dimensional view (Endert et al., 2012). The user interacts with a foraging tool through manipulating the parameters of the model (Endert et al., 2012). Synthesis tools allow users to organize their thoughts spatially, by creating structures like clusters, timelines, and stories (Endert et al., 2012). The use of external spatial displays provides cognitive benefits by allowing users to offload information, essentially using the spatial displays as external memory for organizing thoughts (Endert et al., 2012). Semantic interaction refers to a combination of foraging tools and synthesis tools. In semantic interaction, users interact spatially with a visualization to alter the parameters of an underlying statistical model, and the entire visualization changes to mirror the new parameters (Endert et al., 2012).

Applied to the *Madison Commons* visualization, semantic interaction would mean that users could move articles that they like close to one another, and the visualization would re-sort the display based on the commonalities of those articles. This is effectively a more sophisticated form of attribute ranking. Using a menu to filter based on the education content tag, Near East location tag, and highest popularity is an example of foraging. An example of semantic interaction would consist of dragging two articles you like next to one another, and then having the visualization re-sort the network based on those articles sharing education and Near East tags and both being popular. (Ideally, the re-sorting would be animated to emphasize the changes and prevent change blindness.) The advantage of semantic interaction is that it maintains consistency throughout the learning process, aiding in comprehension: “Semantic interaction creates a more seamless transition between foraging and synthesis, unifying the sensemaking loop” (Endert et al., 2012, p. 9).

**Future Directions**

Obviously, integrating semantic interaction into the *Madison Commons* visualization would be a sophisticated undertaking, representing more of an ideal type than a realistic goal. What I have outlined above are simply principles to guide the creation of a *Madison Commons* visualization. The degree to which each principle is followed will of course be tempered by technical constraints.

In general, though, the emphasis should be on creating a design that aims for engagement and insight over clarity. At times, these differing approaches may conflict. Dwyer et al. (2009), for example, found that users preferred clusters consisting of five to seven nodes, even if those clusters did not precisely mirror connectivity. As Kostelnick (2008) and Hullman et al. (2011) noted, aesthetic embellishments and visual difficulties can facilitate engagement and comprehension even as they undermine clarity. But most scholars note that there is always a balance to be found. More complex visualizations can be engaging because they are challenging; but as noted above, filtering mechanisms are important to prevent information-overload. And while I think interaction should be an important component of the *Madison Commons* visualization (in order to stimulate engagement), Hullman et al. (2011) also cautioned that too much personalization can be detrimental to insight generation. If users can alter the parameters too much, the interaction ceases to stimulate active processing of the information being displayed (Hullman et al., 2011).

So, of course, the final goal is to emphasize engagement, insight, and interaction, but not to lose sight of the advantages of clarity and efficiency. I am confident that a network visualization can be applied to the set of *Madison Commons* articles. I have outlined some guiding principles above, but what will ultimately be most effective will require an iterative process involving the *Madison Commons* audience.

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