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The Concept Plot: a concept mapping visualization tool for asynchronous web-based brainstorming sessions

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Abstract
Electronic brainstorming systems have been shown to lead to more ideas, yet unsupported face-to-face brainstorming is still widely preferred. This paper proposes a graphical user interface for a web-based system for design problem-solving or other intellective tasks involving convergent and divergent thinking. Referring to the literature on group support systems and information and knowledge visualization, the study extends features of concept mapping and synthesizes these into a prototype called the Concept Plot (CP). Based on an advertising design task, the paper shows how the CP can be collaboratively constructed in two directions, as text and pictures are uploaded onto nodes, and these nodes scaled up or down as users click to evaluate ideas. The expectation is that this integrated visualization would diminish information overload, while enhancing the social dynamics of the process. Also presented is the pilot deployment of a Flash prototype. The results were inconclusive, yet promising that a study with more participants might demonstrate the functional and affective benefits of the CP.
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Introduction

In 2005, Nike Corporation ran an interactive billboard on the Reuters panel at Times Square in New York City.[1] Passersby could dial-in a number from their mobile phones and customize a Nike shoe, visualized on the spot for all to see. Consider also Swarmsketch.com, a web-based canvas for distributed, asynchronous drawing. Every week a word becomes the sketch subject, and each site visitor contributes several lines. He or she then votes on the opacity of lines by others, so the resulting darkness value of each line is the average of all its previous votes. These systems for collective visualization are apt examples of what the literature on design support systems has already recommended: hands-on generation and spatial positioning of representations, and appropriation of a design task so that users make the activity their own.[2,3] The objective of this study is to propose a similar approach for group support systems GSS, which have been plagued with low adoption levels. Drawing on information and knowledge visualization, we claim that collaborative systems for problem-solving and ideation tasks can be made more engaging by an extended format of digital concept mapping tools, hereby termed the Concept Plot (CP). The expectation is that this integrated visualization would diminish information overload, while enhancing the social dynamics of the process.

During ideation, a team compares, rearranges, combines, reduces, and evaluates concepts.[4] Examples of such ill-structured problems abound in

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knowledge-based organizations like management consultancies, product design firms, and advertising agencies. Electronic brainstorming systems (EBSs) for intellective tasks involving divergent and convergent thinking have been shown to lead to more ideas, yet unsupported face-to-face brainstorming is still widely preferred.[5] Such ideation processes – also known as vertical and lateral thinking[6] or knowledge expansion and knowledge restriction[7] – are especially common in the field of advertising, which is the focus of this paper. We begin by reviewing GSSs and EBSs, then situate our approach relative to existing work on concept mapping in information and knowledge visualization. We then present the proposed extensions of digital concept mapping, a CP mock-up based on a famous advertisement, and a pilot deployment of our initial Flash-based prototype. The last section concludes with a discussion and next steps.

Background

Group support and electronic brainstorming systems

GSSs are a type of collaborative software tool that goes beyond communication and coordination, to assist joint efforts for creating solutions and making decisions. GSSs for knowledge-based organizations are often called EBSs, and involve a process of idea generation, consolidation, and voting. Systems typically rotate individual contributions around co-located workstations, where each participant expands on a solution with details, argues the solution, or generates a completely new solution.[8,9]

One key dimension of GSSs is its accessibility, in terms of physical availability of the system as well as ease of use. Most GSSs can be found in physical 'decision room' settings, require a facilitator, and are deployed only at especially arranged meetings.[8] Web-based systems such as Basecamp (http://www.basecamphq.com) are a more accessible alternative, providing anytime-anyplace access. Research on such *asynchronous* EBSs, however, is sparse.[10] This is surprising, considering today's distributed global enterprises, and even findings that users produce more ideas when working undisturbed by others.[11] One exception is de Vreede *et al.*[9] who studied asynchronous EBS and found that sessions specifically structured for elaboration on previous teams' contributions were more effective than those where each team started from scratch and then all ideas bundled at the end.[9] Indeed most users seem to perform better with some form of structure, and in fact *freestyle* concept mapping, while not researched in terms of EBS, has led to poorer collaborative learning outcomes compared to a more structured form.[12]

So far we have reviewed functional aspects of EBS. But Dennis and Reinicke argue for the need to explore EBSs in terms of a wider ecosystem, in order to understand their low adoption levels, and general preference for unsupported, face-to-face brainstorming.[13] The latter, for instance, are known to serve as 'status auctions' in design problem-solving firms such as IDEO, where employees showcase their talents. Even in more conservative corporations, EBSs leave participants emotionally unfulfilled, for lack of an affective reward, like the social experience of winning over physically co-present colleagues.[14] These more recent findings seem at odds with one of the obvious advantages of GSSs – that of anonymity. But having the system mark ideas with the names of their contributors has not been a solution, either. According to Chen *et al.*[15]:

> [The ideas are] presented in a large multi-page document in which individual contributions can be lost in a sea of information…. Trying to scan hundreds of lines, 30 lines a time, is not conducive to rapidly synthesizing key thoughts (p. 75).

Indeed subjects engaged in problem-solving routinely overlook as much as 80% of the potential solution space.[10] While information overload in EBS has already been discussed,[16] the visualization aspect is rarely even mentioned. A notable exception is Chen *et al.*, who developed a visualization for *GroupSystems* software, clustering generated ideas using a Kohonen Map algorithm and greatly enhancing visibility of patterns. But this tool supports *post-hoc* analysis of collocated sessions, and to our knowledge, the *Ideaquarium* referred to in the next section is the only EBS visualization tool designed for run-time. This lack of research on the Graphical User Interface (GUI) aspect of EBS, and over-reliance on text, persists 10 years after Shepherd *et al.*[17] found that a simple GUI feature for social comparison – a horizontal line showing to users how they compared to others – increased productivity by 23%.

Concept mapping in information and knowledge visualization

Concept Maps (CMs) comprise a synergy between information visualization (IV) and knowledge visualization (KV). IV, defined as the use of computer-supported, interactive, visual representations to amplify cognition, is typically about access and presentation of large data sets.[18] KV, on the other hand, aims to improve the creation of knowledge among people, by giving them richer means of expressing what they know.[19] A CM is defined as a spatial array representing elements of knowledge by means of nodes and directionally labeled links. The nodes represent concepts and beliefs; links show relations between nodes; and together, nodes and links define propositions.[20] A CM is 'a graphical tool that enables anybody to express their knowledge in a form that is easily understood by others' (Cañas *et al.* [21], p. 207). But Dansereau[22] makes the distinction between IV and KV concept mapping, or *information mapping* and *knowledge mapping*. In the former, the content is presented to the learner or user, and in the latter the user generates the content. One hybrid form is *guide-mapping*, where the structure of the map and a few 'seed' nodes are provided by an expert, while subsequent content is inserted by users, and the map is grown like a crystal formation. This is the format adopted in this study, but the resulting

node-link map can still become an 'undifferentiated web that may need re-structuring' (Dansereau[22], p. 72).

Collaborative restructuring of the CM, for example, is demonstrated in the *Knowledge Explorer*, an interactive desktop visualization of a document repository. Each user constructs their own CM by his or her own exploration, which also automatically contributes to the creation of a network map that all users share.[23] In ideation, however, we are concerned with *content* knowledge, or the 'individual's declarative domain knowledge relevant for coping with a particular task' (Tergan[20], p. 189). This is best seen in *argument mapping*.[24] Argumentation, or the collective deliberation of a controversial standpoint, can easily be represented by node-link map structures, such as Toulmin's data-warrant-claim model.[25] *ClaiMaker,* for instance, is an application for visualizing scholarly discourse, where two concepts are connected by a link with the properties of type, polarity, weight, creator, timestamp and direction.[24] Electronic deliberation via collaboratively built NLM structures has also been proposed by Turoff *et al.*,[26] where nodes and links have attributes such as the degree of agreement on meaning about the concept or relationship. The authors' conceptual model is based on the metaphor of a room and a wall, and until a voting threshold is obtained, new options and arguments lie on the ground.

A similar metaphor for visual assessment is also used in the *Ideaquarium,* a tool for the generation and selection of ideas in an advertising agency.[27] Employees enter their own ideas, and rate those of others inside an aquarium tank by using different images of fish, which rise to the surface as they get more votes. While *Ideaquarium* does not make use of a CM, it is a good example of using spatial positioning *and* graphical representations for visual assessment. Several case studies show how visual metaphors can create a shared context among employees and bridge differing points of view.[19,28,29] But to our knowledge, the only digital application that makes use of CMs with spatial positioning *and* imagery, is the argument mapping tool *VisualExplorer*.[30] While it may be the best example of CMs in GSSs, a limitation with *Visual Explorer* (as with most argument mapping tools) is the reliance on a co-located setting with a facilitator, rather than the anytime-anywhere access mentioned earlier. Finally, specifically to advertising, CMs have been used in Reesink's conceptual brand mapping application.[31] But as with Chen *et al.*'s visualization mentioned earlier, these are *post-hoc* analysis tools, rather than systems to support ideation during run-time.

The Concept plot

Three extensions to concept mapping

Based on the gaps outlined so far, the following section presents the CP. While we expect this form of information and knowledge visualization to enhance idea generation, organization and prioritization, our major expectation is that the CP's interactive graphic format will infuse an element of play and high visibility, promoting appropriation of a design task so that users make the activity their own.[2,3] The following are design guidelines for CP's graphical user interface, or extensions of concept mapping as illustrated in Figure 1.

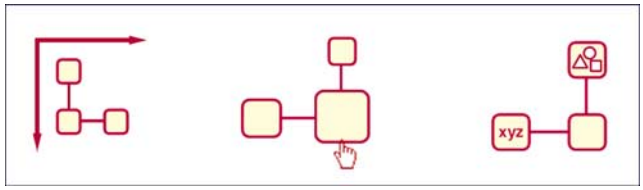

Figure 1 Extensions to concept mapping.

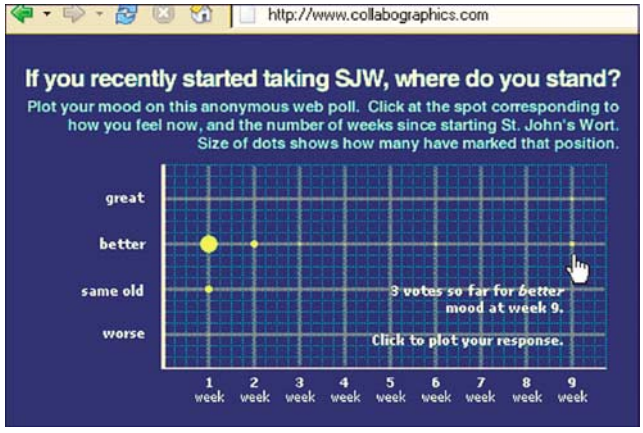

Figure 2 Node scaling in a graphic webpoll.

Number one is a *matrix structure* supporting knowledge construction via divergent and convergent (also known as lateral and vertical) thought processes. This aspect should become clearer in the next section. The key feature of the CP, however, is the *graphical assessment* of ideas via multiuser rescaling of node size through clicks. We have already explored, and successfully pilot-tested, such collaborative voting-visualization for a non-concept map tool called the plot-poll,[32] shown in Figure 2.

In the CP, the 2D spatial positioning of objects can be *unitary* (size of object) and *local-relational* (above, below).[3] The canvas may be diagrammatic in a conceptual way, such as a chessboard [33], or a form of grid. The Kohonen algorithm EBS visualization mentioned earlier maps objects as nodes on a two-dimensional grid, and of course another exemplary spatial visualization is the well-known *Map of the Market* (www.smartmoney.com/marketmap). The CP relies on such structural integration. As the map is grown larger, a birds-eye view is expected to give a sense of context, and easy detection of the most successful idea, and where it came from.

Finally, we propose *pictorial representation*, or externalizing knowledge through text and images. JPGs and GIFs found online can be uploaded onto nodes in seconds. Internet image browsing is in fact an indispensable tool for idea generation in advertising,[7] a topic discussed next.

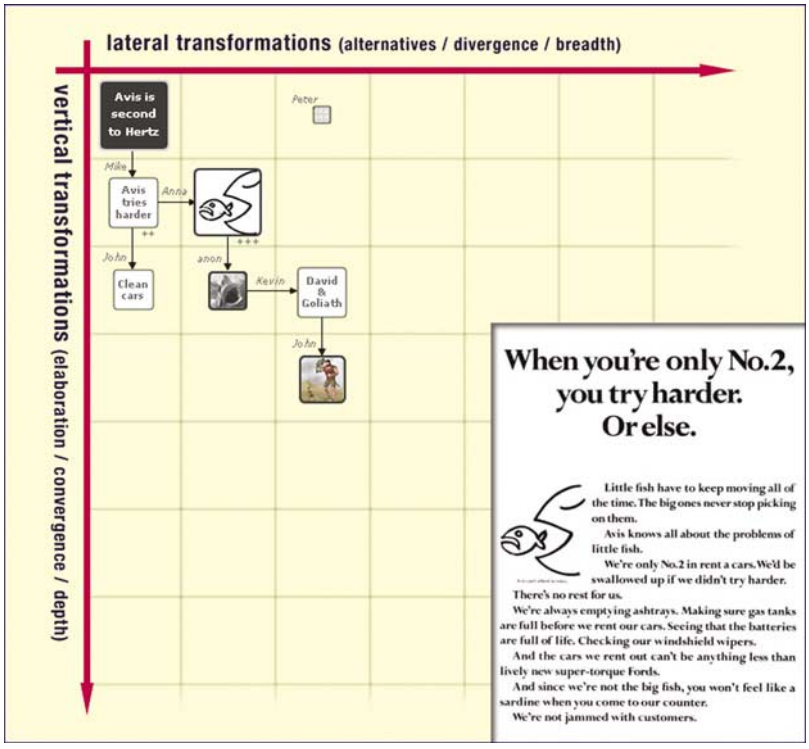

Figure 3 Concept Plot mock-up based on 1963 ad for Avis rental (bottom right).

Concept plot mock-up based on a classic ad

Divergent and convergent thought processes characterizing ideation were already mentioned. In advertising, designers and writers use divergent thinking to sketch fresh ways to present a message. But the essence of that message is distilled or refined via convergent thinking by account planners who write the creative brief.[34] Convergence and divergence are similar to the notion of lateral and vertical transformations. In sketching, a lateral transformation 'modifies a drawing into another related, but distinctly different, drawing', while a vertical transformation 'reinforces an existing drawing through explication and detailing'.[35] Such an ideation process can be hypothetically modeled, or reverse engineered, by looking at one of the most successful campaigns in advertising history.[36] A problem the DDB advertising agency tried to solve was how to capitalize on Avis' weaker position to competitor Hertz. As shown in Figure 3 (bottom-right), the ad's headline – elaborated by a 'prey-predator' visual metaphor – invites the appreciation that Avis had better try harder and keep its gas tanks fuller (etc.), or else fall prey to the 'big fish'.

This concept can be deconstructed by imagining the ideation process that created it, using the concept map structure in Figure 3 (left). Each node is connected to a previous node by selecting from, say, the following link labels: *Elaboration, Alternative, Criticism*, and *Support*. Links also include author's name or are just labeled as anonymous. Each user can vote on each node (except their own) by scaling it up or down. This could be done, for instance, via four buttons: a 'thumbs-up' icon, scaling up the node 20%; a bigger thumbs-up icon, scaling the node 50%; and the same but negative percentage for downscaling. Any image on users' desktops with JPG, GIF, or PNG extensions can be uploaded, not unlike inserting a picture in Microsoft Word. In the example shown, we have started with a strategy 'seed' node, then plotted new ideas sideways (laterally, for divergent thinking), while plotting elaborations downward (vertical, convergent thinking). The fish sketch, for instance, stems from the 'Avis tries harder' concept, but conveys this in a completely new (creative) way. We assume this has turned into the largest node – even though the less popular 'David and Goliath' alternative in text form is followed by a depictive *elaboration*.

Flash prototype pilot test and results

A web-based Flash prototype was developed to test the visual assessment and pictorial representation features of the CP. The matrix structure for lateral and vertical construction was not implemented in this prototype, since it would be the most complex notion to explain to users. Seven graduate students were recruited via e-mail to brainstorm on an advertising concept for the School they attended, part of a major Canadian

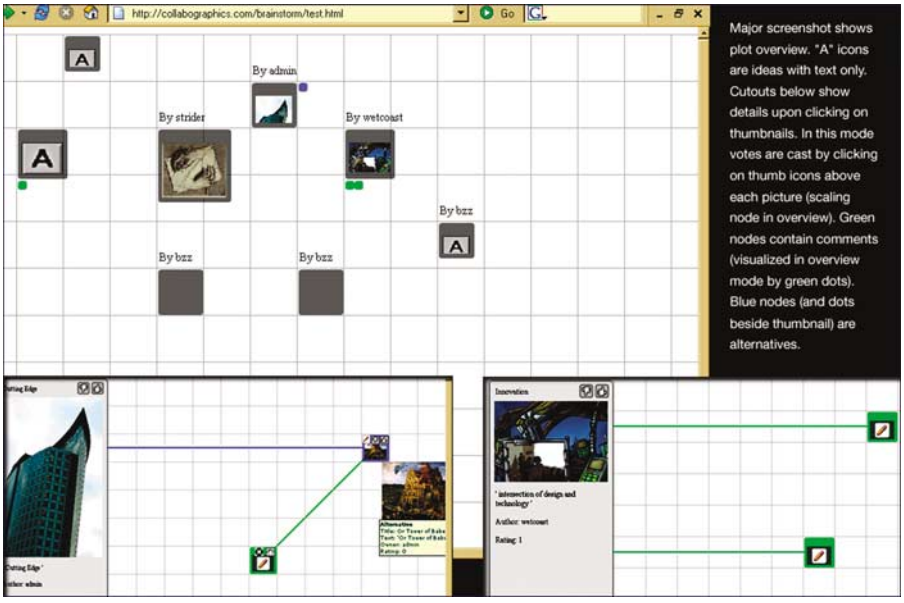

Figure 4 Screenshots from the Concept Plot pilot test.

University. A link in the e-mail led users to the CP tool, which can currently be seen and tried out at collabographics.com/brainstorm/test.html.

While the brainstorming session did generate good ideas, the task outcome overall was somewhat below expectations. Participation was sporadic, and no group dynamics could be observed. On the plus side, most users did manage to upload content, without prior tutorial. To explore satisfaction with the task outcome, a web-based qualitative survey was administered. While users said they definitely preferred this format to text-only brainstorming, they did not necessarily prefer it to face-to-face brainstorming. Some users also reported delays in image uploading. Overall, the results of this pilot evaluation indicate that more effort should be put into securing adequate and consistent participation. In our case an additional problem might have been the exam period students were going through at the time of evaluation. The screenshot in Figure 4 shows the prototype and some of the generated content during the 3-hour distributed session.

Conclusion and next steps

Despite the lack of data to back up the CP design at this time, we believe it offers obvious advantages. Its bi-directional matrix structure can be applied in ideation processes not only representing divergence and convergence, but any sort of duality. Duality is ubiquitous, and even inherent in McGrath's widely accepted taxonomy of group tasks (negotiate *vs* generate, choose *vs* execute, etc.).[37] Another advantage is the precise spatial (re)positioning and scaling of nodes. This is partially demonstrated by another Flash demo at http://www.sfu.ca/~aivanov/demo.htm, which utilizes only 10 lines of ActionScript code. A few disadvantages with the CP format also come to mind, however. While we are confident users would have no problems with the visual assessment feature, not all may be savvy with image search and uploading, and even less so with the notion of bi-directional construction. Other problems might arise from cognitive and social perspectives. The overuse of node and link characteristics to express information may lead to display processing problems, since short-term memory has such finite capacity. As well, a display with exceptionally large nodes on the one hand, yet imperceptibly small 'fringe' opinions on the other, may worsen confirmation bias, or 'groupthink'.

Our development of concept plotting is currently in its early stages. We plan to develop the prototype to include all the proposed features, and then conduct a more rigorous experiment at a multinational advertising agency. Ideally, both a field study and a controlled experiment with multiple conditions should be conducted. A control group consisting of a text-only EBS would seem appropriate, but a challenge would be how to account for the effects of the various design antecedents in a 'fully-loaded' CP condition. Measures would include number of unique ideas, post-test idea recall, coefficients of elaboration on previous ideas, ratio of pictures to text, node size patterns, as well as surveys with instruments for Affective Reward that have recently been developed for EBS.[14,38]

To conclude, this interdisciplinary study aimed to contribute to research on concept mapping, information visualization, and group support systems. Specifically, the paper presented guidelines for the design of a web-based electronic brainstorming system for asynchronous, distributed collaborative ideation tasks. After the brief review of EBS and information and knowledge visualization, we

proposed three digital concept mapping extensions that could improve the user experience in ideation sessions. Synthesized into a format called the CP, these extensions call for plotting content nodes in two directions, allowing text as well as pictures to be uploaded onto nodes, and perhaps most importantly – for nodes to be scaled up or down as users click to cast their assessment. These features are expected to improve visualization, as well as infuse an element of social dynamics. Also presented was a pilot evaluation of this Flash prototype. While it did not lead to any conclusions, a better organized experiment might demonstrate the functional and affective benefits we expect from the CP.

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