Using the Power of Associations: BrainDump - A Revised Nature Inspired Visual Interface for Sensemaking

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ABSTRACT

Creative work – especially in business – is often connected to highly complex data. While current software tools support manifold areas in working with complex data, they are very limited to support creative work. Little research has been done on what kinds of representations are supporting the externalization of mental efforts while making sense of new information. It is especially very challenging to provide appropriate representations for abstract associations.

In this paper a new interactive visualization in form of a revised prototype based on a user test of a previous version [2], [3] is proposed. Knowledge workers are enabled to use a highly flexible visual map to represent and refine their current understanding of a task. Derived from experiments with natural physical substances a metaphor based on fluids, cell structure and soap bubbles is used. This kind of visualization allows the user to pin down associations and to clarify anticipations about relations visually.

Categories and Subject Descriptors

H.5.2. [**Information interfaces and presentation**]: User Interfaces – Graphical user interfaces (GUI)

General Terms

Algorithms, Management, Documentation, Design, Experimentation, Human Factors.

Keywords

Visual Sensemaking, Knowledge Creation, Abstract Knowledge Representation, Interactive Visualization, Fluid Interaction.

1. INTRODUCTION

While making sense of complex information a knowledge worker faces a continuous change between analysis and synthesis. This interdependency has been described as reflection-in-action [p. 21, 10]. Neither structure nor amount of data needed during this process is known in advance. Users will build an incrementally better understanding of the field of work through dealing with the given task itself. They get aspects of structure either bottom up inducing from facts they find, or top down deducing from their previous knowledge [15].

Such a given task is incrementally structured and is subject to highly dynamic change. While current software tools support manifold areas in working with complex data, they are very limited to support creative and unpredictable work [9].

Furnas and Russel [6] define sensemaking tasks as kinds of tasks involving a process of collecting and organizing data to create sense. Thereby knowledge workers often use a fairly simple structure to help solving a given problem. The authors found out that the process is sometimes ill-defined, iterative and complex. Information retrieval, organization and task re-definition are all interacting in sometimes subtle ways. Another important finding of the authors is lowering the cost of basic operations which was often overlooked in current sensemaking systems. To sum up Furnas and Russel observed three stages in the process of sensemaking: learning concepts and facts, finding relationships and forming categories as well as high-level connections. The same basic characteristics apply for complex information gathering tasks using web information. We propose a software tool named BrainDump to help knowledge workers making sense of complex web information. Based on a previous prototype [3] and a respective user test [2], we propose a revised version of BrainDump in this paper. Next to some user interface adaptations to support orientation the main contribution of this paper is a new nature inspired visualization derived from experiments with natural substances.

This paper consists of three main parts: the first part presents related work, the second part explains the previous prototype and the third part explains the design decisions, the interface and visualization of the revised system.

2. RELATED WORK

In this section related approaches inspiring this work regarding visualization are presented as well as our previous investigations. Bubble Clusters [14] is a visualization for manipulating spatial aggregations of objects. The natural expectation of users concerning the behavior of bubbles is leveraged using a spatially efficient bubble shape drawn around objects. Another approach for showing relations among objects is Bubble Sets [5]. Implicit surfaces are used to create a polymorph hull around objects for defining groups as overlay for existing visualizations. The visualization on a futuristic desk called Mind'Space [11] was developed for different views on the same data. The first is a structured view like the tree of directories in operating systems, the second one is an unstructured view using blobs for creating

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relationships. Inspired by these approaches our work aims for a natural organic look and feel to be used for ad-hoc relationships.

As mentioned above, this paper builds on a previous version of a visual information gathering prototype [3]. The main functions of this system are described in this section in order to create a basic understanding of the starting point. The interface appears at the right side of the screen like an extended taskbar (see Figure 1, left). It displays links referring to topics existing in the user's collection. The user can drag and drop parts (pictures, pieces of text, and URLs) on these links, from any document in the browser. While hovering over the links they are magnified (see Figure 1, right). Now the user is able to freely place and relate the respective item, as well to use the item as bookmark to get back to the original web page.

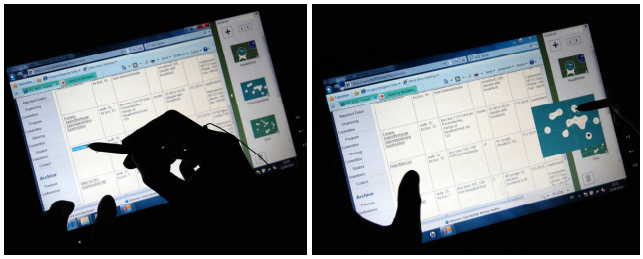

Figure 1: The first prototype [2]: A dropping area on the right side of the browser. Left: Marking a piece of text on a webpage. Right: Dragging the piece of text into the system.

In full screen mode (see Figure 2) collected items (white circles) and created topics (colored circles) can be managed by the user. Furthermore links referring to topics at the right side can be administrated.

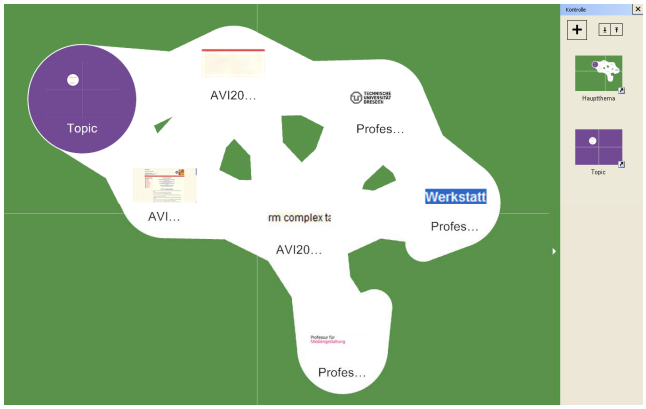

Figure 2: Full screen mode to manage items and topics

In this system topics and collected items can be grouped hierarchically using a zoomable user interface [1]. Items as well as topics can be placed in other topics. To zoom in on a topic the user simply double taps the desired topic - this results in an animated transition to bring up the topic in full screen.

3. THE REVISED INTERFACE CONCEPT

A new visualization concept and design decisions derived from the test results of the previous prototype are explained in this section.

3.1 Nature Inspired Visualization

A nature inspired metaphor is proposed for enabling the user to establish informal relationships with the aim of creating a fluid and changeable impression of it. The goal is to support finding relationships as well as forming categories and high-level connections.

While testing the first prototype it became obvious, that test users where confused by artifacts occurring between clusters of objects (see Figure 2). To find hints for a more natural and expected behavior of the visualization an experimental setup [4] was explored deeper. Participants used substances of their daily life, like eggs (Figure 3) and soap bubbles (see Figure 4), to perform basic operations.

Figure 3: experiments with eggs (left) and a respective digital prototype (right)

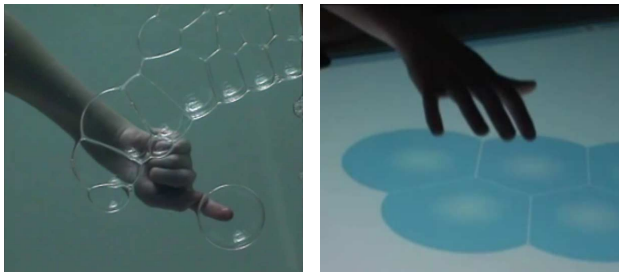

Figure 4: experiments with soap bubbles (left) and a digital prototype (right)

Observing the visual appearance and behavior of these substances in reaction to the users' interactions, digital multi-touch prototypes where developed through algorithmic reduction. Reflecting upon this process, it becomes obvious that physical behavior has to be substituted by graphical representations and animation. Through this substitution, the user is enabled to adopt learned affordances from his or her everyday life experiences.

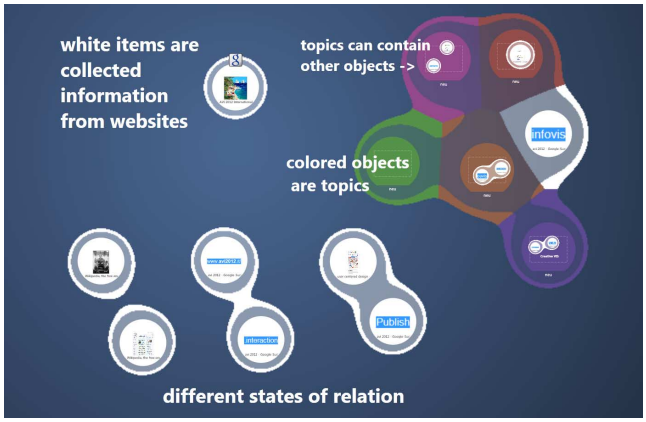

Figure 5: The new nature inspired visualization is combining insights from experiments with eggs and soap bubbles.

Combining these results of the experiments, a new visualization based on Voronoi diagrams and implicit surfaces is created (see Figure 5). Like in the previous prototype, white elements are

collected or created items and colored objects are topics functioning as containers for items and other topics. Thus a hierarchy can be built by dragging one topic into another one. Furthermore annotations can be made freely.

The content is displayed in the core of the objects inspired by the appearance of eggs, surrounded by a nearly free formable area. If objects are moved next to each other they automatically connect and visually combine. Objects of different colors preserve their color, thus creating a soap bubble like visual effect. For an organic look and feel the outline comes with a variable thickness. Due to the real-time response of the visual system and the organic appearance initial test users reported, that they liked the fluid feel and the possibility to play around with the items while making a decision where to place it. Research by Kirsh and Maglio [7] indicates that certain cognitive problems are solved quicker, easier and more reliable by performing actions in the respective context than by performing computational actions only in the head. They presented data based on Tetris, a real-time interactive video game. Players were more effective when randomly rotating and translating pieces instead of developing a strategy for the fewest rotations. Kirsh and Maglio define these actions as epistemic actions [7]. They state "physical actions that make mental computation easier, faster, or more reliable-are external actions that an agent performs to change his or her own computational state. (...) Simplifying mental computation-such actions once again appear to be a cost-effective allocation of the agent's time and effort." [7, page 513]

3.2 Design Decisions for the Interface

The following design decisions are mostly based on insights from the user test results of the previous BrainDump prototype [2]. Nine participants were given a scenario of planning an exhibition trip. This included finding out where and when desired events are going to take place, what costs have to be considered and which hotels should be chosen. Additionally, constraints like restricted budget and time were given for the trip. Despite studying the acceptance of the visualization, possible usability issues, navigation and orientation were observed through recordings of sessions including comments and reactions as well as letting the users think aloud. After the test a questionnaire with 75 questions about subjective feelings was filled out by the participants. In this section their feedback is described in association with new design decisions.

Test participants mentioned that they want to select multiple items and perform operations on them simultaneously. Thus the prototype is optimized for using a tablet-PC with pen and multi-touch input, whereas the first prototype was a single touch or mouse optimized version. For a more efficient use of the limited screen space on a tablet-PC, items from programs or the file system can be dragged into the system by using an expandable portal window of the proposed system (see Figure 6, grey window). While working with the browser, the user is enabled to drag any part of a webpage over it and to subsequently drop the desired object into the portal window (see Figure 6). Thus he can continue to browse and follow his task at hand without the need of switching out of his current application. The portal window moves in as soon as the user hits the edge of it and snaps back as soon as the collection process is finished. To view the system in full screen the user can double tap the portal window.

The user test also showed that the display of the current state of the system as well as possible actions which can be performed were not sufficient. In many systems modes accessed via keyboard or menu-items are used to distinguish actions. Since multi-touch tablet-PCs enable interaction with multiple fingers, both hands may be used for interaction (see Figure 7). The figure shows how the thumb of the device fixing hand can operate on a small area - here a menu. In contrast, the other hand can act freely on the surface, but may also be used to hold the device. This kind of task sharing is comparable to the familiar behavior of the dominant and non-dominant hand as described by Owen et al. [10].

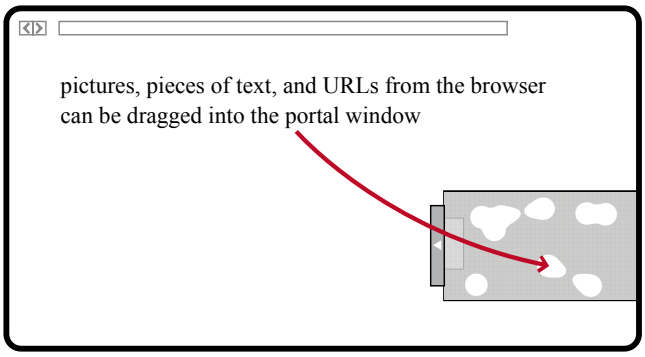

Figure 6: Collecting data into the system

In this way quasimodes [12] can be used efficiently with bimanual interaction. These kinds of modes are only kept active through a constant action of the user, in this case by holding a respective virtual menu button with the thumb of the non-dominant hand (see Figure 7, left).

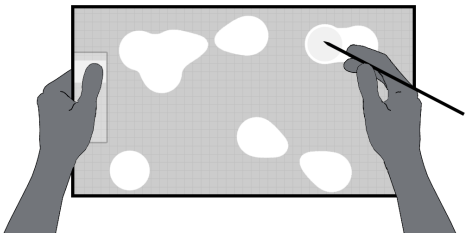

Figure 7: Example of interaction with a tablet-PC. Non-dominant hand (left); dominant hand (right)

As soon as the user lifts the thumb the mode is deactivated. Another possibility for single-touch or one handed interaction is activation through a single tap on a mode with the finger or pen. For deactivation the same interaction is required.

The results of the user test further showed, that sometimes users are getting lost in the space of a topic. To address this problem a radial color gradient is included in every topic (see Figure 8 Background). When the user zooms in and pans the view away from the center of the workspace the background color gets darker. Because of the radial color gradient the user can always see in which direction he has to pan in order to get back to the brighter center of the topic. In Figure 5 the gradient indicates that the center is in the direction of the bottom right corner. While using the first prototype some participants got lost in the depth of the hierarchy, because they anticipated the dropping area (see Figure 1) would have a hierarchical structure, which was not the case. Thus a hierarchical arrangement of small overview portals is introduced (see Figure 8, c). Topics are displayed within these portals. In order to cope with limited screen size only three portals are displayed at once. The two topics being directly above the current one (dark pink in Figure 8) in the hierarchy are displayed. Items can be moved or copied into any of the displayed topics in

the overview portals or onto the workspace. The view switches to the desired topic by double tapping a portal. A single tap on the background translates the current view to the respective point with an animated transition.

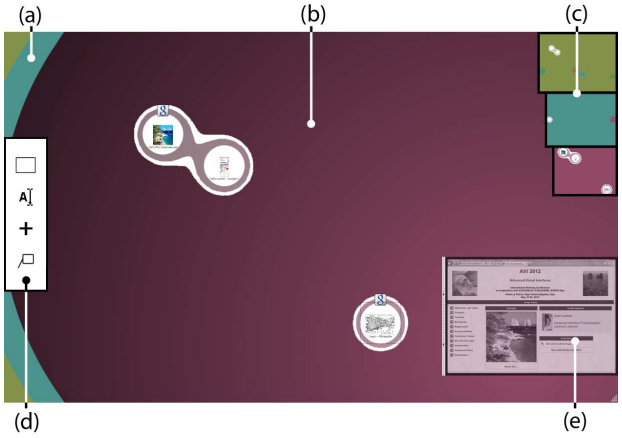

Figure 8: The revised BrainDump interface: backtracking rings (a), workspace with radial color gradient (b), overview portals (c), thumb menu (d) and browser (e)

König [8] found out, that a ZUI in combination with overviews enables a clearly more effective orientation. Thus the whole respective topic is shown in the overview portals. A red navigator rectangle indicates the position of the current view upon the topic. Additionally the backtracking rings (see Figure 8, a) can be used to jump back to a superordinate topic of the hierarchy, like in the previous prototype. An automated animated transition takes the user to the desired topic. By double tapping the portal window (see Figure 8, e) the user can get back to the browser or any other program he used before switching to BrainDump.

4. CONCLUSION AND FUTURE WORK

This paper presents a new nature inspired visualization to support the different stages in the process of sensemaking. According to Furnas and Russel [6] the cost of basic operations is often overlooked in sensemaking systems. With the presented approach information can be collected, related and organized with one single step of interaction. Thus a lowering of the cost of basic operations is likely to be achieved. This is accomplished by a visual approach to connect objects to unique shaped groups and the possibility to relate objects in different visual intensities. Manifold associations can be mapped through one simple and powerful metaphor. In this paper the example of using a browser and web information is used, but in the future this concept can be expanded to all kinds of applications and information, like: emails, documents, office applications and contacts for example - thus having a powerful tool for getting the big picture of disparate data.

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