

Redefining the Focus and Context of Focus+Context Visualizations

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Abstract

The increasing diversity of computers, especially among small mobile devices such as mobile phones and PDAs, raise new questions about information visualization techniques developed for the desktop computer. Using a series of examples ranging from applications for ordinary desktop displays to web-browsers and other applications for PDAs, we describe how a focus+context technique, Flip Zooming, is changed due to the situation it is used in. Based on these examples, we discuss how the use of “focus” and “context” in focus+context techniques change in order to fit new areas of use for information visualization.

Note: For a longer version of this paper, see CD-ROM Proceedings of IEEE Information Visualization 2000.

1. Introduction

Computers are soon being used in almost every kind of situation. However, there is still much work to be done on how to develop interaction design such as information visualizations that work in these new situations. The approach to modify computers and their software to the environment they are used in has been labeled “situated computing”. As the term situated computing may be given many interpretations, and the research community has yet to give an explicit definition of the term, we will stay with a rudimentary notion of situated technology as technology developed for a specific situation or setting with the aim to make it more transparent in relation to a task or situation.

As an illustration of the challenges and constraints posed by situated computing, we will present experiences on how the Flip Zooming visualization technique had to be adapted for various situations, including use on PDAs. The aim of this paper is to highlight some of the implicit presumptions of focus+context techniques we have identified while working with Flip Zooming. Even though these presumptions also can be found in other researchers' work, they have become obvious to us when using the technique in new areas of use.

2. Focus+Context visualization

The basic idea with focus+context visualizations is to enable users to have the object of primary interest presented in detail while at the same time having an overview or a context available. Following the early work of Furnas [9], Spence & Apperley [27] and others, a number of visualization strategies have been developed. The *Graphical Fisheye Views* [21] and the *Rubbersheet View* [22] display two-dimensional maps and images using graphical distor-

tions. The *Perspective Wall* [16] and the *Document Lens* [20] make use of perspectives to give a combined overview and detail presentation. The *Table Lens* [17] uses a spreadsheet-like presentation to visualize information. Techniques developed to visualize graphs and hierarchies include the *Continuous Zoom* [1], the *Hyperbolic Tree Browser* [14], and *Cone Trees* [19].

In some ways, the early work on focus+context visualization was “situated”. For instance, the Fisheye View [8] by Furnas used the structural properties of programming languages to support the many different levels a programmer has to work on simultaneously. Further, the BiFocal Display [25] by Spence and Apperley was designed to meet the needs of the “office professional” who has to deal with a number of different kinds of information more or less simultaneously.

2.1. Initial remarks

Work has been conducted on how to explicitly classify focus+context techniques using various analogies, including *space-scale diagrams* [10], *rubbersheets* [15], *non-linear magnification fields* [13], *multiple dimensions of transformation* [26], and *higher-order visualizations* [5], or by describing them as *interactive externalizations* [28]. However, if there exists a definition of focus+context techniques that researchers agree upon, it is implicit in the literature. This being said, the following description of focus+context techniques comes rather close to being such a definition:

“[focus+context] start from three premises: First, the user needs both overview (context) and detail information (focus) simultaneously. Second, information needed in the overview may be different from that needed in detail. Third, these two types of information can be combined within a single (dynamic) display, much as in human vision.” [7, p. 307]

Assuming that this is an accurate description of how researchers define focus+context, one can make some initial remarks on the premises of focus+context techniques. First, the users requirements are described as needs of information, and that there is a need to access information on at least two levels of detail simultaneously. There is also a more implicit premise that the information visualization will provide both of them. This can be contrasted with a situation where sources of information outside the computer provides contextual information to something displayed on the screen or when the computer supports the user with contextual information about something outside

the computer. By designing information visualizations that provide both levels of detail, one makes an implicit assumption that the computer will have the users, more or less, complete attention.

Second, the fact that the information needed in the overview and in detail may differ, does not only imply that the actual presentation may be different, but that the very kind of information may be different in the two cases. Finally, the notion that focus and contextual information can be combined within a single display does not imply that it is the best solution at all times.

Looking at the focus+context visualization techniques that have been developed, there seems to be some implicit requirements and limitations. Even though we do not think that any of these are due to the premises in the “definition” used above, they can be explained by using this definition as a basis. For the areas of use that these techniques have been developed, these limitations are often motivated, but in order for focus+context techniques to be applicable in other types of situations, it may be necessary to modify or abandon them. To do this, one must first explicitly state the limitations.

3. Applications

In the follow examples, we will show how the notion of focus+context changed as the Flip Zooming visualization technique was used in a number of different applications for a variety of tasks. Briefly, the Flip Zooming technique presents discrete and sequential information in a number of tiles. These tiles are presented in a left-to-right, top-to-bottom fashion that maintains the sequential structure of the information and allows the user to select one tile as the focus. This focus is placed in the center of the display area and is given more screen space.

3.1. The Zoom Browser

The first application to use the Flip Zooming technique was the Zoom Browser [11]. In this web browser, several web pages can be viewed simultaneously and each page is split into a suitable number of tiles linked together by a line (see figure 1). The Zoom Browser conforms to the basic notions of focus+context techniques. However, it offers the user the possibility to view the context information in three different ways: as thumbnails, as summaries, or as a mixture of both. Further, the user can choose not to have any focus, creating a view where all tiles are given equal amounts of screen space.

3.2. The Hierarchical Image Browser

One feature of Flip Zooming is that it allows for hierarchies of visualizations to be visualized as one visualization (c.f. [2]). In the Hierarchical Image Browser [12], the Flip Zooming technique was used to present images of paintings and sculptures according to style and place of origin (see figure 2) in a fashion similar to how an exhibition is ordered into rooms, sections, etc. The Hierarchical Image Browser has the basic functionality of focus+context techniques but allows the user to manipulate the appearance of both the focus and the context by manipulating inner visualizations. Further, since the context is divided into several levels by the use of a nested visualization, there is a clear distinction between different levels of context, ranging

from local to global. As the user can hide the context in each of the visualizations, the appearance of the context as a whole can be manipulated without changing the focus.

3.3. The Digital Variants viewer

The Digital Variants viewer [3] was developed to support literature research on variants of the same texts. Each text is shown in a Flip Zooming visualization by dividing the text into a number of tiles comparable to pages in a book. These presentations are then placed in an outer Flip Zooming visualization, creating a two-layered visualization. To support comparison of two of the inner visualizations, the outer visualization provide two foci placed together at the top of the display area. To ease the comparison of the two focus tiles of the inner visualization, the layout strategy of these inner visualizations also had to be modified (see figure 3). In addition to deviating from focus+context techniques in the same way as the Hierarchical Image Browser, the Digital Variants viewer provides two foci in the outer visualization and places the foci slightly separated from the contexts.

3.4. WEST

The WEST (WEB browser for Small Terminals) application [6] was designed for browsing web pages using PDAs. Similar to the Zoom Browser, web pages were divided into small parts that were shown in different tiles. The tiles were ordered hierarchically, in order to support efficient and structured navigation. However, the very limited screen display meant that only a few of the tiles could be shown simultaneously. To further aid navigation, each tile could present its information in three ways: thumbnail view, text summary view, or link view (see figure 4). WEST was a further step away from traditional focus+context techniques. It is a hierarchical visualization, but only shows the local context as only one level is presented at a time. Further, the user can adjust the view of both focus and context depending on how the application is used.

3.5. PowerView

The PowerView application [4] was developed to provide access to the most common information on PDAs, i.e. address entries, meetings, e-mail, and to-do lists. As PDAs often are used in public areas when the user is interacting with other people, the application was developed to be used in a supportive role for other activities. To provide the user with a relevant context once an individual piece of information had been retrieved, we introduced information links between items to enable the user to indicate a relationship between two pieces of information, regardless of information type (see figure 5). Thus, the information links form a semantic layer on top of the information structure that enables the application to customize what is shown in the context objects depending on what is in focus. Similar to WEST, it only provides local context in each view, but PowerView provides heterogeneous contexts where several different types of information are show together.

3.6. PowerCom

Based on PowerView, the PowerCom application was developed with the aim of exploring how functionality such

as telephony and *context awareness* [23] can be incorporated with an integrated presentation of information normally stored on PDAs. The main difference in the application compared to PowerView, is that PowerCom handles several context views simultaneously since several activities and events can be taking place at a time. By having these context views available, the user can easily switch between them without having to select the relevant entry and retrieve the information manually (see figure 6). The PowerCom application goes one step further in trying to match the focus and the context of the information visualization with the user's focus of attention and the user's context. As this focus can quickly change between different activities and any activity can require several types of information to perform, the application is designed to support rapid changes of focus, and to provide a unified presentation of several different kinds of information.

4. Discussion

When developing these applications, we have each time been forced to expand, reduce or modify the Flip Zooming technique. During these modifications, we have exposed a number of preconceptions about Focus+Context techniques in general. These preconceptions should not be seen as negative in themselves; in fact, in most cases they are probably the most sensible approach. However, in some new areas of use alternative methods or variations may be advantageous or even required for a technique to be feasible, and in these cases, the preconceptions may limit the usability of the technique.

4.1. Focus or foci?

A seemingly trivial observation of the name focus+context visualization is that focus is not in its plural form, foci. In most applications, this might be a natural limitation since users often only work with one object at a time. However, some activities require users to directly compare objects or switch between several different objects very rapidly. As long as techniques require explicit user input to change focus, there always exists a small interaction overhead cost, making it more difficult to switch between activities. One way to remove or mitigate this overhead is to allow several foci at the same time or to make it very easy to switch between different foci.

In its original form, Flip Zooming did not allow users to work with several foci in parallel. However, multiple foci were enabled in the Digital Variants Viewer in order to support the comparison of documents. In the PowerCom, multiple foci were also introduced but were not visualized together as they represented the different activities not being performed simultaneously. The RubberSheet view [22] exemplifies another variant of having multiple foci.

4.2. Focus vs. center of attention

Traditionally, focus+context techniques change focus when a user has selected a new point of interest, in the form of a particular position on the display or a distinguishable object. However, when the user is performing an activity or task involving other applications, or even people and objects outside the computer, the focus of the visualization does not match the center of the user's attention: while the focus selected by the user in the visualization still is a focus

in that it might be close to describing the user's interest, it is not the only focus that interaction designers have to acknowledge in order to create usable technology. In the case of traditional focus+context techniques, the difference between the focus of the visualization and the user's center of attention might not have been a great problem, since the PC is usually occupies it's users more or less complete attention. However, when designing for mobile users, or for any setting where the environment has to be acknowledged, understanding this distinction might be important.

When working with the PowerView and PowerCom applications, we tried to design with this distinction in mind. Some consequences of this line of reasoning was that several different information types should be presented together, and that every view in the applications should focus on helping the user with a simple task. Looking at related work, Spence and Apperley designed the BiFocal Display [27] as an information visualization technique dealing with a number of different kinds of information more or less simultaneously.

4.3. Differentiable context

When using a hierarchical visualization, the distinction between local and global context is almost trivial: some pieces of information are more closely related than others, depending on where in the hierarchy they are located. This can be used to create different presentations of context objects depending on how far from the focus they are located. This is, for instance, used in the Fisheye View [8] and in several graphical focus+context techniques based on distortion, where the distortion increases with the distance from the object in focus (c.f. [14]). However, the activity at hand might also require the user to be able to manipulate how the context is presented. We define a context as being a differentiable context if one can distinguish and manipulate different parts of the context independently.

Due to the modularity of hierarchical Flip Zooming visualizations, both the Hierarchical Image Browser and the Digital Variants Browser automatically support differentiable contexts. Looking at related work, Sarkar and Brown [21] use a function $G(x)$ to determine where context objects should be placed, giving two examples (based on Cartesian and polar geometric transformations). By introducing variants of these functions with parameters that the user can control, these techniques could be extended to allow the user to modify the presentation of the context in a fashion similar to that found in dynamic queries [24]. Giving the user some form of control over the degree of interest (DOI) function in [9,17] would also enable user-defined context presentations, but would be most beneficial if the context is easily differentiable.

4.4. Multiple views of context

Similar to the point made about focus, the word context is in singular form in focus+context visualizations. This is often intuitive, as the context of something is everything that is perceived to be near it. However, what is near it depends highly on the viewer's point-of-view. Changing the point-of-view may radically change the perception of the context (and the focus) without changing what is the focus of the visualization. Translated to focus+context visualizations, changing the point-of-view becomes the possibility to easily change the whole context, or the presentation of the focus and context, while maintaining the same focus.

The Zoom Browser and WEST used multiple ways of presenting the same focus and context in order to provide the user with several ways of accessing the information visualized. The PowerCom applications also used multiple context but for another reason. As it enables the user to rapidly switch between different activities, each represented by a selected object in the application, it is only natural that each of these has its own context.

4.5. Homogenous and heterogeneous contexts

Most information visualizations only visualize one type of information. The use of such a homogenous context makes it possible to use the inherent structure of the information in order to create a structured presentation. However, many times different types of information are related, e.g. an email from a person and the contact entry for that person. Presenting such information together as a context creates a heterogeneous context.

Both the PowerView and PowerCom application uses heterogeneous contexts. By doing this, they differ from most visualization techniques, which may show different types of information, but either merge all information into one presentation or treat all information as belonging to a more general type that incorporates all types present. With the PowerCom application, the use of audible information was introduced, creating a system where additional perceptual modes such as hearing, are added to what might constitute focus and context in an application. This expansion can be seen as a tentative step towards what Card, et al. [7, p. 7] calls information perceptualization.

5. Concluding remarks

Using a number of examples, we have illustrated how methods and principles from information visualization can be applied in novel settings and be made to fit constraints posed by situated computing. It has been our ambition to illustrate two issues that interaction designers will have to face when even more forms of computer use enters the agenda. First, to what extent existing techniques might be applied, and second, to learn more about the existing techniques by using them in new areas of use. As for the first ambition, we have described what modifications had to be made of the Flip Zooming technique for use in different situations. As for the second, we presented a number of pre-conceptions or premises of focus+context visualizations that may restrict the development of focus+context visualizations for novel use situations.

While the applications presented here differ from more traditional focus+context visualizations in some ways, we still think that they qualify as such. While the notion of "focus" and "context" has been given partly new interpretations, this has been in order to pursue the basic ideas of focus+context visualization. In other words, in order to realize the essential ideas of focus+context techniques in new situations of computer use, one must move beyond the traditional notions of focus+context techniques.

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7. References

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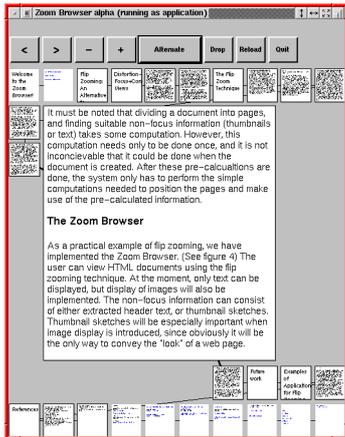


Figure 1. The Zoom Browser, providing a view of several different web pages divided into a number of tiles.



Figure 2. The Hierarchical Image Browser. Flip Zooming visualizations are shown within other Flip Zooming visualization, creating a hierarchy where every node has its own focus.

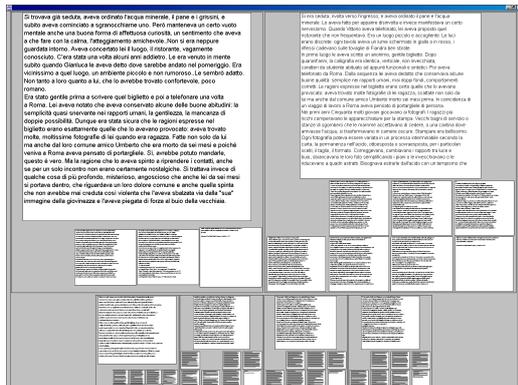


Figure 3. The Digital Variants Browser. The top level Flip Zooming visualization uses two foci in order to facilitate comparison between two different texts.

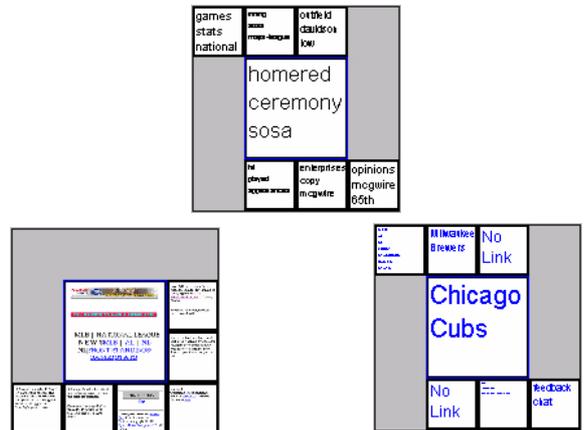


Figure 4. The Web browser of Small Terminals (WEST). All three views are shown in their actual resolution of 160*160 pixels. The views are, from left to right, the thumbnail view, the keyword view and the link view.



Figure 5. PowerView application showing a heterogeneous context.

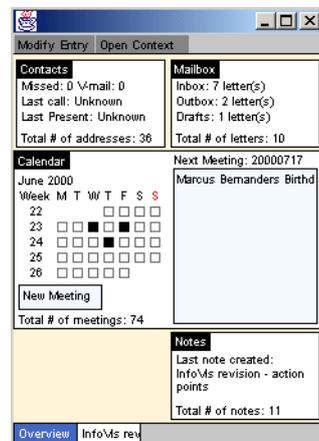


Figure 6. The initial view in the PowerCom application.