

# **A User Centered Approach for the Design and Evaluation of Interactive Information Visualization Tools**

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## **Introduction**

The proposed focus of this chapter is to discuss the design and evaluation of interactive Information Visualization (InfoVis) tools. The approach we take is based on our view of users' interaction within the context of InfoVis as an experience. As a result of this we propose a user centered approach to the design and evaluation of InfoVis tools, which is a common practice in HCI but not in the field of InfoVis. In this proposal, we briefly explain what interaction in the context of InfoVis means, followed by a brief overview of the user centered methodical approach we propose for designing and evaluating interactive visualization tools. The approach we generated resulted from our experiences of working with and designing an academic literature visualization tool. From these experiences, we conclude that understanding the users' subjective experiences within the domain of interest should be considered the primary step in the design and evaluation process of interactive InfoVis tools. Throughout the chapter we will give detailed examples at the various stages of the design and evaluation process from our experience of building the academic literature visualization tool. In addition, at each of the design and evaluation stages we intend to explain how these concepts can be generalized for designing and evaluating interactive InfoVis tools. Each section in this proposal gives a brief overview of some of the main concepts we intend to explain in detail in the chapter.

## **InfoVis is an Experience**

Information Visualization (InfoVis) is the visual representation of abstract data of a specific domain on a computer screen. In addition to the visual representation, interactivity is a major component of these tools (Card et al, 1999). We consider users' interaction with InfoVis systems as an experience, due to the nature of the activities that users are engaged with, in addition to the knowledge being gained. Building and designing InfoVis tools is complex: it involves finding understandable interactive visual representations of huge amounts of abstract data. It is this abstractness that forms the challenge for both the designer and the user. On the one hand, the designer must come up with meaningful visual representations of the targeted domain, which would efficiently communicate the intended domain concepts to the user. On the other hand, the user interprets these representations and builds mental images from which knowledge is gained. The cognitive nature of the user activity forms a challenge to the designer, since the designer's conceptualization of the user's model may not reflect the model built by the user. Interaction is a key to achieving higher levels of knowledge.

## **Interaction: Visual and Physical**

In this chapter we will emphasise the fact that interaction should not only be considered from the technical perspective, which concentrates on the transformations that occur on the represented data, but should also take into consideration the user's interaction with the interface as in HCI. We define user's interaction with an InfoVis tool as incorporating both: mental activities, which include the creation of mental images of the represented domains; and physical activities, which

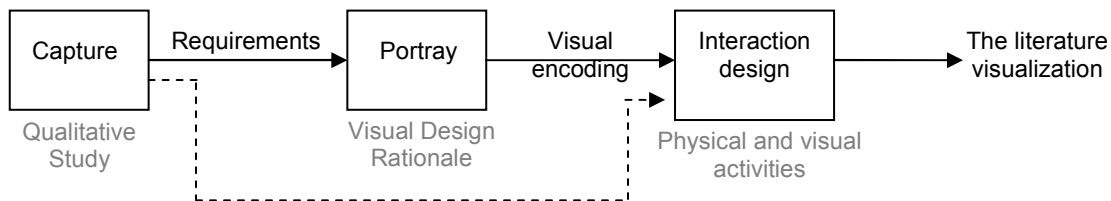
incorporate the actual physical actions that the users engage with in order to communicate with the system, such as clicking on a button, sliding a slider, etc. The visual representations respond to the physical commands given by the users and, depending on the user's interpretation of such responses the user may decide to issue another command, and so on (Norman, 1990) until the final goal is achieved, hence reaching higher levels of knowledge. Ideally, each of these physical actions complements the mental activities. We will demonstrate the means with which both of these activities can be incorporated into the design and evaluation of the InfoVis tools.

## A User Centred Methodical Approach

InfoVis systems are designed and built for the user, hence we emphasise that the user should be the centre of the design process. The methodical approach undertaken in the design of our academic literature visualization tool starts with the understanding of the user experiences within the domain context, and ends with designing and evaluating the academic literature visualization tool (Faisal et al, 2006b).

### The Design

The methodical design approach we will describe in this chapter is made out of three essential steps: capturing the experience, portraying the experience and designing the interaction.



**Figure 1. User Centered Methodical Approach**

#### *Capture the Experience*

We captured users' experiences by conducting a qualitative study with members of the research community (Faisal et al, 2006a). Semi-structured interviewing was used as the data gathering framework due to its flexibility, hence revealing information that was not previously known. Interviews were conducted with researchers of varying experiences in the fields of HCI and Psychology. The interviews were transcribed and analysed using the Grounded Theory methodology (Strauss and Corbin, 1998). Categories and concepts were revealed which will be explained in detail in the intended chapter.

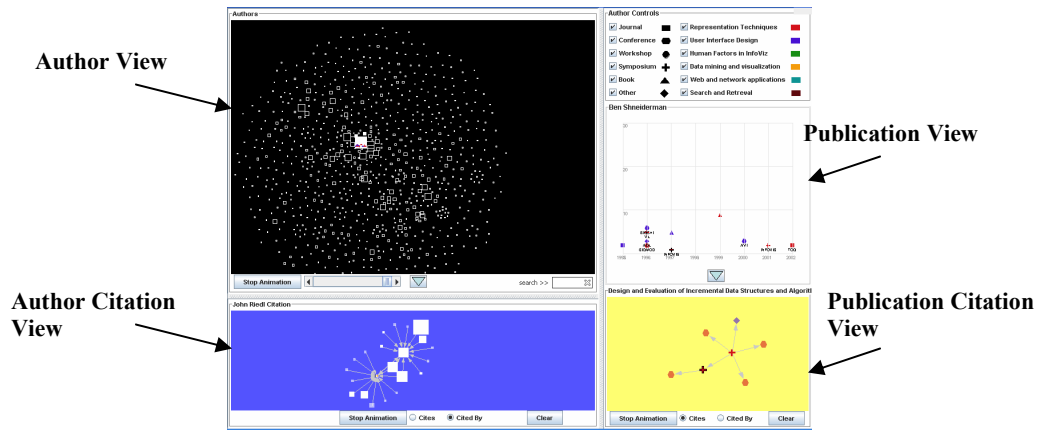
#### *Portraying the Experience*

The generated descriptive theory allowed us to generate a high-level design rationale. Several design decisions were based upon the qualitative data analysis. For example: our study revealed that citation relationships need to be presented not just between authors, and between papers but also papers and authors: for example, all the authors that cited a specific paper. Detailed explanations of this high-level design rationale will be discussed.

#### *Interaction Design*

A detailed description of the design of visual and physical activities will be described, ranging from the low-level visual encodings, such as: the shape and the color of the visual representations

to the low-level physical activities which involve the choice of interaction techniques. All of which satisfies our high-level system rationale.



**Figure 2. Prototype of the Academic Literature Visualization Tool**

We developed a preliminary prototype (Figure 2) of a literature domain. The data we visualized was the dataset used for the InfoVis'04 contest which includes the complete metadata of 8 years for all InfoVis conference papers and references from 1995 to 2002 (Ke et al, 2004). The design decisions were based exclusively on the results of the descriptive theory.

The chapter will demonstrate in detail how the understanding of the users' academic literature sense making experiences influenced the design of the visualization tool. It will reveal how this understanding assists the visualization designer in determining the data layout in addition to the interactive activities that need to be incorporated into the InfoVis tool. For example in the case of our literature visualization: the descriptive theory revealed that the authors, in other words the members of the community, are at the center of all domain sense-making activities, e.g. P2: *"It is hard to separate that [articles] from authors, cause ultimately they were written by authors"*. As a result, we decided to make the authors view the main visualization view with which the user interacts with the tool (Figure 1). When it comes to the interactive activities, from our descriptive theory we generalized a set of activities that, when engaged with, would enable users to gain more insight into their literature domains. These activities incorporate both interactive tasks and visual feedbacks which would reveal additional information. For example: the participants indicated that there was a need to identify the other authors of the paper not just the first author, e.g. P5: *"I always need to know the second and or third author"*. The tool as we will describe in the chapter represents the collaboration relationship in various manners.

## The Evaluation

In order for users to gain domain related knowledge from InfoVis tools the user must interact and interpret low-level visual representations, such as shapes, colors, size, etc. To ensure the usability of InfoVis tools the evaluation process must incorporate both low-level and high-level tasks. The low-level tasks are mainly related to evaluating the visual representations. This is essential in order to determine whether the user can understand the syntax of the visual language. It is from these tasks that higher levels of knowledge are gained. The high-level tasks will evaluate whether or not higher levels of knowledge can be generated from the visualization tool. This knowledge forms the goal of the InfoVis tools. Hence we emphasize that evaluating both the low-level and the high-level are essential. In order to ensure that both the low-level and high-level tasks form a

realistic representation of the domain related tasks, they have been generated from the qualitative study we conducted.

### *Low-Level Tasks*

In order to evaluate the low-level tasks we use the visual task taxonomies identified by Zhou and Feiner (1998) such as: identify, locate, rank, generalize, correlate, etc. These taxonomies, as explained by Morse and Lewis (2000), are used to generate low-level tasks. The tasks that we devised from the taxonomies were generated from the results of the interviews we conducted. For example, during the course of one of the interviews the participant was asked how he identified relevant authors, and he answered: “I would use his [influential author] papers as a way of kinda giving me pointers of other people who’s work I might look at”. As a result, for the *locate* taxonomy we generated the following low-level task: “The *Eyes have it...* paper by Shneiderman cites another paper by *J. A. Wise*; who does that paper cite?”. Other examples will be discussed in the chapter.

### *High-Level Tasks*

Unlike with the low-level tasks, we argue that with high-level tasks these are no right or wrong answer. As the user explores the domain through the low-level tasks they build and understanding of generalized high-level concepts of the represented domain. It is these tasks, we believe, that represents the goals of InfoVis tools. In our study we generated these tasks from the qualitative study we conducted. An example of such a task: “if you had to write a paper about interaction techniques which authors would you reference and why?”

At the mean time we are in the process of evaluating our academic literature visualization tool. Our intention is to include a section in the chapter where the results of this study will be included.

## **Summary**

Interacting with InfoVis tools is an experience that users engage with. Due to the large amount of information that is represented and the varying user goals, InfoVis tools must be designed for and evaluated by the user. In this proposal we briefly demonstrated the concepts we intend to discuss in detail in the “Design and Evaluation” chapter where we will demonstrate how a user centred approach can influence the design in ways that would have been impossible otherwise. In addition, we will discuss the evaluation of InfoVis tools from the perspective of both the low and high level tasks, which we strongly believe to have important influence on the evaluation process and will lead to crucial insights. All of the above concepts will be discussed from the perspective of the academic literature domain. However, throughout the chapter, we will refer to the ways with which these concepts can be generalized to benefit the general design and evaluation of interactive InfoVis tools.

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