New forms of Human-Computer Interaction for Visualizing Information

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Goal

The Graphical User Interface (GUI) – although developed in research laboratories in the late 1970s – is still the dominant interaction paradigm in Information Visualization. We propose a new interaction paradigm called **Blended Interaction**. It combines ideas of Embodied Cognition, Multimodal Interaction, Reality-Based Interaction & Ubiquitous Computing. This is intended to stress that a *single* increase in the reality aspect of the interaction cannot go far enough. The particular challenge – and from the user's standpoint, the key advantage – lies in a meaningful marriage between the tested real-world options and the digital world. As a minimum this marriage must exist on the levels of the interaction, communication, of the way we solve problems with conventional tools (workflows), and of the design of the space or the architecture of buildings and places. The digital world often offers entirely new possibilities and takes the form of interactive devices of various shapes but also of intelligent everyday objects (e.g. the 'Internet of things'). In our view, interaction concepts can indeed offer a new quality of interaction, but only when the design of the interaction includes *all these domains at the same time and with equal weighting.*

We test the suitability of our ideas of Blended Interaction concepts by using specific application examples that are being worked on as part of current research projects. Our experiences show that this new interaction paradigm has also great potential for interacting with visualization. For example, we have developed multi-touch scatter plots & facet maps for tangible user interfaces supporting the searching & browsing in Digital Libraries. We have embedded different visualizations into a Zoomable Object-oriented Information Landscape (ZOIL), which supports our vision of using visualizations on different displays of different size at the same time. We have developed specific kind of search tokens that supports collaborative search activities.

For example, we try to address the following research questions:

- How can future interactive InfoVis tools look like, especially in the light of the idea Blended Interaction?
- How can future interactive InfoVis tools benefit from Multi-Displays & Multimodal environments used by Multiple Users?
- What are the specific design requirements for multi-touch visualizations?
- How can we support the collaborative use visualization tools?

Background

Important recent findings in cognitive psychology as well as the vision of Ubiquitous

Computing (Weiser 1991) have contributed significantly to a critical questioning of the GUI paradigm. A new point of view has established itself in cognitive psychology in recent years. In addition to the internal – and to us, invisible – cognitive processes in the brain, this view gives priority to studying our interaction with the environment and with other human beings in terms of its significance for cognitive development. This led to the realization that this view – termed **Embodied Cognition** (Dourish 2001) – is very significant for our spiritual development and everyday behavior. Arguably, our cognitive development is decisively influenced by our physical and social interaction with objects and living beings in our environment. This has at least two implications for the field of Human-Computer Interaction: first, promoting the richest possible interaction with the computer; second, including such interaction with the social environment in the overall considerations.

In this context, rich interaction means chiefly the number and type of senses and physical skills that can be employed in the situation. This is also known as **Multimodal Interaction** (Oviatt 2008), in which, in addition to speech input, touch-sensitive displays and the manipulation of real-world objects in combination with digital displays play a particularly important role today. Combining Multimodal Interaction with the interaction with real world objects (also called Tokens) is referred to as **Tangible Computing** (Ishii & Ullmer 1997) in the research field. The dominance of Tangible Computing must also be viewed against the background that current technical innovations (iPhone from Apple, Surface Tabletop Computer by Microsoft) have reached the commercial market and thus technologies (e.g. multi-touch recognition, token recognition, touch-sensitive displays, etc.) also exist that are sufficiently robust to enable a variety of applications outside the laboratory. In parallel, users' first experiences with these new products have been positive and they are therefore very willing to try out new forms of Human-Computer Interaction. At the same time, their social interaction with other users should also be taken into consideration. This form of interaction is referred to as Social Computing in the research field and principally takes into account the fact that today tasks or problems are frequently solved by groups.

Under the heading **Reality-Based Interaction** (Jacob et al. 2008) combined the above-mentioned findings in cognitive psychology as well as the technical developments in the fields of multimodal interaction, tangible computing and social computing in a new paradigm. The general objective is to orientate the interaction with the computer to the interaction with the real, non-digital world and thus to make it more reality-based – or easier to grasp, one could say. In this case, really easy to 'grasp' in both senses of the word: in the sense of touching and in the sense of understanding. Jacob and his co-authors set out four guiding principles for fashioning a reality-based interaction: "Note that people have common-sense knowledge about the physical world"; "Bear in mind that people have both body awareness and physical skills"; "Bear in mind that people have both spatial awareness and spatial skills" and finally, "Take into account people's social behavior and their social skills of interaction and communication". These four principles are a helpful introduction to structuring the complex design space of this new form of interaction and making it

more understandable.
In 1991, Marc Weiser published his vision of the computer of the 21st century. This vision has become known by the term **Ubiquitous Computing** in the scientific community. He saw the traditional PC – the dominant medium of human-computer interaction – becoming less important and expected the future to be characterized by a large number of networked, context-sensitive interactive devices with widely differing form factors. Very perceptively, he stated an essential objective as follows: "By pushing computers into the background, embodied virtuality will make individuals more aware of the people on the other ends of their computer links. ... Ubiquitous computers, ..., reside in the human world and pose **no barrier to personal interactions**" (Weiser 1991, emphasis added by the authors). His vision therefore implicitly includes the assumption that the interaction between human and computer will orientate itself to the way in which we interact with things and people in the real world. We now see an overlap between the objectives of Reality-Based Interaction and the vision of Ubiquitous Computing.
The next stage of development of human-computer interaction will therefore be marked by the goal of orientating the interaction with a variety of different displays within the meaning of Ubiquitous Computing to the principles of Reality-Based Interaction. In this situation, users interact on their own or in groups at the same place and seamlessly switch between real-world interaction plus communication and computer-aided interaction plus, where appropriate, communication (e.g. with a person or members of another group at another location). This leads to a **mix (blend) of the real and the digital world in multiple domains**, namely

- the **interaction**: e.g. writing with digital pens on paper is an analogue and digital representation; interacting with real-world objects such as tokens combines analogue interaction with the resulting digital changes,
- the **communication**: e.g. tokens and multi-touch displays enable an equitable form of communication, because several users can interact simultaneously or because normal social conventions can be observed immediately,
- the real and computer-aided **operations (business processes)**: e.g. during a visit to an exhibition, it is possible to switch smoothly between a virtual tour and the real tour; when we search in a library, traditional stack/shelf-centered research can be combined with digital search facilities; while conducting a brainstorming session as part of a design meeting, traditional creativity techniques in the form of cards can be combined with digital facilities for sorting, categorizing, etc., and
- shaping the **physical environment**: e.g. configuring the rooms for new forms of interaction and communication. The design of the interaction includes not only walls, floors, and ceilings, for example, but also sound and light. This is configuring the architecture in its widest sense.

Literature

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