

PREFACE

The problem of visual thinking provided the motivation for another edition of this book. From the moment I finished the first edition, I felt the need to explore further the broader issues of how we use visualizations as cognitive tools in problem solving. The initial inspiration for the account that has emerged came from an essay by Kevin O'Regan (1992), wherein he argued that we do not have a detailed image of the world in our heads. As he put it, the world is "its own memory." He maintained that the reason we see a coherent world is that we can sample it any time we need to with a rapid eye movement or a redirection of attention within a single fixation. O'Regan was not the first to make this point, and I had already argued something similar with respect to space perception in the first edition. However, after reading O'Regan's eloquent essay I started to think more seriously about the implications of the detailed representations of the visual world.

This fact—that most of what we see is actually "out there," not in our heads—has profound implications. It explains why one's ability to think is extremely limited without external props and tools. Most cognition can be regarded as a distributed process that includes cognitive components, such as the visual system, verbal processing systems, and memory structures traditionally studied by psychologists, plus cognitive tools such as paper and pencil, diagrams, books, and the manipulation of external symbols on paper. Very rapid problem solving can be done with the right interactive display, as we pull out patterns through rapid visual searches. Increasingly, cognitive tools are computer-based, and an interactive visualization is a critical interface between the human and machine. The much-debated issue of whether or not computers can be intelligent is beside the point—people are not very intelligent without external cognitive tools. Intellectual products, such as books, pictures, theories, designs, and plans are, with few exceptions, the products of cognitive systems made up of human brains acting in concert with cognitive tools. Thus, productive intelligence can be said to reside in the system as a whole.

The process of visual thinking is the subject of an entirely new final chapter. This provides an account of visual thinking that has visual queries as a central component. Visual queries are acts of attention, pulling out patterns from the display, to meet the requirements of the task at hand. The other key components of this account of visual thinking are the data representation and the cost of acquiring knowledge—a function of both the cognitive overhead of using the computer interface and various navigation costs. Eye movements, zooming, and hyperlinks can all be treated as navigation devices whose various tradeoffs must be considered carefully in cognitive systems design.

In addition to the new chapter on visual thinking, this edition is expanded and updated throughout. It contains new sections on topics including color sequences, flow visualization, and

face perception. It has many new references and figures. A new appendix deals with how to evaluate visualization techniques.

I wish to acknowledge two individuals for their contributions to the visual thinking chapter. The work of my graduate student, Matt Plumlee, has been especially helpful in showing how useful, practical guidelines for interface design can come from a relatively simple cognitive systems model. Conversations with Ron Rensink, of the University of British Columbia, also substantially influenced my thinking.

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