

# Keynote Address

## From Information Visualization to Sensemaking: Connecting the Mind's Eye to the Mind's Muscle

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### ABSTRACT

Looking back on the tenth anniversary of the first Symposium on Information Visualization, much has been accomplished. The computer's power has been exploited to give quick visual form to abstract data, to interact, and to warp detail to follow the user's changing interest. Moreover, the design space of visualizations has been systematized with reference models, taxonomies, and monographs relating visualization to perceptual and graphical constraints. Looking ahead, however, I will argue that the era of pure information visualization is over. The path ahead depends on giving much more attention to the purposes of visualization and its use. Leaving aside communication, the purpose of information visualization is insight, or more particularly, a larger process that might be called sensemaking. I will sketch out the nature of sensemaking, exemplify it empirically in a practical, urgent setting, and suggest how theories of sensemaking could be developed. I will then describe systems that subsume information visualization as part of an emerging class of sensemaking systems combining visualization (the mind's eye) with semantic content analysis and sensemaking operations (the mind's muscle). Not surprisingly, a focus on sensemaking is a good generator of new visualizations. But these developments also suggest that it may be time for the information visualization field to alter its boundaries to go beyond the merely visual.

### BIO

Stuart Card is a Senior Research Fellow and the manager of the User Interface Research group at the Palo Alto Research Center. His study of input devices led to the Fitts's Law characterization of the mouse and was a major factor leading to the mouse's commercial introduction by Xerox. His group has developed theoretical characterizations of human-machine interaction, including the Model Human Processor, the GOMS theory of user interaction, information foraging theory, and statistical descriptions of Internet use. These theories have been put to use in new paradigms of human-machine interaction including the Rooms workspace manager, papertronic systems, and the Information Visualizer. The work of his group has resulted in a dozen Xerox products as well as the contributing to the founding of three software companies, Inxight Software, Outride, and Content Guard. Card is a co-author of the book *The Psychology of Human-Computer Interaction*, a co-editor of the book, *Human Performance Models for Computer-Aided Engineering*, and has served on many editorial boards, government panels, and university review boards. He received his A.B. in Physics from Oberlin College and his Ph.D. in Psychology from Carnegie Mellon University, where he pursued an interdisciplinary program in psychology, artificial intelligence, and computer science. He has been an adjunct faculty member at Stanford University. His most recent book, *Readings in Information Visualization* was published in 1999. He is currently developing a supporting science of human-information interaction and visual-semantic prototypes to aid sensemaking. Card is a Fellow of the ACM, the first recipient of the ACM CHI Lifetime Achievement Award, and the first member of the ACM CHI Academy.