

Nicholas F. Polys Research Statement

Vision

Through my research in Virtual Environments and Information Visualization, I have employed both 'basic' and 'applied' science. In the former, I examined fundamental questions about the nature of human perception and cognition in an attempt to discover principles that apply to interactive, information-rich environments. These principles find manifestation and application in the engineering processes of 'applied' science, where solutions must be found for a specific problem or domain. Each approach has value of its own, but real progress only happens when they are used together. In the field of Computer Science especially, the combination of methods is crucial in order to keep pace and relevance with technological development. Fundamental advances drive new systems and new systems open up new fundamental questions.

Information-Rich Virtual Environments

My PhD research examined the nature of Human-Computer Interaction (HCI) in integrated information spaces – a common situation where patterns and relationships exist between spatial, abstract, and temporal information. We have termed this union of virtual environments and information visualization research 'Information-Rich Virtual Environments' (IRVEs). Specifically, my work has focused on graphical design techniques to combine these information types and the roles of perceptual cues in comprehension, mental workload, and task performance. This research has led to interesting and applicable results for a number of emerging display technologies.

Important questions remain for IRVEs including: how can IRVEs best support scientific insight and problem solving across immersive contexts? What data models and software functionalities are required for effective IRVEs? Relatedly, what are the requirements of next-generation information architectures and standards technologies such as X3D and the Semantic Web? Finally, how can we use EEG data to adapt IRVE interfaces and augment cognition in realtime environments?

Research and development of IRVEs will continue to have an impact across industries and domains. The volume and complexity of heterogeneous data continues to grow, and scientists, engineers, and designers will continue to require better analytic and visualization tools to manage it in a useful way. There are a number of specific applications where the benefit of IRVEs can be seen. For example, in the fields of biology and medicine, scientists examine the properties and relationships of structures, from cells to tissues to gross anatomy. Similarly, in chemistry, astronomy or architecture, understanding the spatial nature of processes is crucial for insight - using IRVEs can reduce the cognitive distance between the investigator and their data. Additionally, the principles and techniques of IRVEs could be fruitfully applied to educational spaces, as in the multimedia software and curricula that train and educate new scientists and practitioners.

Future Opportunities

My direction of basic research for the future will be further exploration of the perceptual and cognitive impacts of IRVE interface designs across desktop, large-scale, and immersive displays. This involves continued iteration of designs and experimentation through the methods of Usability Engineering, specifically toward multi-modal, embodied, and 3D user interfaces. However, it is crucial not only to improve designs, but also to make them practical. For this reason, future research should also include application development with researchers in other domains.

Collaborations and development with domain experts will be especially fruitful for IRVEs. Such multi-disciplinary collaboration will lead to next-generation information tools further leveraging of XML for data interchange, providing web-services to high-performance computing systems, and pushing the visualization and interface capabilities of open standards. Lastly, I am a firm believer in the open source software movement, which has provided a powerful means to develop and deploy new tools with robust functionality and low financial cost.