

Seeing The Unseen: Visualization in Education

Thomas G. West
Author of *In the Mind's Eye*
and *Thinking Like Einstein*

J. Jerry Uhl
Professor of Mathematics
University of Illinois

James Martinez
Art and Technology Director
Wye River Upper School

1 Introduction

The panel will consider “seeing the unseen”--the use of information and scientific visualization in education--what are we doing, what have we learned, where we may be going. From the earliest days, SIGGRAPH has focused on the importance of information visualization and on the use of interaction to aid and reinforce learning and understanding. This panel will focus on a discussion of examples of using visualization at the university level and at the high school level. Some of the history and potential of visualization in varied courses and settings will be reviewed. The panel will consider a well-established use of visualization (in teaching mathematics) and, in another case, the beginning use of visualization, computer graphics and related technologies at the high school level (teaching art, technology and other subjects). Recent research findings will be reviewed and case studies will suggest future developments in the use of visualization technologies and techniques in educational settings.

2 Exposition

From the earliest days, SIGGRAPH has focused on the importance of information visualization and on the use of interaction to aid and reinforce learning and understanding. Specific visualization programs were initiated by the National Science Foundation and others in the 1980s, especially at the NSF-funded Supercomputer Centers. The SIGGRAPH Education Committee and Conference Program sponsored several presentations and panels on this subject in the early and middle 1990s. Some have argued that since 1999, we all have had supercomputers on our desks--so that we can now take full advantage of the power of visualization in education and work. However, it has become apparent that beyond the technology, there are many other barriers to widespread use.

In this panel we will look at one case of a well-established use of visualization (in teaching mathematics) and at another case where visualization is just beginning to be used at the high school level (teaching art, technology, math,

history and other subjects). Recent research findings will be reviewed. Case histories of the work of highly creative visual thinkers suggest future prospects for the widespread use of these technologies and techniques over time.

Panelist Thomas G. West is the author of the book *In the Mind's Eye-- Visual Thinkers, Gifted People with Dyslexia and Other Learning Difficulties, Computer Images and the Ironies of Creativity*. The book argues that major advances in computer visualization technologies promise to transform education and the workplace--greatly increasing the perceived value of visual talents for understanding patterns in complex systems in business, the sciences and other fields.

West observes that many visual thinkers (sometimes with some degree of dyslexia or other language difficulties) are already leaders in areas of technological innovation as well as science and business--as technological changes make their distinctive visual strengths more and more valuable just as their academic and language weaknesses become less and less important. For years West wrote the column, “Images and Reversals,” for SIGGRAPH’s *Computer Graphics*. Recently, these columns have been collected into a book with the title: *Thinking Like Einstein--Returning to Our Visual Roots with the Emerging Revolution in Computer Information Visualization*.

Panelist Dr. J. Jerry Uhl is Professor of Mathematics at the University of Illinois at Urbana-Champaign. Years ago, Uhl was active in the National Science Foundation-sponsored reform of calculus teaching at the university level. As consequence of his work with these reform programs, he is author, with W. Davis and H. Porta, of the interactive courseware, *CALCULUS & Mathematica* (Addison-Wesley)--using high-level, general-purpose mathematics software along with graphic computers. The innovative approaches used in this courseware have been widely adopted and are in use by many modern calculus courses and textbooks. Some argue that this courseware may provide the model for successful interactive learning in many fields, especially employing the power of visualization.

In the approach of Uhl and his associates, students are encouraged to think and learn visually first--before traditional lectures and verbal descriptions. A major shift in learning technique (along with delightful informality and irreverence) is apparent in the authors' instructions to their students: "One of the beauties of learning [our way] is your opportunity to learn through graphics you can interact with. In this course, your eyes will send ideas directly to your brain. And this will happen without the distraction of translating what your eyes see into words. Take advantage of this opportunity to learn visually with pure thought uncorrupted by strange words. The words go onto an idea only after the idea has already settled in your mind. This aspect of [our approach] distinguishes it from other math courses."

Uhl has acknowledged the role of early SIGGRAPH education panel discussions on the development of their innovative system: "Previously, we had not realized fully how central the role of visualization was to what we were trying to do. We were already on the right path without really knowing it. . . . In our project, . . . we have learned the effectiveness of teaching the concepts visually using graphic software prior to verbal explanations. Our students have gained a deeper understanding of the subject and they can recall and apply the material long afterward, which is rare for students taught with conventional methods."

Panelist James Martinez is Art and Technology Director at the Wye River Upper School in Wye Mills, Maryland. WRUS is a new school designed for bright students with learning differences, some of whom are dyslexics with high visual-spatial talents. With an MFA from the University of

Delaware, Martinez has taught previously at the college level. His photography and movie making course offers state of the art techniques in creating digital photos and movies, using student and faculty laptops and digital photographic equipment. He leads interested students in developing their portfolios for post secondary work. He has organized several student exhibits, as well as serving as webmaster for WRUS and coordinating all issues of technology. Martinez has recently been invited to join the SIGGRAPH Education Committee and is currently working on ways to incorporate information visualization, scientific visualization and computer graphics into various aspects of the high school curriculum.

3 Conclusion

A review of examples of visualization at the university level and at the high school level indicates that great potential can be realized much more rapidly. The history and potential of visualization in varied courses and settings were reviewed. The panel considered a well-established use of visualization (in teaching mathematics) and, in another case, the beginning use of visualization, computer graphics and related technologies at the high school level (teaching a range of subjects). Recent research findings were reviewed and case studies suggested future paths of development in the use of visualization technologies and techniques in a range of educational settings.

e-mail addresses:

thomasgwest@aol.com

jamesmartinez@wyeriverupperschool.org

j-uhl@uiuc.edu