

**Adoption of Stereoscopic Displays in Geographic Education:
A Persistent Problem in Geographic Visualization***

by

Terry Slocum, Alan Halfen, Travis White, Dan Hirmas
Stephen Egbert, Dave McDermott, and William Johnson

*This material is based upon work supported by the
U.S. National Science Foundation under Grant No. NSF0066173.
Any opinions, findings, and conclusions or recommendations expressed
in this material are those of the author(s) and do not necessarily
reflect the views of the National Science Foundation.

One persistent problem in geographic visualization has been that advancements in presentation technologies, such as stereoscopic displays, have ironically generated excitement in the higher education community while remaining largely unadopted in the classroom. In this paper, we review the history of stereoscopic displays, investigate whether the time is ripe for the dissemination of these displays, discuss an ongoing research project using stereoscopic displays, and consider the role and future of geographic visualization in education.

Cartographers and other geoscientists have long noted the potential of stereoscopic displays. For example, Jensen (1978) argued that if “the...figure-ground relationship is best described as if it were a three-dimensional phenomenon...why not produce...maps capable of providing truly three-dimensional figure-ground relationships to improve comprehension?” Jensen’s argument for using stereo images was tempered by the fact that visualization at that time required a cumbersome hand-held stereoscope. Computer-based stereoscopic displays developed in the late 1980s (Moellering 1989) were not widely adopted, presumably because of their expense. At the beginning of the twenty first century, stereoscopy received a major impetus with the development of cost-effective GeoWall systems for presenting stereo images to large classes. Developed as a collaboration of computer scientists and geologists, the GeoWall system has had its greatest impact in geology. For example, in 2006, more than one-third of undergraduate non-major Earth Science students in the US were using a GeoWall in their coursework (Johnson et al., 2006) and at least one geology text (Reynolds et al. 2010) currently includes a distinctive GeoWall component. Geographers have also experimented with the GeoWall system (Anthamatten and Ziegler 2006; Slocum et al. 2007), but the technology has not yet approached adoption levels in geology departments or classes. Outside of academia we have seen a rapid growth in stereoscopic technology. This began with the IMAX systems in the 1990s and has now reached a stage where stereo movies, television, cameras, and phones are increasingly commonplace. This prevalence of stereoscopy in everyday life raises the question, “Why hasn’t the technology caught on in education, both at the K-12 level and in higher education.” Cost is obviously a primary factor, but this is likely to decrease over the next few years. Another factor is ease of use. For example, the installation is complicated by the need for two projectors. This problem, however, is also being alleviated, as single projector systems are now possible, and large-format non-projection systems may be feasible in the future. Another factor, often overlooked, is a consideration that a portion of the population cannot see in stereo; estimates range from 5 to 10% of the population. (Coutant and Westheimer 1993; Sekular and Blake 2002)

In an effort to evaluate stereoscopic technology in higher education, we are testing the effectiveness of these displays in introductory physical geography classes, both at the University of Kansas and at Haskell Indian Nations University. Our basic question is whether use of stereoscopy in these classes will enhance visualization when compared to non-stereoscopic 3-D presentations (images in which other 3D cues are used such as occlusion, aerial perspective, and motion). Examining this question will help us analyze the cost/benefit of stereoscopic displays in geography courses. Since the beginning of 2011, we have been developing 3-D content appropriate for stereoscopic display and testing the effectiveness of this content in an actual classroom. We have considered a range of issues related to using stereoscopic displays in the classroom including: the nature, benefits, and limitations of various stereoscopic technologies (e.g., active vs. passive stereoscopic displays); practical issues associated with installing stereoscopic systems in the classroom; development of 3-D content; effects of student location in the classroom relative to the display; student inability to see in stereo; and development of an experimental design to assess the effectiveness of stereoscopy.

Testing the effectiveness of stereoscopy leads to the more general question: how can the sophisticated visualization techniques that the commission is developing be integrated into geoscience education? Presuming that at least some of these visualization techniques can be practically integrated, what are the best practices for accomplishing this.

References

- Anthamatten, P. and S. S. Ziegler. 2006. Teaching geography with 3-D visualization technology. *Journal of Geography* 105: 231-237.
- Coutant, B. E. and G. Westheimer. 1993. Population distribution of stereoscopic ability. *Ophthalmic & Physiological Optics* 13 (1): 3-7.
- Jensen, J. R. 1978. Three-dimensional choropleth maps: Development and aspects of cartographic communication. *The Canadian Cartographer* 15 (2): 123-141.
- Johnson, A., J. Leigh, P. Morin and P. Van Keken. 2006. GeoWall: Stereoscopic visualization for geoscience research and education. *IEEE Computer Graphics and Applications* 26 (6): 10-14.
- Moellering, H. 1989. A practical and efficient approach to the stereoscopic display and manipulation of cartographic objects. *AUTO-CARTO 9 Proceedings*, Baltimore, Maryland, pp. 1-4.
- Reynolds, S. J., J. K. Johnson, M. M. Kelly, P. J. Morin and C. M. Carter. 2010. *Exploring Geology*. Second Edition. New York: McGraw-Hill.
- Sekular, R. and R. Blake. 2002. *Perception*. New York: McGraw Hill.
- Slocum, T. A., M. D. Dunbar and S. L. Egbert. 2007. Evaluating the potential of the GeoWall for geographic education. *Journal of Geography* 106 (3): 91-102.