# Position Paper on Visualization Research Challenges

Robert Moorhead
Professor of Electrical and Computer Engineering
Director of the Visualization, Analysis, and Imaging Lab
Mississippi State University

It is my position that the three greatest challenges in visualization today are:

1. common data representations,
2. cross-discipline functionality, and
3. a knowledge of which techniques work best when.

**Common data representations**: The visualization research community has developed many visualization methods, yet most are dependent on the topology and/or geometry of the representation. More effort needs to be focused on determining data representations that work for a wider array of discipline-specific problems. NetCDF and HDF have progressed a long way, but for too long we have let the applications dictate the output format, rather than provide the domain scientists with a universal format that would allow a common visualization toolkit to work for many domains. We do need to involve the domain scientists in developing the formats. We need to understand what their issues are and we need to convince them that a less than optimal format for their domain will actually help them by increasing the rate at which people in their research area can visually analysis their data. In summary, we need something like xv or Image Magic for data.

**Cross-discipline functionality**: This follows naturally from and is predicated on solving the first challenge. We need visualization systems that work across disciplines – a visualization system that can display data from multiple domains efficiently. For example, a system that can display data stored on grid vertices, edges, or faces would be useful. A potentially productive approach would be to fund a multidisciplinary group of research developers (e.g., developers of BYU suite of water resource visualization tools, Kitware, CEI, etc.) to develop a common data representation and a toolkit with common functionality. Once we start building this infrastructure, our visualization algorithm work will increase in its impact.

**Visualization Expert Systems**: We need to know which techniques work best under a plethora of situations. When a scientist is studying shedding vortices, what technique works best to visualize those in internal flows and external flows? We need to know which technique works better, as well as when and why if possible. This research will require user studies over algorithm development. The community needs to continue demanding better proof of improvement, as it has begun to do. This means visualization scientists need training in how to design user studies. They must learn the issues of internal and external validity, for example. The work will probably require a multidisciplinary team involving cognitive scientists, HCI scientists, and people trained in the communicative arts. If we can make some major strides in this area, visualization will become as common as playing a production DVD and a lot more exciting since scientists will be able to explore their data, knowing they are doing it the right way.