

Given current advances in computing technology, increasingly large amounts of data are being collected to gain a deeper understanding of a particular domain. This trend is evident across an ever-growing span of technical disciplines and industries. Computer graphics and visualization are invaluable technologies for extracting, analyzing, and conveying the information contained within this collected data. Visualization is the process of representing data with communicative images and, subsequently, interacting with these visual representations, while computer graphics provides the mechanisms for creating these images.

IBM Research's involvement in graphics and visualization research is long-standing and has produced notable contributions, such as Benoit Mandelbrot's work on fractals, Arthur Appel's invention of ray tracing for rendering realistic images and the hidden line algorithm, and Jack Bresenham's scan conversion algorithms for lines and circles. In the area of image compression, Joan Mitchell and Gerry Goertzel played a key role in the Consultative Committee for International Telephony and Telegraphy (CCITT) Group 3 facsimile transmission standard, and William Pennebaker and Joan Mitchell worked on the JPEG standard for still image data compression. Other important innovations include arithmetic coding, novel simplification, smoothing, compression, and meshing algorithms for handling complex three-dimensional geometry.

Past and present research in this area covers a broad span: efficient visualization frameworks and systems for processing and viewing complex data models, digital watermarking images for copyright protection, parallel coordinates for visualizing multi-dimensional data, toolkits and perceptual experiments for creating accurate and effective visualizations, weather system visualization, and use of the Cell Broadband Engine™ technology for graphics applications. The technologies stemming from this research have affected IBM's hardware and software product offerings, including the Imagine and Shape module in Dassault Systèmes' solid modeler CATIA and IBM's Deep Computing Visualization offering, as well as numerous IBM initiatives, such as the Egyptian Culture Project. The current focus of our graphics and visualization research is based on two main themes: representing and processing both image and geometry data and visualizing large-scale data sets using innovative techniques.

Molecular dynamics simulation rendered on a four-tile display wall using the Scalable Visual Networking component of IBM's Deep Computing Visualization (DCV).

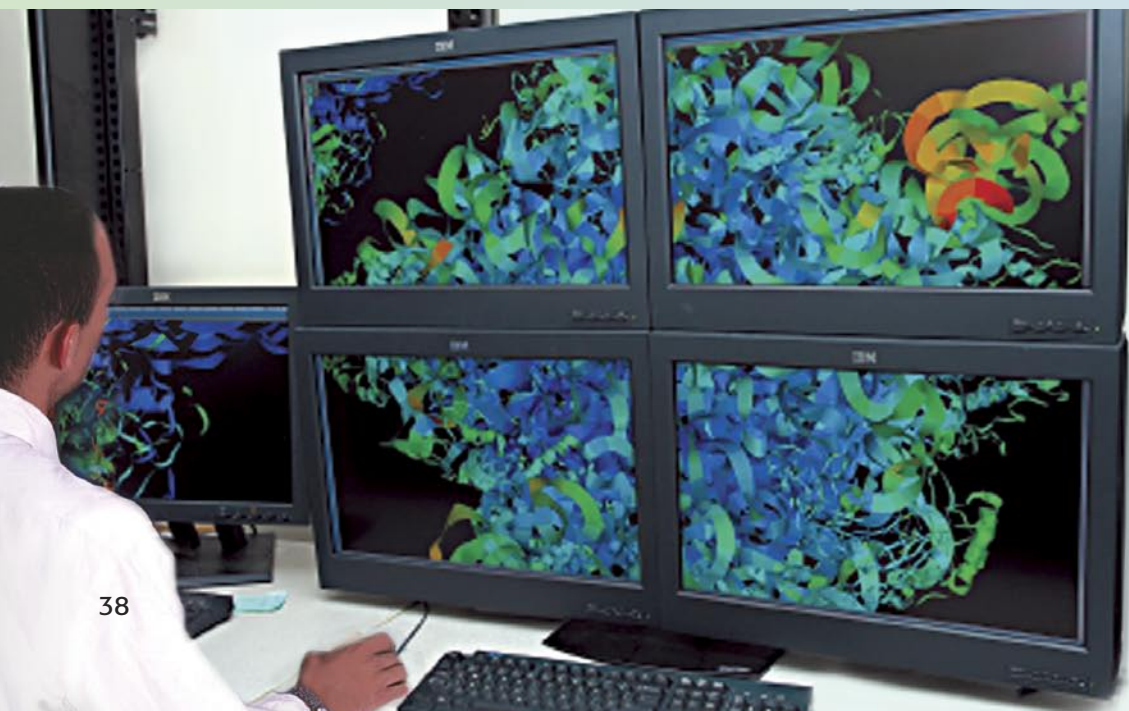


IMAGE AND GEOMETRY PROCESSING

Research in image and geometry processing includes the physical acquisition of geometric and image data through scanning, digital representation, and processing. The goal is to generalize successful two-dimensional image processing techniques so that they may be used to operate on three-dimensional surfaces. IBM's multi-resolution subdivision surface representation treats a three-dimensional mesh of arbitrary topology as a generalization of a two-dimensional image. This representation allows operations such as transcoding, compression, transmission over networks, Computer-Aided-Design (CAD), multi-resolution editing, physical simulation, and rendering. This set of tools enables industrial designers to create new products with organic shapes and tightens the feedback loop between modeling and simulation.

DEEP COMPUTING VISUALIZATION

For demanding visualization tasks that distill terabytes of data into graphical form, researchers are developing systems, such as IBM's Deep Computing Visualization (DCV) offering, for geometric processing and rendering on small clusters of workstations or on large-scale and massively parallel systems. Central to DCV is software for enabling cluster-based graphics rendering and immersive displays. The role of this software is to virtualize the parallelism of the cluster, the associated graphics and networking hardware, and the display technology.

Scanned mesh of pharaoh head in the Egyptian National Museum (1). Automatically generated quad domains (2). Two subdivisions control meshes over this domain (3 & 4). Nose restored by multi-resolution editing (5). The model of the pharaoh head is courtesy of the Egyptian Center for Documentation of Cultural and Natural Heritage.

