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Visualization

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In pockets of deep prehistory, humans made the first marks on their world. Those marks were completely new images, images that had not existed before. The painting and tooling on stone walls recorded and attempted to explain human interaction with the world. Languages, alphabets, systems of numbers and physical structures came much later. Each new tool eventually became interconnected with the others to produce more complex means of studying, recording and building the human-world relationship. These pockets of activity moved, merged, divided or died. The accumulations of perceptions, knowledge and technology continued to mix and reconnect.

Most often, the human wanted to "see" the sense of all of this. Observing and visualizing mentally remained an essential beginning point for thinking. Although some cultures deny visualization as a basis for their beliefs and actions, the image in some way or another has provided a unique power for the human spirit. Geometry, astronomy, physics, painting, sculpture, architecture and cartography made ideas visual and at the same time provided tools for further visualization. The telescope and microscope made the unseeable seen. But artists were still the image makers. They revealed the realities, and they invented the fantastic. After the Renaissance, a gradual separation began between art and science. The invention of photography brought a drastic change in visualization. Soon millions of people could easily make pictures, but the thinking behind the picture, the visualization, was often absent. The artists moved from a presentation of reality, now quickly captured by the camera, to the invention of new images and new ways of seeing the world. By this time, society had accepted science as a major source of information, knowledge and truth; and science was perceived to be more about words and numbers than about images.

Television brought another kind of visual revolution. For most people, it was not a picture-making machine. It arrived in the footsteps and traditions of the movies and brought packaged pictures to be consumed. Providing entertainment, companionship and escape, television required no understanding of images, how they work or how they are made.

Our individual and collective visualization has been prompted, changed or curtailed by our inventions, beliefs, education, cultures, times and geography. Each one of us retraces, in a way, the path of

history. As children, we make our marks much the same way the cave painters did. We climb through our years adding tools as we need them or as our society thinks we need them. Much of what most of us learn is a chancy accumulation of stereotypes, myths and skills.

Regrettably, our skills often end at the level of simple recognition. We try to find a sense of meaning in both the sophistication of our culture and our early primal knowing. Our visual sense and abilities are tied to points somewhere between these quite different mental nodes.

In the past few years, cognitive scientists, computer scientists, visualization scientists, artists and technicians have begun working together in an attempt to understand better how we think with images. They are calling this work "Visualization." One particular branch progressing under a grant by the National Science Foundation is labeled "Visualization in Scientific Computing." The following section by McCormick, DeFanti and Brown (eds., 1987) attempts to define this work and speaks elegantly to a broad concern:

Visualization and Society

The art of visual communication

The English language uses many visual metaphors. We generalize "observation" to mean any perception, call futurists "visionaries" and ask "do you see" when agreement is sought. Certainly, no one can imagine human or mammalian development without sight. Among the professions, the practice of medicine is inconceivable without vision. While Eastern cultures revere people skilled in visual communication, such as artists and calligraphers, we Westerners take visual skills for granted and tend to hold artists in low esteem.

Mass commercial appeal of visualization

Visualization is a captivating entertainment commodity, as evidenced by society's enthusiasm for video games, rock videos on television and special effects in feature films. The development of visualization techniques and algorithms for the commercial and entertainment marketplaces, where the objective is to generate realistic-looking images, is already a substantial field of investigation of significant commercial importance.

Scientific potential of visualization

The application of visualization to scientific computing will undoubtably face a type of cultural inertia well exhibited by the pre-computer history of visual technology. Over the past 100 years, each newly developed visual medium first mimicked the

old. Still cameras were first used to replace landscape and portrait artists. Movies first captured theater from fifth row center: it took 20 years to discover the *vocabulary* to move a camera around. Television neatly adopted the style and content of film; only now are its real-time and interactive capabilities being developed, as in the use of instant replays and graphic overlays. Visualization, the new interactive visual medium, has great potential for new modes of use beyond its origins in rotating logos for television.

Most people see the end result of visualization -- reproduced still color photographs or movies. With the exception of flight simulator trainees and video game players, all those not actually in the process of producing visualization see it as one-way and non-interactive. One cannot publish interactive systems in a journal.

The process of scientific discovery, however, is essentially one of error recovery and consequent insight. The most exciting potential of wide-spread availability of visualization tools is not the entrancing movies produced, but the insight gained and the mistakes understood by spotting visual anomalies while computing. Visualization will put the scientist into the computing loop and change the way science is done.

Visualization provides a new challenge to education. It has not appeared in the education reports and studies of the eighties because it has been invisible. It could not be seen, let alone be seen as a basic. Art has been called a basic, but visualization goes far beyond art education as we now know it. Producing students who are visually literate and are able to think visually is as important as developing skills usually targeted for reform in our educational systems, and for the same reasons -- we need fully operational citizens who can imagine what needs doing.

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