



SIGGRAPH 1992

*19th International Conference
On Computer Graphics and
Interactive Techniques*

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COURSE NOTES

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INTRODUCTION TO
SCIENTIFIC VISUALIZATION
TOOLS AND TECHNIQUES

Organizer

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Lecturers

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Gregory Nielson

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Lloyd Treinish

IBM T.J. Watson Research Center

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1 Course Description

This course provides an introductory overview to the field of scientific visualization. Rather than describe whiz-bang visualization systems which might not be available to the attendees; the course will be tailored towards useful information by approaching the subject from a data domain point of view. The course will look at color, data models and different classes of data: 2D fields, 3D fields, fields on unstructured grids, multivariate data sets, thereby providing the fundamental concepts followed by specific tools and techniques for visualizing those data domains. Actual tools and techniques for visualizing a variety of scientific data sets will not only be presented but also provided as part of the course notes. This course will provide exposure to tools and techniques across a wide variety of platforms and software packages.

2 Course Objectives

The objective of this course is to provide a working knowledge of the concepts, techniques and currently available tools for scientific visualization. The attendee can expect to gain not only an overall view of the field of scientific visualization but also specific methods for solving scientific visualization problems. Attendees will walk away with a clear idea of what procedures are followed when creating images from scientific data.

3 Level/Background

We anticipate that the typical attendee will have had little exposure to current scientific visualization tools and techniques. Attendee should be familiar with scientific data sets and fundamental mathematics and some previous introduction to computer graphics would be quite useful.

1 Course Schedule

8:30am - 8:45am

Introduction 15 mins Instructor: Chuck Hansen
Introduction to the course, instructors, outline and overview

8:45am - 9:15am

Use of Color 30 mins Instructor: Chuck Hansen
Introduction to the effective use of color in scientific visualization.

9:15am - 10:15

2D scalar data 60 mins Instructor: Mike Krogh
Tools and techniques for visualizing 2D scalar data.
Use of colormaps, imaging principles, image enhancement.

10:15 - 10:30

Break 15 mins
relax

10:30 - 11:30

3D scalar data 60 mins Instructor: Todd Elvins
Tools and techniques for visualization of 3D scalar data (volume visualization).
Geometry based volume visualization, ray casting techniques.
When is it useful and when is it not.

11:30 - noon

2D and 3D vector data 30 mins Instructor: Chuck Hansen
Tools and techniques for visualization of 3D vector fields.
Use of 3D glyphs both static and dynamic.
How to combine these with scalar information.

noon - 1:30pm

Lunch 90 mins
yum-yum

1:30 - 2:30

Unstructured data 60 mins

Instructor: Alex Yarmarkovich

Instructor: Larry Gelberg

Tools and techniques for visualizing scientific data based on unstructured grids.

Problems and solutions for handling such data sets.

2:30 - 3:30

Data models 60 mins

Instructor: Lloyd Treinish

Problems when dealing with scientific data sets.

What is a data model and why is a data model necessary.

Examples of existing solutions.

3:30 - 3:45

Break 15 mins

relax

3:45 - 4:45

Multivariate Data 60 mins

Instructor: Gregory Nielson

Cases where one variable is identified as being dependent on the other, independent variables.

Methods for surface-on-surface and volumetric data.

4:45 - 5:00

Closing Summary 15 mins

Instructor: Chuck Hansen

1 Lecturer Biographies

Chuck Hansen

Chuck Hansen is project leader for visualization in the Advanced Computing Laboratory (ACL) at Los Alamos National Laboratory. He is responsible for the scientific visualization environment for the DOE High Performance Computing Research Center at the ACL. He has extensive experience in the field of scientific visualization particularly as it applies to very large scale computational environments.

Dr Hansen received his BS from Memphis State University in 1981. He received a PhD in Computer Science from the University of Utah in 1987. He was a Bourse de Chateaubriand PostDoc Fellow at INRIA, Rocquencourt France, in 1987 and 1988. He was a visiting faculty member at the University of Utah prior to joining the LANL technical staff. In addition to his duties at LANL, he serves as an adjunct faculty member at the University of New Mexico and New Mexico Tech. His research interests include scientific visualization, 3D shape representation and geometry, and computer vision. Dr. Hansen has organized and participated in short courses on computer graphics and scientific visualization.

Mike Krogh

Michael Krogh, NCSA Visualization Consultant Krogh is has been a Consultant at the National Center for Supercomputing Applications at the University of Illinois since 1987. Initially providing consulting and training on the NCSA supercomputers, he now specializes in scientific visualization and virtual reality. Krogh has also been an instructor for Parkland College's Visualization Curriculum. He has a B.S. in Computer Science/Mathematics from the University of Illinois and expects to complete a M.S. in Computer Science this summer. Krogh is a member of ACM and IEEE.

T. Todd Elvins

T. Todd Elvins is an associate staff visualization programmer at the San Diego Supercomputer Center (SDSC) in San Diego, California, where he works in a group of software engineers and animators who research new computer graphics techniques that allow scientists to gain greater insight into a broad variety of scientific problems. He was involved in the design and implementation of the SDSC Advanced Scientific Visualization Laboratory and has participated in numerous collaborative visualization projects with SDSC scientists.

The San Diego Supercomputer Center (SDSC) is one of four centers in the United States created by the National Science Foundation to foster and support research through computational science. SDSC is operated by General Atomics, is part of the University of California, San Diego, and receives support from the National Science Foundation and the State of California.

Larry Gelberg

Larry Gelberg is a Member of the Technical Staff at Advanced Visual Systems Inc. He is a programmer and designer of the AVS (Application Visualization System) visualization environment. His interests include scientific visualization, computer graphics, and computer animation. Prior to working for Advanced Visual Systems Inc., he was employed by Stardent Computer in the Visualization Software Group and by TASC (The Analytic Sciences Corporation) in their Imaging Technologies Section. Mr. Gelberg received his B.S. in Computer Engineering from Boston University in 1981. He is a member of ACM-SIGGRAPH.

Alexander Yarmarkovich

Alexander Yarmarkovich is a Member of the Technical Staff at Advanced Visual Systems Inc. He is a programmer and designer of the AVS (Application Visualization System) unstructured data models and algorithms. His interests include scientific visualization, numerical methods, finite element analysis. Prior to working for Advanced Visual Systems, he worked on the AVS product at Stardent Computer. Prior to Stardent Computer he worked for Aries Technology, in the Finite Element Modeling group and for Creare Inc., in the CFD group. Mr. Yarmarkovich received his M.S. in Applied Mathematics from Moscow University, USSR in 1983.

Lloyd A. Treinish

Lloyd A. Treinish is a research staff member in the Scientific Visualization Systems Group in the Computer Sciences Department at IBM's Thomas J. Watson Research Center in Yorktown Heights, NY. He works on techniques, architectures and applications of data visualization for a wide variety of scientific disciplines. His research interests range from computer graphics, data storage structures, data representation methodologies, data base management, computer user interfaces, and data analysis algorithms to climatology, cartography, space plasma physics and planetary astronomy. Particularly, Mr. Treinish is interested in generic or discipline-independent techniques for the storage, manipulation, analysis and display of data. Earlier he did similar work in the development of advanced scientific data systems, including studying space and atmospheric phenomena, for over a decade at the National Space Science Data Center of NASA's Goddard Space Flight Center in Greenbelt, MD. A 1978 graduate of the Massachusetts Institute of Technology with an S.M. and an S.B. in physics, and an S.B. in earth and planetary sciences, Mr. Treinish has been at IBM since April 1990. He is a member of the IEEE Computer Society (IEEE-CS), the IEEE-CS Technical Committee on Computer Graphics, the Association for Computing Machinery (ACM), ACM SIGGRAPH, the National Computer Graphics Association, the Planetary Society, and the American Geophysical Union.

Gregory M. Nielson

Gregory M. Nielson is a professor of computer science and adjunct professor of mathematics at Arizona State University where he teaches and does research in the areas of Computer Graphics, Computer Aided Geometric Design and Scientific Visualization. He has lectured and published widely on the topics of curve and surface representation and design; interactive computer graphics; scattered data interpolation; and the analysis and visualization of multivariate data. He has collaborated with several institutions including NASA, Xerox, and General Motors. He is a participatory guest scientist at Lawrence Livermore National Laboratory.

Professor Nielson is on the editorial board of ACM's Transactions on Graphics, the Rocky Mountain Journal of Mathematics, Computer Aided Geometric Design, Visualization and Computer Animation Journal, Computer Graphics and Applications and the new Russian Journal on Computer Graphics.

He is one of the founders and members of the steering committee of the IEEE sponsored conference series on Visualization and he currently chairs the IEEE Computer Society Technical Committee on Computer Graphics. He is also a member of ACM and SIAM. Professor Nielson received his Ph.D. from the University of Utah in 1970.