SIGGRAPH 93
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on Computer Graphics and
Interactive Techniques

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COURSE NOTES 02

Introduction to Scientific Visualization Tools and Techniques

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Table of Contents

Course Overview

Course Description	1 - 1
Schedule	1 - 2
Lecturer Biographies	1 - 3

Use of Color — Mike Bailey

Guidelines for the Use of Color	1 - 1

2D scalar data — Mike Krogh

Lecture Slides	2 - 1
Reading List for 2D Fields	2 - 8
NCSA Sci Vis Software Suite	2 - 9
Raster Graphics and HDF	2 - 15
Color Sequences for Univariate Maps	2 - 26

3D scalar data — Todd Elvins

Lecture Slides	3 - 1
Volume Visualisation Systems	3 - 12
Survey of Algorithms for Volume Visualisation	3 - 13
Annotated Bibliography	3 - 20

Vector Data — Chuck Hansen

Lecture Slides	4 - 1
Visualisation of Vector Fields	4 - 4
The *Stream* polygon	4 - 11
The Virutal Windtunnel	4 - 18
Moving Iconic Objects in Sci Vis	4 - 26

Data Models — Chuck Hansen

Lecture Slides	5 - 1
Intro to Data Management Methods for Sci Vis	5 - 5
Background	5 - 6
Data Characteristics	5 - 7
Implementations and Techniques	5 - 15
Metadata	5 - 21
Evaluation Criteria	5 - 23
Addtional Reading	5 - 26
Table of Selected Software	5 - 29
NetCDF An Interface for Scientific Data Acess	5 - 36

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 and Mike Bailey
Introduction to the course, instructors, outline and overview

8 45am 10 15am

Use of Color 90 mins Instructor Mike Bailey
Introduction to the effective use of color in scientific visualisation

10 15 10 30

Break 15 mins
relax

10 30am noon

2D scalar data 90 mins Instructor Mike Krogh
Tools and techniques for visualising 2D scalar data
Use of colormaps, imaging principles, image enhancement

noon 1 30pm

Lunch 90 mins
yum yum

1 30pm 3 15pm

3D scalar data 105 mins Instructor Todd Elvins
Tools and techniques for visualisation of 3D scalar data (volume visualisation)
Geometry based volume visualisation, ray casting techniques
When is it useful and when is it not

3 15pm 3 30pm

Break 15 mins
relax

3 30pm 4 15pm

2D and 3D vector data 45 mins Instructor Chuck Hansen
Tools and techniques for visualisation of 3D vector fields
Use of 3D glyphs both static and dynamic
How to combine these with scalar information

4 15pm 4 45pm

Data models 30 mins Instructor Chuck Hansen
Problems when dealing with scientific data sets
What is a data model and why is a data model necessary
Examples of existing solutions

4 45pm - 5 00pm

Closing Summary 15 mins Instructor Chuck Hansen

1 Lecturer Biographies

Mike Bailey

Mike Bailey is the Manager of Scientific Visualization at the San Diego Supercomputer Center in San Diego, CA

Mike received his PhD from Purdue University in Computer Aided Design and Com puter Graphics in 1979 From 1979- 1981 he was a member of Sandia National Laboratories' Technical Staff, specializing in developing CAD/graphics tools for mechanical designers From 1981-1985, Mike served on the faculty of Purdue University, where he taught and conducted research in the areas of computer graphics and computer aided mechanical engineering In 1984, Mike was awarded the Society of Automotive Engineers (SAE) Ralph Teetor award for excellence in teaching He was promoted to the rank of Associate Professor in 1985 In 1985, Mike becam e the Director of Advanced Development at Megatek, where he managed a group of engineers who were charged with developing Megatek's next generation of computer graphics technology

In 1989, Mike accepted the position at the San Diego Supercomputer Center (SDSC), one of four National Science Foundation supercomputer centers in the country Mike heads a group of software engineers and artists/animators who research new techniques in c omputer graphics Mike and his group collaborate with some of the nearly-3000 SDSC users as they apply visualization techniques to better understand a broad variety of scientific problems In addition, Mike holds a joint appointment as an Adjunct Professor in Applied Mechanics and Engineering Sciences at the University of Cali fornia at San Diego and uses this as a vehicle to teach computer graphics and scientific visualization at the undergraduate and graduate levels

Mike is a member of the Association of Computing Machinery (ACM), the Specal Interest Group on Computer Graphics (ACM SIGGRAPH), the National Computer Graphics Association (NCGA), and the American Society of Mechanical Engineers (ASME) Mike served on the ACM-SIGGRAPH national Executive Committee from 1986-1990 He has served as chair of the courses program at the SIGGRAPH inter national conferences in 1984, 1985, 1987, and 1988 He recently served as co-chair for the 1991 SIGGRAPH international conference

Mike's areas of interest include high performance computer graphics, scientific visualization, graphics hardcopy, geometric modeling, and computer aided mechanical design and analysis

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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 Cen ter 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

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Michael Krogh

Michael Krogh is member of the visualization team in the Advanced Computing Lab (ACL) at Los Alamos National Laboratory He is involved with developing visualiza tion software for Thinking Machines Corporation CM 5 and various graphics systems located in the ACL He is also involved with distributed processing

Prior to joining the ACL, Krogh was member of the Visualization Group in the National Center for Supercomputing Applications at the University of Illinois There he was involved with development, consulting, and training on scientific visualization, and virtual reality, and various supercomputers Krogh has also been an instructor for Parkland College's Visualization Curriculum He has a B S in Computer Sci ence/Mathematics and a M S in Computer Science from the University of Illinois Krogh is a member of ACM and IEEE

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T **Todd Elvins** Todd Elvins is an associate staff visualization programmer at the San Diego Supercomputer Center (SDSC) in San Diego, California, USA Todd earned a B A in Business Economics and a B S in Computer Science, both at U C Santa Barbara, and a M S in Computer Science at the University of Utah He worked at Culler Scientific Systems in Santa Barbara, California from 1984 to 1986 where he developed system software for a minisupercomputer project

In 1988, Todd accepted a position at SDSC, one of four National Science Foundation supercomputer centers in the country 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 Todd has also been involved in the design and implementation of the SDSC Advanced Scientific Visualization Laboratory and has participated in numerous collaborative visualization projects with some of the nearly 3000 SDSC users Todd has been active in the computer graphics community for the past seven years, has participated in numerous conferences, courses, and workshops, and has spoken at many visualization meetings including a 1990 SIGGRAPH course entitled "State of the Art in Data Visualization", a 1992 SIGGRAPH course entitled "Introduction to Scientific Visualization Tools and Techniques" He served as Conference Chairman for the 1990 San Diego Workshop on Volume Visualization, and he chaired a SIGGRAPH 1991 panel entitled "Scientific Visualization on Advanced Architectures"

Todd has lectured on volume visualization for Eurographics in the U K , for the University of California, San Diego, and for GraphiCon'92 in Russia Todd also spoken on volume visualization for IBM in Austria, for SIBGRAPI in Brazil, and for INTEVEP in Venezuela

Todd has published several technical papers on visualization and volume visualization, has contributed to several textbooks, and is an enthusiastic speaker and teacher He is a member of the Association of Computing Machinery, the Special Interest Group on Computer Graphics, the Sun Users Group, and the Institute of Electrical and Electronic Engineers Technical Committee on Computer Graphics

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