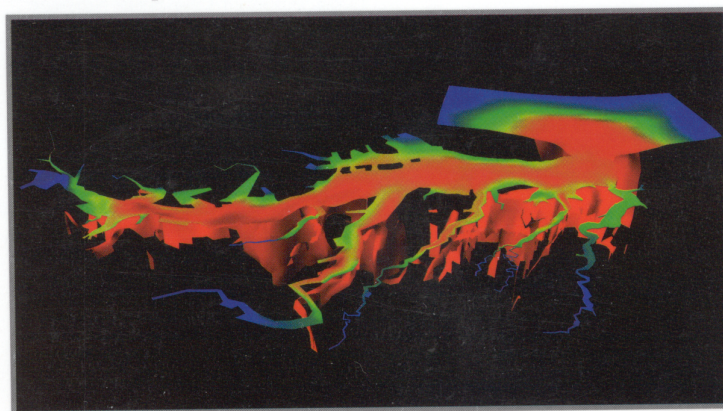


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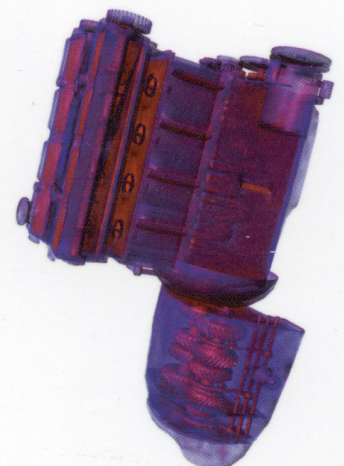
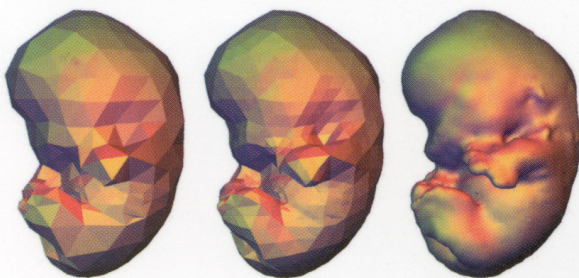
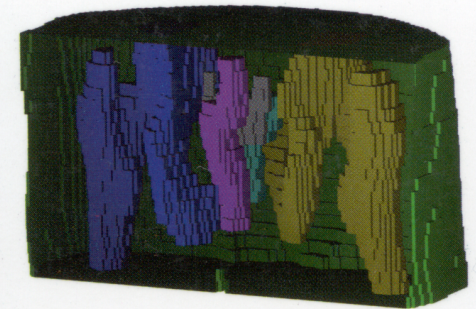
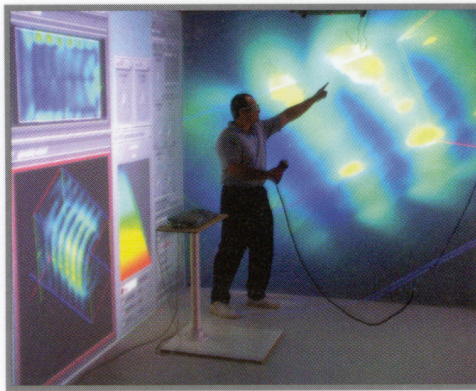
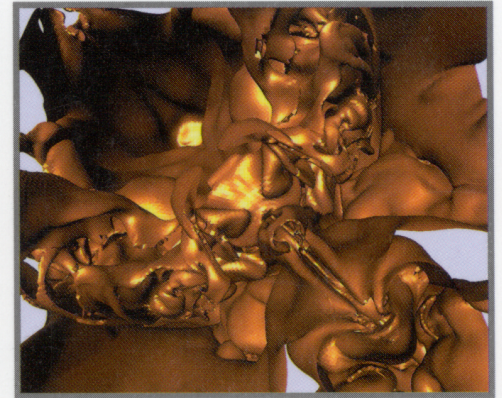
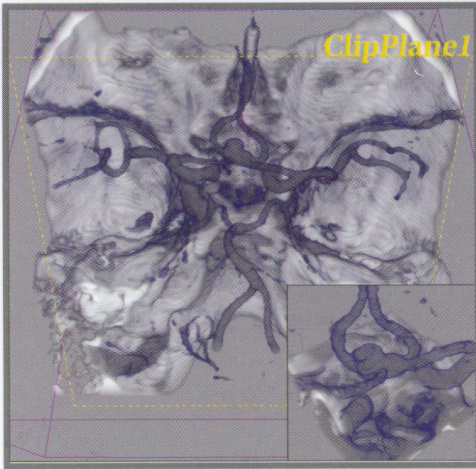
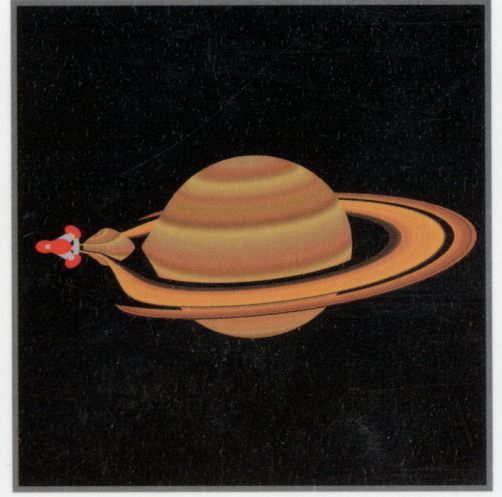
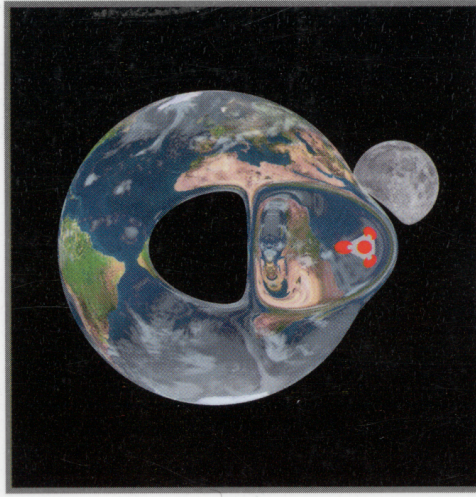
OCTOBER 8 – OCTOBER 13, 2000
SALT LAKE CITY, UTAH
EDITED BY THOMAS ERTL, BERND
HAMANN AND AMITABH VARSHNEY



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Preface

Welcome to IEEE Visualization 2000! We are pleased to present to you in this volume the proceedings of IEEE Visualization 2000, being held during October 8 — 13, 2000 in Salt Lake City, Utah. As we move forward to a new millennium, we find that the visualization technologies have permeated almost all facets of human endeavors in science, engineering, medicine, and entertainment and are undeniably influencing the very quality of our lives. As the ubiquity of visualization has grown over the last few decades, so too has the scope of this conference. This year the conference provides an intellectually stimulating program spanning a diverse set of applications, a rich set of data and information representations, and a variety of algorithms and systems. We see this conference as fulfilling the important mission of providing a forum to promote interaction amongst researchers, developers, and users of various visualization technologies and applications. This annual Visualization Conference series is sponsored by the IEEE Computer Society's Technical Committee on Visualization and Graphics in cooperation with ACM SIGGRAPH. We hope that you will find this year's program tightly packed with exciting papers, educational case studies, and thought-provoking panels between the visionary keynote and the capstone sessions.

Keynote and Capstone Addresses

We are delighted to have Michael Cohen from Microsoft Research as this year's keynote speaker. In his Keynote address "Visualization of Everyday Things", he shares with us his insights on how visualization can help us reveal the hidden structure and beauty around us in our everyday lives.

It is our pleasure to have Olivier Faugeras from INRIA, France and EE and CS Departments at MIT, conclude the conference with his Capstone address "Variational Methods in Medical Imagery: Application to the Segmentation of Anatomical Structures". He will discuss general design principles behind the use of variational methods for solving segmentation problems based on the geometric information about the target structures.

Papers

This year the conference received 151 paper submissions of which 52 were selected by peer review to appear in these proceedings. This represents an increase of about 20% in paper submissions over the previous year. Another milestone this year has been the introduction of electronic submission of papers in addition to the regular hardcopy submissions. We were pleasantly surprised by the enthusiastic and hearty response to our introduction of electronic submissions. As many as 128 papers were submitted electronically this year. We also received several positive comments from members of the Papers Committee and reviewers on electronic availability of papers which allowed them to download the papers from home and while traveling. Although this mode of dual submissions increased the work load of ensuring consistency in the conference databases, we view this as an essential step in the longer-term vision of an all-electronic submission and review process. The

electronic submissions and review for the conference were greatly assisted by the START conference management software written by Rich Gerber, Jeff Hollingsworth, and Adam Porter from the University of Maryland at College Park.

To maintain the high quality and fairness of the selection process, this year's Papers Committee consisted of 23 visualization researchers, all leaders and visionaries in their respective areas of research from around the world. Each member of the Papers Committee was responsible for reviewing, summarizing, and calibrating the scores of reviewers for all the papers assigned to him/her. We feel that this process allowed a better comparative evaluation of papers as well as distributed the decision-making process more fairly. In case of a potential conflict of interest for a reviewer, a Papers Committee member, or a Papers Co-Chair, the paper was reviewed and evaluated by alternates. The members of the Papers Committee this year were:

Georges-Pierre Bonneau
Alan Chalmers
Daniel Cohen-Or
Leila De Floriani
David Ebert
Stephen G. Eick
A. Robin Forrest
Tom Funkhouser
Markus Gross
Hans Hagen
William Hibbard
Victoria Interrante

David Kenwright
Hans-Georg Pagendarm
James Painter
Alex Pang
Hanspeter Pfister
Holly Rushmeier
Jarek Rossignac
Claudio Silva
Samuel P. Uselton
Jarke van Wijk
William Wright

The growing influence of the visualization algorithms, software, and systems is clear from the rise in the quality as well as the quantity of papers submitted and accepted by the conference this year. The accepted papers cover a broad spectrum of research topics including biomedical and scientific applications, information visualization, visual and haptic displays, visual perception, flow visualization, tetrahedral grids, volume rendering, isosurfaces and polygonal meshes, and multi-dimensional visualization systems. This compilation of high-quality research would not have been possible without the hard work and diligence of the authors as well as the reviewers. The authors of the selected papers are acknowledged through their work presented in these proceedings. We would especially like to acknowledge the conscientious and thorough reviews provided by the reviewers, several of whom took precious time off from their jobs, job searches, sabbaticals, and even summer vacations, with hardly any tangible rewards, except for the satisfaction from a job well done and from furthering the cutting-edge in visualization research. This year we solicited expert opinions from the following 227 reviewers:

James P. Ahrens
 Marc Alexa
 Lisa Sobierajski Avila
 Norman Badler
 Mike Bailey
 Chandrajit Bajaj
 H. Harlyn Baker
 Pauline M. Baker
 David C. Banks
 Dirk Bartz
 Stephen A. Benton
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 Sabine Coquillart
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 Roger A. Crawfis
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 Tali Dafner
 Stephan Diehl
 Mark Duchaineau
 Jihad El-Sana
 David Ellsworth
 José Encarnação
 Klaus Engel
 Robert F. Erbacher
 Francine Evans
 Norberto Ezquerro
 Shiaofen Fang
 Steve Feiner
 James D. Foley
 David F. Fracchia
 Sarah F. Frisken
 Bernd Fröhlich
 Martin Frühauf
 Henry Fuchs
 Issei Fujishiro
 Fabio Ganovelli
 Michael Garland
 Michael J. Gerald-Yamasaki
 Martin Göbel
 Michael Goss
 Craig Gotsman
 Michel Grave
 Günther Greiner
 Georges Grinstein
 Eduard Gröller
 Andre P. Gueziec
 Stefan Gumhold
 Baining Guo
 Stefanie Hahmann
 James Kwangjune Hahn
 Robert Haines
 Charles Hansen
 Andrew Hanson

Xuejun Hao
 John Hart
 Peter Hastreiter
 Helwig Hauser
 Taosong He
 Chris Henze
 Lambertus Hesselink
 Karl Heinz Höhne
 Lichan Hong
 Matthew C. Humphrey
 Alfred Inselberg
 Takayuki Itoh
 T.J. Jankun-Kelly
 Chris Johnson
 Kenneth I. Joy
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 Rolf van Lengen
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 Mark Livingston
 Suresh K. Lodha
 William Lorensen
 Lin Luo
 Kwan-Liu Ma
 Raghu Machiraju
 Nadia Magnenat-Thalmann
 Gordon D Mallinson
 Tom Malzbender
 Dinesh Manocha
 Kenneth M. Martin
 Robert McDermott
 Kevin McDonnell
 Michael Meißner
 Dimitri Metaxas
 Jörg Meyer
 Christopher Migdal
 Torsten Möller
 Robert J. Moorhead
 Heinrich Müller
 Klaus Mueller
 Shigeru Muraki
 Ken Musgrave

Karol Myszkowski
 Peter Neugebauer
 Ulrich Neumann
 Gregory Nielson
 Chris North
 Art Olson
 Renato Pajarola
 Rick Parent
 Jun Park
 Steve Parker
 Valerio Pascucci
 Ronald Peikert
 Andreas Pommert
 Frits Post
 Enrico Puppo
 Werner Purgathofer
 Huamin Qu
 Christoph Ramshorn
 Dave Reed
 Freek Reinders
 Penny Rheingans
 Theresa-Marie Rhyne
 Bill Ribarsky
 Kay A. Robbins
 Jonathan C. Roberts
 Lawrence Rosenblum
 Martin Roth
 Martin Rumpf
 Georgios Sakas
 Richard Salter
 Andrea Sanna
 Dietmar Saupe
 Gerik Scheuermann
 Daniel R. Schikore
 Florian Schröder
 Will Schroeder
 Roberto Scopigno
 Hans-Peter Seidel
 Hikmet Senay
 Jonathon Shade
 Ariel Shamir
 Naeem O. Shareef
 Raj Shekhar
 Han-Wei Shen
 Peter Shirley
 Ben Shneiderman

David Sigeti
 Kris Sikorski
 Deborah Silver
 Kenneth R. Sloan
 Peter-Pike Sloan
 Hans J.W. Spoelder
 Oliver G. Staadt
 Detlev Stalling
 Wolfgang Straßer
 Werner Stuetzle
 Philip M. Sutton
 Edward Swan
 Ayellet Tal
 Russell M. Taylor
 Demetri Terzopoulos
 Jim Thomas
 Ulf Tiede
 Lloyd Treinish
 Greg Turk
 Mike Vannier
 Luiz Velho
 Guy Vezina
 Keith Voegelé
 Stefan Walter
 Matthew Ward
 Gunther Weber
 Manfred Weiler
 Henrik Weimer
 David Weinstein
 Daniel Weiskopf
 Rüdiger Westermann
 Ross T. Whitaker
 Mary C. Whitton
 Allan R. Wilks
 Craig M. Wittenbrink
 Hans Jurgen Wolters
 Pak C. Wong
 Helen Wright
 John R. Wright
 Yunnan Wu
 Roni Yagel
 Terry S. Yoo
 Ilmi Yoon
 Suya You
 Michael Zyda

The Papers Co-Chairs are particularly thankful to Aravind Kalaiah and Xuejun Hao, graduate students at SUNY Stony Brook and now at the University of Maryland at College Park, for their substantial help in keeping the papers submission and reviewing process moving smoothly. We would also like to acknowledge the timely and generous cooperation of several staff at the Center for Visual Computing, SUNY Stony Brook, including Brian Tria, Anne Kilarjian, and Stella Mannino.

Case Studies

This year the Visualization conference has selected an eclectic mix of 21 Case Studies that document and report the experiences of visualization researchers and practitioners on a diverse set of visualization applications and techniques. The application areas cover biomedical, scientific, environmental, information, and physics applications. This uniquely impressive, educational, and high-quality track at this conference has been organized by the Case Studies Co-Chairs, David Kao, (NASA Ames) and Robert van Liere (Center for Mathematics and Computer Science, Amsterdam). They were assisted in their efforts by the conscientious and diligent reviewing by these 43 experts:

Dirk Bartz	Wim de Leeuw
Barry Becker	Wilfred Lefer
Dan Bergeron	Kwan-Liu Ma
Edwin Blake	Robert Moorehead
Ken Brodlie	Jurriaan Mulder
Tom Crockett	Heinrich Müller
Shiaofen Fang	Patrick J. Moran
Issei Fujshiro	Frits Post
David F. Fracchia	Freek Reinders
Michael Gerald-Yamasaki	Georgios Sakas
Martin Göbel	Dieter Schmalstieg
Eduard Gröller	Han-Wei Shen
Hans Hagen	Deborah Silver
Robert Haimes	Lloyd Trensih
Andrew Hansen	Keith Voge
Helwig Hauser	Val Watson
Chris Henze	Peter Williams
Ivan Herman	Craig Wittenbrink
William Hibbard	Jack van Wijk
Victoria Interrante	Hans Wolters
Jaap Kaandorp	Pak Wong
Ulrich Lang	

Panels

The panels track at the Visualization conference provides an interactive forum to present and debate interesting and controversial topics of current and future interest. The Panels Co-Chairs Rachael Brady (Beckman Institute, Urbana-Champaign), Jamie Painter (TurboLinux Turbolabs, New Mexico), and Michael Goss (Hewlett-Packard Laboratories) have selected a set of three panels presented and moderated by the experts in the field. The panels will discuss the impact of computer games on the field of visualization, the selection and role of transfer functions in visualization, and next-generation visualization displays.

Video

As every year, the proceedings are accompanied by a collection of submitted videos. Thanks are due to the Video Chair, Robert J. McDermott, for his professional work and dedication in producing the video proceedings.

CD-ROM

As in the years before, the papers, case studies, panels, tutorials, and symposia are also provided electronically on a CD-ROM as a supplement to the proceedings. Thanks are due to Torsten Möller, this year's Publications Chair, for assembling and producing this material.

Additional Material

In addition to the material in the proceedings, IEEE Visualization 2000 includes two symposia, "Information Visualization" and "Volume Visualization and Graphics," and a workshop on "Semantic Visualization of Nonquantitative Relationships". The conference also features tutorials, demonstrations, a Creative Applications Lab, and Work in Progress.

Additional Acknowledgments

Many individuals, whose names are not mentioned above, have contributed many hours and significant efforts in making IEEE Visualization 2000 and these proceedings a success. We would like to warmly thank Conference Co-Chairs Charles Hansen, Chris Johnson, and Steve Bryson for their tireless dedication, coordination of all the activities, and valuable advice at every stage. We also thank the Program Co-Chairs David Ebert and Mike Bailey for being in constant touch with us and helping ensure that the process of submission, review, selection, and compilation proceeded smoothly. We would like to thank Richard Coffey and Nathan Galli, our logo designers. Finally, we owe a huge thanks to Torsten Möller (Simon-Fraser University), for his invaluable assistance in assembling the proceedings. Torsten's meticulous attention to detail, dedication, and talent are self-evident in the high quality production of the proceedings and CD-ROM. We would also like to thank Stephen Spencer for serving as a great resource and help in ensuring the smooth production of these proceedings.

We hope that you find Visualization 2000 conference and proceedings informative, thought-provoking, and useful and participate again in the Visualization '01 in San Diego, California.

Thomas Ertl, Bernd Hamann, and Amitabh Varshney
Papers Co-Chairs and Co-Editors of the IEEE Visualization 2000 Proceedings