DOE/ER/25137--T1

FINAL TECHNICAL REPORT

FOR

THE DEPARTMENT OF ENERGY

ON

DE-FG02-92ER25137

THE GEOMETRY CENTER
UNIVERSITY OF MINNESOTA
1300 SOUTH SECOND STREET, STE. 500
MINNEAPOLIS, MN 55454

November, 1995

DISCLAIMER

The Center's Mission Statement

The mission of the Geometry Center is to develop, support, and promote computational tools for visualizing geometric structures, for facilitating communication among mathematical and computer scientists and between these scientists and the public at large, and for stimulating research in geometry.

The Center's Overall Goals

1. To develop and maintain technological and computational tools for the visualization of geometric structures and for the communication of mathematics.

2. To disseminate and promote the use of geometric visualization technology in research and education throughout the mathematical and computer sciences communities.

3. To facilitate research in the mathematical and computer sciences by developing, maintaining, and promoting technological tools and by providing infrastructure support such as conferences, workshops, and visitor programs.

4. To develop, experiment with, and promote the use of visualization technology in mathematical sciences education at all levels.

5. To promote an awareness of the importance of the mathematical sciences in the larger scientific community, in the industrial community, and in the public at large.

6. The Center will promote cultural, gender, and ethnic diversity in all of its structures and programs.

The Postdoctoral Program

The resident research program of the Center is built upon the strength of the postdocs. The Center strives to recruit highly talented young scholars who are expected to have the scientific maturity to design and carry forth their own research programs, and are also expected to interact strongly in the full life of the Center, which includes the work of the technical staff and various activities in communication and education. In particular, they need to have substantial experience in computing.

Postdocs partially supported by the Department of Energy included:

Brad Barber	While at the Center, Dr. Barber's research revolved around algorithms that take into account imprecise data and finite-precision arithmetic, two fundamental aspects of computer programming that are frequently overlooked by algorithm developers and implementors. He is the creator of the *qhull* software program, an efficient process for computing the convex hull of a collection of points in any dimension. An enhanced version handled imprecise data and arithmetic and selective processing. It also provides a library interface to the qhull algorithms so that they can be included into user-written programs. This is the first convex-hull code to handle roundoff errors in three dimensions and higher.
Leonidas Palios	Dr. Palios augmented an existing C implementation of the polyhedron tetra-hedralization algorithm of Chazelle and Palios, so that graphical output readable by geomview is produced. This led to the production of the video "Tetrahedral Break-up." He also implemented an early version of his algorithm to tetrahedralize the 3D-region "between" a convex polyhedron and a convex polygon. The program was further augmented to produce graphical output, which can be piped to geomview, yielding an interactive animation. The program was used to create the video "tetrahedralizing the 3D-region Between a

Convex Polyhedron and a Convex Polygon: The Movie" animating the algorithm.

C. Goodman-Strauss — While at the Geometry Center, Dr. C. Goodman-Strauss pursued several projects. Primarily, he resolved a long standing question concerning aperiodic tilings of the plane and other spaces, proving that any substitution tiling of E^n, n>1 could be enforced by matching rules. This subsumed almost all known examples of aperiodic tilings. He also produced a much simpler aperiodic tiling of any E^n based on similarities of the cubic lattice. Many smaller projects were undertaken, such as deriving fractal froths of regular dodecahedra, developing physically realizable kaleidoscopes in which a viewer can see hyperbolic space, and finding efficient codings of adjacencies in symbolic dynamical systems and in the hypercube. He also pursued various educational iniatives.

The Short Term Visitor Program

Visitors to the Geometry Center find themselves in an excellent computing environment designed by and for mathematicians. This is a unique experience in the mathematical sciences community, and many visitors have made good use of it. Facilities are arranged so that visitors can get to work immediately, with none of the usual difficulties associated with a new computing environment.

There were 319 visits from 191 different visitors between February 1991 and June 1995. Visits lasted from one day to several months, with an average visit lasting about 9.6 days. Some visitors used the Center facilities and the computer expertise of the staff to develop programs, videos, or images. Others shared programs or research ideas, or collected teaching materials.

Much of the work at the Center is driven by visitor research, so staff members, apprentices, and student assistants are eager to get involved, helping with technical problems, offering suggestions, and sometimes writing programs.

Visitors partially supported by Department of Energy funds included:

Dennis Roseman	University of Iowa	8/12-18/94; 7/6-19/94; 8/27-29/93; 7/22-29/93; 5/1-7/93; 4/11-23/93; 3/21-27/93; 3/1-12/93; 2/8-19/93; 1/6-29/93
James Curry	University of Colorado	7/20-26/94
Andrzej Stasiak	Lab. d'Analyse Ultrastructurale, Switzerland	7/5-29/94
John Maddocks	University of Maryland	7/29-30/94
Michael Tabor	University of Arizona	7/29-30/94
Richard Handell	University of Iowa	7/29-30/94
Michael Kowalczyk	University of Tennessee	5/21-27/94
Andrew Stone	Stanford University	5/23-27/94
John Stern	ANU, Australia	5/23-27/94
Wilhelm Schlag	University of California, Berkeley	5/22-29/94
Juan J. Abad	University of Texas, Austin	5/22-28/94
Alexander Vologodskii	University of California, Berkeley	7/24-31/94; 3/22-26/93
Uwe Mayer	University of Utah	5/23-27/94
Steve Kerckhoff	Stanford University	5/21-22/94; 8/20-24/93
Stacy Green	Hurst, TX	5/31-6/2/94
Robert Meyerhoff	Boston University	6/3-11/94; 3/9-13/94; 9/11-14/93
Scott Sutherland	SUNY, Stony Brook	6/22-29/94
D.D. Hilke	Maryland Science Center	7/9-12/94
Stephanie Ratcliffe	Maryland Science Center	7/9-12/94
Jean Taylor	Rutgers University	5/23-28/94
Judy Moran	Trinity College	4/17-30/94
Bruce Peckham	University of Minnesota, Duluth	3/29/94
Jim King	University of Washington	3/31-4/13/94
David Dobkin	Princeton University	3/4-5/94; 2/1-5/93
Viet Elser	Cornell University	11/18-20/93

Leonidas Guibas	Stanford University	11/14-17/93
Mark Levi	Rensselaer Polytechnic Institute	11/17-19/93
Ken Stephenson	University of Tennessee	10/20-24/93
Rob Kusner	University of Massachusetts	7/16-18/93; 9/1-5/93; 2/3-8/93
Robert Almgren	University of Chicago	8/9-20/93; 2/18/93
William Goldman	University of Maryland	9/13-14/93
Peter Doyle	University of California, San Diego	8/31-9/5/93; 3/22-26/93
David Anderson	Rutgers University	8/5-27/93
Troels Jorgensen	Columbia University	8/1-6/93; 11/19-22/92
David Caraballo	Princeton University	8/7-28/93
NungKwan Yip	Princeton University	8/7-27/93
John Harer	Duke University	8/21-24/93
Andrew Roosen	Rutgers University	8/16-27/93
Craig Carter	NIST	8/21-27/93
Joe Christy	MSRI	7/18-21/93; 3/22-26/93
Jeffrey Weeks	Canton, NY	7/18-21/93; 3/22-26/93
Ted Stanford	Columbia University	6/7-7/31/93; 3/22-26/93
Herb Clemens	University of Utah	7/17-19/93; 10/29-31/92
Daniel Asimov	NASA Ames Research Center	5/24-27/93
Bill Floyd	VPI&SU	5/11-22/93
Jim Cannon	Brigham Young University	5/11-22/93
Frank Quinn	VPI&SU	5/20-23/93
Greg McSchane	University of Warwick, England	5/10-6/3/93
Hui Ma	Indiana University	5/8-21/93
Glenn Chappell	University of Illinois, Urbana-Champaign	5/17-22/93
Chris Hartman	University of Illinois, Urbana-Champaign	5/17-22/93
Ian Redfern	University of Warwick, England	5/10-6/3/93
Andrew Hanson	Indiana University	5/5-12/93; 1/24-26/93
Ayellet Tal	Princeton University	4/26-30/93
Barry Merriman	University of California, Los Angeles	5/12-15/93
Mitsuyuki Ochiai	Nara Women's University, Japan	3/18-4/14/93
Katsuhiko Matsuzaki	Tokyo Institute of Technology, Japan	5/21-6/12/93
Ruth Gornet	Washington University	4/27-28/93
Harold Parks	Oregon State University	4/18-25/93
James White	University of California, Los Angeles	3/22-26/93
Louis Kauffman	University of Illinois, Chicago	3/21-25/93
Amir Assadi	University of Wisconsin, Madison	3/5-15/93
Scott Carter	University of Southern Alabama	3/21-25/93
Audun Holme	University of Bergen, Norway	2/15-19/93; 2/16-19/93
Tony Robbin	New York	3/20-26/93
Adam Deaton	Princeton University	2/1-7/93
Stan Tenen	Meru Foundation	3/21-25/93
Marjorie Senechal	Smith College	3/15-19/93
David Broman	Rice University	3/20-26/93
Greg Buck	St. Anselm College	3/21-28/93
Sostenes Lins	Recife, Brazil	3/20-4/6/93
Andras Stipsicz	Rutgers University	3/27-4/25/93
Alfred Gray	University of Maryland	3/16-21/93
Peter Wolfenden	University of California, Los Angeles	3/22-26/93
Morwen Thistlethwaite	University of Tennessee	3/22-26/93
DeWitt Sumners	Florida State University	3/22-26/93
Dev Sinha	MIT	3/22-26/93
Dale Rolfsen	University of British Columbia	3/22-26/93
Jozef Przyticki	Odense University, Denmark	3/22-26/93
Ken Millett	University of California, Santa Barbara	3/22-26/93
Sam Lomonaco	University of Maryland	3/21-27/93
Philip Holmes	Cornell University	3/21-26/93

Claus Ernst	Western Kentucky University	3/22-26/93
John Emert	Ball State University	3/22-26/93
Yuanan Diao	Kennesaw State College	3/22-26/93
Kenneth Bromberg	Brown University	3/22-26/93
Thomas Banchoff	Brown University	3/22-26/93
Stephen Zoren	University of Michigan	1/14/93
George Francis	University of Illinois, Urbana-Champaign	1/18-26/93
Patrick Hanrahan	Princeton University	1/8-10/93
Henry Wente	University of Toledo	1/27-2/2/93
William Thurston	Princeton University	1/8-11/93
Fred Almgren	Princeton University	1/8-10/93
Bob Riley	SUNY, Binghamton	11/15-21/92
John Lott	University of Michigan, Ann Arbor	11/5-7/92
Steve Rumsby	University of Warwick, England	11/7-13/92
Michael Hirsch	Princeton University	10/28-11/4/92
Jim Cobb	IBM	10/28-11/1/92

The Technical Staff

The Center's systems administrator, Scott Bertilson, was supported under this grant. His job duties included, but were not limited to:

- Installation, maintenance, and inventory tracking of hardware;
- Serving as the Center's liaison with hardware vendors. Collecting and filing price and other information regarding specific equipment, and making recommendations regarding what equipment the Center should purchase.
- Installation, documentation, and maintenance of software on the Center's computer system.
- Management of the daily operation of the Center's computer system, including tape backups, printer and ohter peripheral device maintenance, basic user support, and hardware and software maintenance. In addition to the above general responsibilities, the person will train and supervise apprentices, undergraduate students, and graduate students to assist in carrying out the above functions.