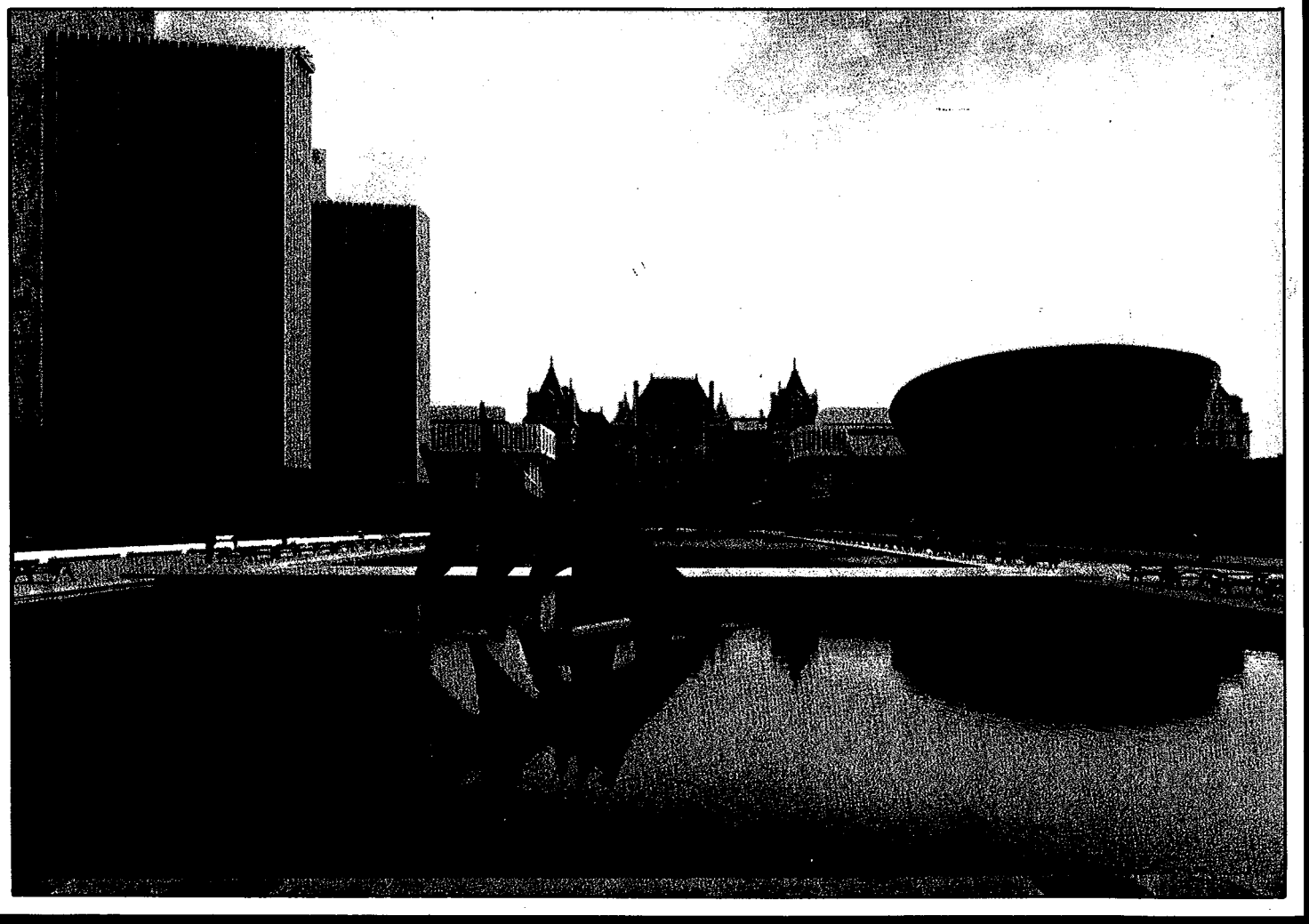
SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS

SIAM CONFERENCE ON APPLIED GEOMETRY July 20–24, 1987

Hilton Hotel • Albany, New York



SHORT COURSE

Short Course on Uses of Surfaces in Industry: Geometric Modeling, Machine Vision, and Motion Planning
Sunday, July 19
Albany Hilton, Ballroom A-B

This course will focus on the various aspects of mathematical representations of surfaces with emphasis on their actual or potential use for solving industrial problems.

Speakers: Paul Besl, General Motors Research Laboratories; Rida Farouki, IBM T. J. Watson Research Center; Gordon Wilfong, AT&T Bell Laboratories; Ramon Sarraga (Organizer), General Motors Research Laboratories.

The course will provide a fairly broad introduction to both fundamental mathematical problems and engineering applications.

Themes

- Motion Planning around Polyhedral Obstacles
- Role of Surfaces in Computer Vision
- Boundary Evaluation in CAD/CAM Solid Modeling Systems
- Surface Modeling Problems

There will be a panel question-and-answer period at the end of the program. Preprints of the lecture materials will be distributed upon check-in.

Attendees should pre-register for the short course, as on-site registration cannot be guaranteed.

PROGRAM

8:30 AM **Motion Planning**
Gordon Wilfong

10:00 AM Coffee

10:30 AM **Surfaces in Computer Vision**
Paul Besl

12:00 PM Lunch

1:30 PM **Computational Issues in Solid Boundary Evaluation**
Rida Farouki

3:00 PM Coffee

3:30 PM **G-1 Bézier Patching of Irregular Surface Shapes**
Ramon Sarraga

5:15 PM **Program Adjourns**

Registration Fees

	SIAM Member	Non-Member	Student Member	Student Non-Member
Advance	$75	$ 90	$30	$40
On-Site	$90	$105	$40	$50

* Registration fee includes preprints and lunch

TABLE OF CONTENTS

ORGANIZING COMMITTEE

Harry McLaughlin, Chair
Rensselaer Polytechnic Institute

Carl de Boor, University of Wisconsin, Madison

David R. Ferguson, Boeing Computer Services

John Hopcroft, Cornell University

Leon Seitelman, Pratt & Whitney Aircraft Co.

Ramon Sarraga, General Motors Research Laboratories

Michael Wozny, National Science Foundation (on leave from Rensselaer Polytechnic Institute)

Special Functions

Welcoming Reception
Sunday, July 19, 8:00 PM
Prefunction Area, Ballroom Level
Cash Bar

Beer Party
Monday, July 20, 6:15 PM
Prefunction Area, Ballroom Level
$10.00

Dinner and Ballet
Wednesday, July 22, 5:15 PM
Saratoga Performing Arts Center
$34.00

Coppelia, performed by the New York City Ballet, music by Leo Delibes and choreographed by Balanchine and Danilova, coupled with the delightful choices of a dinner buffet (Shrimp, Chilled Scallops, Baked Blue Fish, Chicken Divan, Steak tips with Mushrooms, Pasta Primavera, Carved Roast Beef, Baked Ocean White Fish, Garden Vegetables) can only promise to be the makings of a memorable evening. Therefore, SIAM has purchased a limited number of tickets (covered) which are available on a first come, first served basis at the beautiful outdoor Saratoga Performing Arts Center. The entire evening including dinner, performance, wine and transportation all for $34.00.

Invited Presentations

Monday, July 20, 9:00 AM
Invited Presentation 1
Geometric Issues and Algorithms Related to Robot Motions

Studies of robot motions planning have made use of increasingly sophisticated algorithmic ideas in geometry. The speaker will review some of the techniques that have been employed with emphasis on the use of so-called Davenport-Schinzel sequences. Other ideas drawn from algebraic topology will also be reviewed and experimental implementations of some of the algorithms described.

Jacob T. Schwartz
Courant Institute of the Mathematical Sciences
New York University

Monday, July 20, 9:45 AM
Invited Presentation 2
Geometric Approaches to Computational Problems

In recent years the geometric approach has been applied, often in unexpected ways, to solve computational problems in various contexts. In many cases combinatorial problems need to be embedded in Euclidean space before significant progress can be made with tools in geometry. For example, there are discrete combinatorial problems for which computationally efficient methods have been discovered by viewing problems geometrically and applying linear-programming style algorithms; there are also discrete problems whose complexity has been determined by examining the properties of the geometric complexes associated with the original combinatorial structures.

In this talk we will discuss the state of development along these lines, presenting paradigms from application areas including communications, combinatorial algorithms, and proving lower bounds in computational complexity. We will also discuss the directions in which future progress can be expected.

Andrew Yao
Princeton University

Tuesday, July 21, 9:00 AM
Invited Presentation 3
The Generation and Uses of Aperiodic Tilings

Tilings are complete coverings of the plane, without gaps or overlappings, using one or more sets each of which consists of infinitely many identical geometric shapes. Certain devices or shapes lead to periodic tilings where one basic arrangement repeats itself infinitely many times in two more fixed directions.

A tiling is "aperiodic" if no translation is a symmetry of the tiling itself, or of any other tiling possible with the same tiles. Aperiodic tilings first arose in decision theory and in recreational mathematics; recently they have attracted wide attention through their relations to "quasicrystals"—solid state phenomena which contradict traditional crystallographic ideas (in particular, violate the "crystallographic restriction").

Most attempts to describe the aperiodic tilings relevant to quasicrystals are based on reducing high-dimensional periodic tilings to three (or two) dimensions by suitable projections or other operations. These methods will be explained and compared to more direct methods based on relations between neighboring tiles and not needing higher dimensions.

Branko Grünbaum
University of Washington

Tuesday, July 21, 9:45 AM
Invited Presentation 4
Solid Modeling and Manufacturing Applications

Here is a presentation about a hybrid method of solid modeling with boolean operations and open ended primitives based on parametric rational n-dimensional mathematics. The unique features derived from this mathematical base are the range of part shapes included and the degree of automation that can be achieved in machining of parts and tooling. Complex part shapes are modeled by combinations of splines and meshes, transformational sweeps, dimensional contractions, offset primitives and constructive solid geometry operations.

Machining is automated by careful selection of reliable algorithms which can be implemented for this unified mathematical base. A prototype software system implementation of the method (called TRUCE (for tri-dimensional rational unified cubic engine) has been developed by General Electric and applied to industrial problems involving geometric complexity in design and tooling.

John K. Hinds
General Electric Corporate Reseach and Development

Tuesday, July 21, 2:00 PM
Invited Presentation 5
Free-Form Modeling with Cubic Algebraic Surfaces

Geometric modeling of free-form shape has traditionally been accomplished using parametric surface patches, most commonly by cubic patches. An alternate method for defining a surface is by using an implicit equation. An advantage of implicitly defined surfaces is that their algebraic degree is lower than that of comparable parametric surfaces. For example, bi-cubic patches generally have an algebraic degree of eighteen, whereas cubic algebraic surfaces are of degree three.

Recently, a technique was developed for controlling the shape of a cubic surface and for fitting together a piece-wise collection of bounded cubic surface patches with tangent continuity. These techniques will be presented, along with algorithms for parametrizing cubic algebraic surfaces.

Thomas W. Sederberg
Brigham Young University

Wednesday, July 22, 9:00 AM
Invited Presentation 6
Robot Systems That Sense, Plan and Manipulate

An intelligent robot should have three generic capabilities:

- The ability to perceive its environment and to locate objects of interest.
- The ability to act on its environment.
- The ability to plan actions to achieve its goals.

Many robot systems have exhibited subsets of these capabilities but, surprisingly, very few systems (aside from some mobile robots) have ever embodied all of these capabilities in non-trivial form.

A new integrated robot system, HANDEY, that combines these three capabilities is now under development at MIT. It consists of six major modules: geometric modeling system, laser-range finder, model-based object localizer, collision-free path planner, grasp planner, and robot trajectory-control system. Its domain is that of assembly of planar-faced polyhedra, both convex and nonconvex. The user starts by building accurate geometric models for all the objects to be manipulated, and then specifies a sequence of MOVE commands that specify an object and its destination. HANDEY locates each part on its worktable, grasps it, and takes it to the destination while avoiding collisions. The unique features of HANDEY are its ability to operate on a wide class of objects and to operate in a cluttered environment.

The speaker will review the computational problems that must be solved to achieve the integration of the three generic capabilities and describe HANDEY.

Tomas Lozano-Perez
Massachusetts Institute of Technology

Wednesday, July 22, 9:45 AM
Invited Presentation 7
Gröbner Bases: An Algorithmic Algebraic Method for Non-Linear Geometry

Gröbner bases are certain standard forms for systems of multivariate polynomial equations. The Gröbner basis form of polynomial systems can be obtained by a general algorithm. In the talk this algorithm will be explained and various applications of Gröbner bases in non-linear computational geometry will be presented: inverse robot kinematics, geometrical theorem proving, solid modeling, geometrical decomposition and determination of global properties of geometrical objects, for example, dimension.

Bruno Buchberger
Johannes Kepler University

Wednesday, July 22, 11:00 AM
Invited Presentation 8
Implicitization and Parametrization of Curves and Surfaces

Geometric modeling is largely concerned with representations of curves and surfaces. A plane curve may be described either by one bivariate implicit equation or a pair of univariate parametric equations. Likewise, a surface in space is described either by a trivariate implicit equation or a triad of bivariate parametric equations. From the computational viewpoint, it is important to be able to go back and forth between these two modes of description.

Algorithms are being developed for rational and polynomial parametrizations of both curves and surfaces. An algorithmic irreducibility criterion has been designed to decide when a rationally parametrizable curve is actually polynomially parametrizable. The reverse process of implicitization leads to problems of generalizing the Sylvester resultant. This may be attacked by the symbolic method of classical invariant theory. It is hoped that a greater understanding of the underlying mathematics will facilitate the development of useful algorithms.

The algorithmic irreducibility criterion and the resultant problem both have a bearing on the Jacobian conjecture in algebraic geometry. Thus, the interplay between computational algorithms and the underlying mathematics is clearly mutually beneficial.

Shreeram S. Abhyankar
Purdue University

Wednesday, July 22, 11:45 AM
Invited Presentation 9
The Application of Geometric Reasoning to Vision and Robotics

Robotics requires the use of formal procedures which are characterized as decision trees. Well-known approaches include the Grobner basis, Collins' method of cylindrical decomposition, and Wu's method, a fairly common theoretical approach.

The central problem that the speaker will address is to decide the consistency of a given two-dimensional view with the three dimensional object, which is given algebraically. Use is made of methods for planning robot paths. In the time-dependent case, the hand-off problem between two robots can also be dealt with.

Recently, some new methods for decision procedures in geometry problems have been developed. These methods provide a new way for looking at solid models as algebraic relations versus the classical approach that employs face-edge-vertex (topologically-oriented, boundary) models.

The speaker will apply these methods to problems in model-based vision and robot geometry.

Joseph L. Mundy
General Electric Corporate Research and Development Center

Thursday, July 23, 2:00 PM
Invited Presentation 10
Subdivision Algorithms for Curves and Surfaces

Various algorithms in use in computer-aided geometric design can be interpreted as corner-cutting or "whittling" algorithms, i.e., as generating a sequence of broken lines, each of which is obtained from its predecessors by cutting off one or more of the corners. The first of these to be developed is probably de Rham's trisection algorithm; the best known are Chaikin's algorithm, degree-raising for the Bernstein-Bezier form, and knot insertion for splines.

A survey is given for the current state of such algorithms with special emphasis on their generalization to surfaces.

Carl de Boor
University of Wisconsin, Madison

Thursday, July 23, 2:45 PM
Invited Presentation 11
Computer Modeling and Simulation

The modeling and simulation of objects will play a vital role in computer-aided design and off-line robot programming. Currently, solid modeling systems are capable of modeling rigid solids, computing their volume and inertial properties, calculating offset surfaces, and testing for interference between two parts. Simulation systems tend to be ad hoc and a general purpose model driven simulation system is nonexistent.

The ability to represent physical objects in multiple domains and to carry out model driven simulations will have far reaching consequences. Today, researchers are beginning to develop the software systems that will allow easy construction of models and simulations. The speaker will discuss the science base needed to support software systems capable of representing, manipulation and reasoning about physical objects.

John Hopcroft
Cornell University

Friday, July 24, 9:00 AM
Invited Presentation 12
Semiparametric Surfaces

Over the last twenty years, computer-based surface description software has become an essential tool in the automotive, aircraft and shipbuilding industries. Such software uses primarily the parametric surface description. Consideration is being given to the use of "algebraic surface description."

Two examples have been encountered recently of surfaces which do not fit either mould by definition. These are the "blend" which is generated by intersections of offset algebraic surfaces, and the "developable". In each case there is a natural parametrization in one direction, but not in the other.

The speaker will discuss how such surfaces might be converted to more conventional descriptions and how they might be interrogated directly.

Malcolm Sabin
Finite Element Graphics System, Ltd.
Cambridge, England

Minisymposia

1. **Geometry Processing**
   Gerald Farin, Arizona State University
2. **Algebraic Methods in Geometry**
   Bruno Buchberger
   Johannes Kepler University
   Linz, Austria
3. **Geometric Tolerancing**
   Vijay Srinivasan, IBM-T.J. Watson Research Center
4. **Geometric Continuity**
   Wolfgang Boehm
   Technical University of Braunschweig
   Federal Republic of Germany
5. **Visual Multi-Dimensional Geometry with Applications**
   Alfred Inselberg, IBM Scientific Center
6. **Blending Surfaces**
   Christoph Hoffmann, Purdue University
7. **Motion Planning**
   Michael Wesley, IBM-T.J. Watson Research Center
8. **Non-Tensor Product Surfaces**
   David R. Ferguson, Boeing Computer Services
9. **Probabilistic Approaches to CAGD (Computer-Aided Geometric Design)**
   Ronald N. Goldman
   Control Data Corporation
10. **Algebraic Geometry in Geometric Modeling**
    Miriam Lucian, Boeing Commercial Airplane Company
11. **Computational Geometry**
    W. Randolph Franklin, Rensselaer Polytechnic Institute
12. **Mesh Generation**
    David A. Field, General Motors Research Laboratories
13. **Data Reduction for Splines and Its Applications**
    Tom Lyche, University of Oslo
14. **Digital Geometry**
    Robert A. Melter, Long Island University
15. **Parallel Methods in Geometry**
    Harry McLaughlin, Rensselaer Polytechnic Institute
16. **Shape Control in Surface Design**
    David R. Ferguson, Boeing Computer Services

PROGRAM-AT-A-GLANCE

Saturday, July 18/PM

5:00 PM/Prefunction Area, Ballroom Level
Registration opens for Short Course

10:00 PM
Registration Closes

Sunday, July 19/AM

Short Course on Uses of Surfaces in Industry: Geometric Modeling, Machine Vision, and Motion Planning

7:00 AM/Prefunction Area, Ballroom Level
Registration opens for Short Course

8:30 AM/Ballroom A-B
Motion Planning
Gordon Wilfong
AT&T Bell Laboratories

10:00 AM/Prefunction Area, Ballroom Level
Coffee

10:30 AM/Ballroom A-B
Surfaces in Computer Vision
Paul Besl
General Motors Research Laboratories

Sunday, July 19/PM

12:00 PM/Ballroom C-D
Lunch

1:30 PM/Ballroom A-B
Computational Issues in Solid Boundary Evaluation
Rida Farouki
IBM-T.J. Watson Research Center

3:00 PM/Prefunction Area
Coffee

3:30 PM/Ballroom A-B
G-1 Bézier Patching of Irregular Surface Shapes
Ramon Sarraga
General Motors Research Laboratories

5:00 PM/Prefunction Area
Registration Opens for Conference

8:00 PM/Prefunction Area
Welcoming Reception
Cash Bar

10:00 PM
Registration Closes

Monday, July 20/AM

7:30 AM/Prefunction Area, Ballroom Level
Registration Opens

8:30 AM/Ballroom A-B
Opening Remarks

9:00 AM/Ballroom A-B
Invited Presentations 1 and 2
Chair: Carl de Boor
University of Wisconsin, Madison

9:00 AM/Ballroom A-B
Geometric Issues and Algorithms Related to Robot Motions
Jacob T. Schwartz
Courant Institute of Mathematical Sciences
New York University

9:45 AM/Ballroom A-B
Geometric Approaches to Computational Problems
Andrew Yao
Princeton University

10:30 AM/Prefunction Area
Coffee

11:00 AM/CONCURRENT SESSIONS

Minisymposium 1/Ballroom A-B
Geometry Processing
Chair: Gerald Farin
Arizona State University

Minisymposium 2/Ballroom C
Algebraic Methods in Geometry
Chair: Bruno Buchberger
Johannes Kepler University
Linz, Austria

Minisymposium 3/Ballroom E
Geometric Tolerancing
Chair: Vijay Srinivasan
IBM-T.J. Watson Research Center

Monday, July 20/PM

12:30 PM/**Lunch**

2:00 PM/CONCURRENT SESSIONS

Minisymposium 4/Ballroom A-B
Geometric Continuity
Chair: Wolfgang Boehm
Technical University of Braunschweig
Federal Republic of Germany

Minisymposium 5/Ballroom C
Visual Multi-Dimensional Geometry with Applications
Chair: Alfred Inselberg
IBM Scientific Center

Minisymposium 6/Ballroom E
Blending Surfaces
Chair: Christoph Hoffmann
Purdue University

3:30 PM/Prefunction Area
Coffee

4:00 PM/CONCURRENT SESSIONS

Contributed Presentations 1/Ballroom D
Surface Methods
Chair: C. N. Shen
Rensselaer Polytechnic Institute

Contributed Presentations 2/Ballroom A-B
Solid Modeling
Chair: Donald P. Peterson
Sandia National Laboratories

Contributed Presentations 3/Ballroom E
Computational Geometry 1
Chair: Yves de Montaudouin
Lehigh University

Contributed Presentations 4/Ballroom C
General Topics
Chair: Subhas Desa
Carnegie Mellon University

6:15 PM/Prefunction Area
Beer Party

Tuesday, July 21/AM

9:00 AM/Ballroom A-B
Invited Presentations 3 and 4
Chair: Ramon Sarraga
General Motors Research Laboratories

9:00 AM/Ballroom A-B
The Generation and Uses of Aperiodic Tilings
Branko Grünbaum
University of Washington

9:45 AM/Ballroom A-B
Solid Modeling and Manufacturing Applications
John K. Hinds
General Electric Corporate Research and Development Center

10:30 AM/Prefunction Area
Coffee

11:00 AM/CONCURRENT SESSIONS

Minisymposium 7/Ballroom E
(11:00 AM–1:15 PM)
Motion Planning
Chair: Michael Wesley
IBM-T.J. Watson Research Center

Minisymposium 8/Ballroom C
Non-Tensor Product Surfaces
Chair: David R. Ferguson
Boeing Computer Services

Minisymposium 9/Ballroom A-B
Probabilistic Approaches to Computer-Aided Geometric Design (CAGD)
Chair: Ronald N. Goldman
Control Data Corporation

Tuesday, July 21/PM

12:30 PM/**Lunch**

2:00 PM/Ballroom A-B
Invited Presentation 5
Chair: Leon Seitelman
Pratt & Whitney Aircraft Co.

Free-Form Modeling with Cubic Algebraic Surfaces
Thomas W. Sederberg
Brigham Young University

2:45 PM/Prefunction Area
Coffee

3:15 PM/CONCURRENT SESSIONS

Contributed Presentations 5/Ballroom E
Mathematical Methods 1
Chair: Mladen Luksic
University of Texas at San Antonio

Contributed Presentations 6/Ballroom D
Robot Path Planning 1
Chair: Daniel Koditschek
Yale University

Contributed Presentations 7/Ballroom C
General Topics
Chair: Seymour Haber
National Bureau of Standards

Contributed Presentations 8/Ballroom A-B
Computational Geometry 2
Chair: Don J. Orser
National Bureau of Standards

Poster Session 1
Beverwyck Room

Wednesday, July 22/AM

9:00 AM/Ballroom A-B
Invited Presentations 6 and 7
Chair: Michael Wozny
Rensselaer Polytechnic Institute

9:00 AM
Robot Systems That Sense, Plan and Manipulate
Tomas Lozano-Perez
Massachusetts Institute of Technology

9:45 AM
Gröbner Bases: An Algorithmic Algebraic Method for Non-Linear Geometry
Bruno Buchberger
Johannes Kepler University

10:30 AM/Prefunction Area
Coffee

11:00 AM/Ballroom A-B
Invited Presentations 8 and 9
Chair: Wolfgang Boehm
Technical University of Braunschweig
Federal Republic of Germany

11:00 AM
Implicitization and Parametrization of Curves and Surfaces
Shreeram S. Abhyankar
Purdue University

11:45 AM
The Application of Geometric Reasoning to Vision and Robotics
Joseph L. Mundy
General Electric Corporate Research and Development Center

Wednesday, July 22/PM

12:30 PM/**Lunch**

2:00 PM/CONCURRENT SESSIONS

Contributed Presentations 9/Ballroom E
Surface Applications
Chair: Nelson Max
Lawrence Livermore National Laboratory

Contributed Presentations 10/Ballroom D
Image Processing
Chair: Y. J. Tejwani
Southern Illinois University

Contributed Presentations 11/Ballroom C
Robot Path Planning 2
Chair: Vassilios D. Tourassis
University of Rochester

Contributed Presentations 12
Ballroom A-B
Algebraic Curves and Surfaces
Chair: Miriam L. Lucian
Boeing Commercial Airplane Co.

5:00 PM/Saratoga Performing Arts Center
Dinner & Ballet

Thursday, July 23/AM

8:45 AM/CONCURRENT SESSIONS

Minisymposium 10/Ballroom C
Algebraic Geometry in Geometric Modeling
Chair: Miriam Lucian
Boeing Commercial Airplane Company

Minisymposium 11/Ballroom A-B
Computational Geometry
Chair: W. Randolph Franklin
Rensselaer Polytechnic Institute

Minisymposium 12/Ballroom E
Mesh Generation
Chair: David A. Field
General Motors Research Laboratories

10:15 AM/Prefunction Area
Coffee

10:45 AM/CONCURRENT SESSIONS

Contributed Presentations 13
Ballroom A-B
Computational Geometry 3
Chair: Paula Beaty
Colorado State University

Contributed Presentations 14/Ballroom C
Robot Path Planning 3
Chair: Jaroslaw R. Rossignac
IBM-T.J. Watson Research Center

Contributed Presentations 15/Ballroom D
Curves
Chair: John A. Roulier
University of Connecticut, Storrs

Contributed Presentations 16/Ballroom E
Graphics and Image Processing
Chair: Peter Waksman
University of Rochester

Thursday, July 23/PM

12:30 PM/**Lunch**

2:00 PM/Ballroom A-B
Invited Presentations 10 and 11
Chair: Harry McLaughlin
Rensselaer Polytechnic Institute

2:00 PM
Subdivision Algorithms for Curves and Surfaces
Carl de Boor
University of Wisconsin, Madison

2:45 PM
Computer Modeling and Simulation
John Hopcroft
Cornell University

3:30 PM/Prefunction Area
Coffee

4:00 PM/CONCURRENT SESSIONS

Contributed Presentations 17
Ballroom A-B
Mesh Generation
Chair: R. E. LaBarre
United Technologies Research Center

Contributed Presentations 18/Ballroom C
Computational Geometry 4
Chair: Howard B. Wilson
University of Alabama

Contributed Presentations 19
Beverwyck Room
Applications and Implementations
Chair: Wayne D. Smith
Mississippi State University

Contributed Presentations 20/Ballroom D
Mathematical Methods 2
Chair: Michael O'Connor
IBM-T.J. Watson Research Center

Contributed Presentations 21/Ballroom E
Path Planning Plus Geometric Modeling
Chair: Boris Aronov
Courant Institute of Mathematical Sciences

Friday, July 24/AM

9:00 AM/Ballroom A-B
Invited Presentation 12
Chair: David R. Ferguson
Boeing Computer Services

Semiparametric Surfaces
Malcolm Sabin
Finite Element Graphic System, Ltd.
Cambridge, England

9:45 AM/"Summing Up"
Michael Wesley
IBM-T.J. Watson Research Center

10:15 AM/Prefunction Area
Coffee

10:30 AM/CONCURRENT SESSIONS

Minisymposium 13/Ballroom E
Data Reduction for Splines and Its Applications
Chair: Tom Lyche
University of Oslo

Minisymposium 14/Ballroom C
Digital Geometry
Chair: Robert A. Melter
Long Island University

Minisymposium 15/Ballroom A-B
Parallel Methods in Geometry
Chair: Harry McLaughlin
Rensselaer Polytechnic Institute

Minisypmosium 16/Ballroom D
Shape Control in Surface Design
Chair: David R. Ferguson
Boeing Computer Services

12:00 PM/Conference Adjourns

Special Notice to Contributed Presentation Authors and Chairmen of Contributed Presentation Sessions:

Fifteen minutes are allowed for each contributed presentation. Presenters are requested to spend a maximum of 12 minutes for their presentation, and 3 minutes for questions and answers.

Please note:

For presentations with more than one author, an underlineation is used to denote the author who will present the paper.

Monday, July 20/11:00 AM
Minisymposium 1/Ballroom A-B
GEOMETRY PROCESSING

Much effort in geometric modeling is spent on "Geometry Generation", examples being the generation of a curve from data points or the fitting of a surface through a curve network. However, in order to produce a final product, the initial geometry has to be processed further: instances of such "Geometry Processing" are intersections, offsets, blends, or a ray traced image of an object. Geometry processing is often much more complicated than geometry generation and is just beginning to emerge as a discipline in its own right.

CHAIR AND ORGANIZER
Gerald Farin
Arizona State University
Tempe, AZ

Surface/Surface Intersections
R. E. Barnhill
Arizona State University
Tempe, AZ

Imprecise Geometric Computation
R. T. Farouki and V. T. Rajan
IBM—T. J. Watson Research Center
Yorktown Heights, NY

An Improved Penalty Function for Implicit Blending of Multiple Surfaces
Alyn P. Rockwood
Evans & Sutherland Computer Corp.
Salt Lake City, UT

Monday, July 20/11:00 AM
Minisymposium 2/Ballroom C
ALGEBRAIC METHODS IN GEOMETRY

Two algorithmic methods for solving large classes of problems in real and complex algebraic geometry will be presented: Collins' method of "Cylindrical Algebraic Decomposition" and applications of Buchberger's method to "Geometrical Theorem Proving". In the two lectures, together with plenary lecture of Buchberger, recent applications in robot programming (path finding, collision detection, inverse kinematics), geometrical theorem proving, solid modeling and global analysis of nonlinear geometrical objects will be given. Existing software for the two methods will be described.

CHAIR AND ORGANIZER
Bruno Buchberger
Johannes Kepler University
Linz, Austria

Geometrical Theorem Proving Based on Polynomial Ideal Theory
Bernhard Kutzler
Johannes Kepler University
Linz, Austria

Cylindrical Algebraic Decomposition: A Universal Algorithmic Algebraic Method for Real Geometry
George E. Collins
Ohio State University
Columbus, OH

Monday, July 20/11:00 AM
Minisymposium 3/Ballroom E
GEOMETRIC TOLERANCING

Geometric tolerancing is an area that deals with representing and processing information about the allowable variation in a product geometry. Note that this is not an area that addresses issues of numerical "tolerances" that are associated with imprecise arithmetic calculations in a computer. More specifically, we are interested only in the tolerances that engineers specify on a product. The purpose of this minisymposium is to bring together some of the state-of-the-art research that has been going on in the area of geometric tolerancing, and provide a forum for discussion on this topic. Three talks are scheduled on the mathematical and computational issues of geometric tolerancing.

CHAIR AND ORGANIZER
Vijay Srinivasan
IBM—T. J. Watson Research Center
Yorktown Heights, NY

Vector Space Approach to Mathematical Representation of Tolerances
Joshua Turner
IBM Data Systems Division
Poughkeepsie, NY

Functional Requirements and Geometric Tolerances
Rangarajan Jayaraman
IBM—T. J. Watson Research Center
Yorktown Heights, NY

Geometric Tolerances and Mathematical Programming
V. Thomas Rajan
IBM—T. J. Watson Research Center
Yorktown Heights, NY

Monday, July 20/2:00 PM
Minisymposium 4/Ballroom A-B
GEOMETRIC CONTINUITY

In the last six years the interest in "visual continuity" of curves and surfaces has been growing: In 1981 Barsky started his work with the use of a special B-spline like function over uniform knots, having two so-called "shape parameters". Nearly at the same time, a simple Euclidean construction of curvature continuous splines was given by Farin. In 1985, W. Boehm generalized the construction of the Bézier points of a cubic spline curve or surface to curvature continuous cubics and to torsion continuous quartics. Nearly at the same time, T. Goodman and K. Unsworth developed a Mansfield-like recursion for the evaluation of generalized β-B-splines [Goodman, Unsworth '85]. Some more theoretical aspects were considered in 1985 by Dyn, Micchelli and others.

CHAIR AND ORGANIZER
Wolfgang Boehm
Technical University Braunschweig
Braunschweig, W. Germany

Geometric Continuity for Triangular Bézier Patches
Bruce Piper
University of Utah
Salt Lake City, UT

Nu-Spline Fractals
Gregory M. Nielson
Arizona State University
Tempe, AZ

Surfaces with Geometric Continuity
Hans Hagen
Technical University of Braunschweig
Braunschweig, W. Germany

Monday, July 20/2:00 PM
Minisymposium 5/Ballroom C
VISUAL MULTI-DIMENSIONAL GEOMETRY WITH APPLICATIONS

A non-projective mapping $R^N \rightarrow R^2$ for any positive integer N is obtained from new system of parallel coordinates. Relations in N variables are portrayed as planar "graphs" having certain properties analogous to the corresponding hypersurface in R^N. In the plane a point $\leftarrow\rightarrow$ line duality leads to efficient algorithms for convex merge and intersection of convex sets. A line in R^N is represented by $N-1$ planar points and a hyperplane by $N-1$ vertical lines. These enable some geometrical constructions and the representation of polyhedra in R^N. The representation of a class of more general convex and nonconvex hypersurfaces is known. There is an algorithm for constructing and displaying any point interior, exterior or on a hypersurface belonging to these classes. Computer graphics implementations will be shown of: 1) the representations; 2) algorithms; 3) the phase-space in N variables; 4) application to exploratory data analysis in statistics; and 5) a new air traffic control system (i.e. R^4) where the time and space trajectory information is displayed and used in collision avoidance (proximity) and routing.

CHAIRS AND ORGANIZERS
Alfred Inselberg
IBM Scientific Center
Los Angeles, CA
and
Bernard Dimsdale
University of California
Los Angeles, CA

The Plane with Parallel Coordinates
Alfred Inselberg
IBM Scientific Center
Los Angeles, CA

Multi-Dimensional Bifurcation and Chaos
J. Rivero
IBM Scientific Center
Los Angeles, CA

Exploratory Multi-Variate Data Analysis in Statistics with Emphasis on Multi-Dimensional Data Clusters
E. Wegman
George Mason University
Fairfax, VA

Complex System Design and Operation
J. Helly
Aerospace Co.
Los Angeles, CA

Monday, July 20/2:00 PM
Minisymposium 6/Ballroom E
BLENDING SURFACES

Blending surfaces are found on virtually all manufactured objects. Technically, they are surface elements intended to round or fill edges and corners. They are also useful for fairing. Efficient methods exist for deriving blending surfaces automatically for edges and for corners of limited complexity. This minisymposium describes recent research perfecting these techniques and developing a comprehensive theory assessing the scope of the method.

CHAIR AND ORGANIZER
Christoph Hoffmann
Purdue University
West Lafayette, IN

Issues in Implicit Blending
(to be presented by the chair)

Piecewise Quadric Blending of Implicitly Defined Surfaces
Lasse Holmstrom
Laboratory of Information Processing Science
Helsinki, Finland

Construction of Low Degree Blending Surfaces
Joe Warren
Rice University
Houston, TX

Tuesday, July 21/11:00 AM–1:15 PM
Minisymposium 7/Ballroom E
MOTION PLANNING

Motion planning has been studied as an example of geometric reasoning since the earliest days of computer-based robotics. In this tutorial session, four speakers cover the subject from theoretical, algorithmic, and practical points of view. The first speaker (Lozano-Perez) will give an overview of the subject and cover the topic of: collision-free motion planning and controlled-collision fine motion planning. The second speaker (Yap) will address the computational complexity issues in geometric motion planning. The third speaker (Kanade) will cover the integration of sensory information, particularly vision, into the motion planning process. The final speaker (Khatib) will present a potential field approach to practical low level motion planning in the context of a layered system.

CHAIR AND ORGANIZER
Michael Wesley
IBM—T. J. Watson Research Center
Yorktown Heights, NY

An Overview of Motion Planning
Tomas Lozano-Perez
Massachusetts Institute of Technology
Cambridge, MA

Theoretical and Complexity Aspects of Motion Planning
Chee Yap
Courant Institute of Mathematical Sciences, New York University
New York, NY

Sensor Integration for Robot Mobility
Takeo Kanade
Carnegie-Mellon University
Pittsburgh, PA

(title to be announced)
O. Khatib
Stanford University
Stanford, CA

Tuesday, July 21/11:00 AM
Minisymposium 8/Ballroom C
NON-TENSOR PRODUCT SURFACES

Tensor product surfaces have proven to be extremely valuable in many areas of surface design. However, there are many significant areas where tensor product surfaces are inappropriate, e.g., scattered data approximation. The next step in surface methods will involve developing models which are not based on tensor products. Investigators have begun to concentrate on piecewise polynomial surfaces with a view toward understanding them and their usefulness for applications. Difficult mathematical problems concerning the structure of these surfaces and their applicability to engineering problems remain. This minisymposium will present overviews of this area including problems, recent work and applications.

CHAIR AND ORGANIZER
David R. Ferguson
Boeing Computer Services
Seattle, WA

Multivariate Splines
Peter Alfeld
University of Utah
Salt Lake City, UT

Convex Multivariate Approximations to Scattered Data
Thomas Grandine
Boeing Computer Services
Seattle, WA

Tuesday, July 21/11:00 AM
Minisymposium 9/Ballroom A-B
PROBABILISTIC APPROACHES TO COMPUTER-AIDED GEOMETRIC DESIGN (CAGD)

Many of the blending functions of Computer Aided Geometric Design (CAGD)—including Bernstein polynomials, B-splines, and even Lagrange polynomials—can also be used to model simple stochastic processes. Therefore the geometric properties of the corresponding curves and surfaces can be derived largely from probabilistic considerations. To introduce this minisymposium, the speakers will: explain why probability and geometry are so closely linked in CAGD; Give several examples of properties of Bézier curves and surfaces which can be derived from simple probabilistic arguments; and discuss some additional geometric properties for which a probabilistic interpretation has yet to be found.

CHAIR AND ORGANIZER
Ronald A. Goldman
Control Data Corporation
Arden Hills, MN

Introduction to the Probabilistic Approaches to CAGD
(to be presented by the chair)

Urn Models on CAGD
Phillip J. Barry
University of Utah
Salt Lake City, UT

Using Urn Models for Fast Curves and Surface Generation
Tony D. DeRose
University of Washington
Seattle, WA

Thursday, July 23/8:45 AM
Minisymposium 10/Ballroom C
ALGEBRAIC GEOMETRY IN GEOMETRIC MODELING

Presentations in this minisymposium will encompass both general methods and their applications. "Geometric Reasoning with Logic and Algebra" and "Elimination Methods for Systems of Polynomial Equations in Several Variables" will present algebraic geometry methods applicable in modeling; "C^1 Rational Finite Elements" and "Parametric Cubics as Algebraic Curves" will be applications of such methods. We hope this symposium will be of interest both to specialists and to people getting into the field.

CHAIR AND ORGANIZER
Miriam L. Lucian
Boeing Commercial Airplane Co.
Seattle, WA

C^1 Rational Finite Elements
Eugene Wachspress
University of Tennessee
Knoxville, TN

Geometric Reasoning with Logic and Algebra
Dennis Arnon
Xerox Research Center
Palo Alto, CA

Elimination Methods for Systems of Polynomial Equations in Several Variables
Andrew Ness
IBM—T. J. Watson Research Center
Yorktown Heights, NY

Parametric Cubics as Algebraic Curves
Richard Patterson
Indiana University—Purdue University
Indianapolis, IN

Thursday, July 23/8:45 AM
Minisymposium 11/Ballroom A-B
COMPUTATIONAL GEOMETRY

Implications of present and future properties of computation such as roundoff and parallel processors are considered in the session. Robust computation of subdivisions in the presence of finite precision computations is presented. Next a systematic method of

exploiting parallel architectures in algorithms such as convex hull determination is given. Finally, new data structures that are stable and minimize the number of special cases in operations such as polygon overlay are presented.

CHAIR AND ORGANIZER
W. Randolph Franklin
Rensselaer Polytechnic Institute
Troy, NY

On Parallel Algorithms in Computational Geometry
Minsoo Suk and S. J. Oh
Syracuse University
Syracuse, NY

Verifiable Geometric Computations Using Finite Precision Arithmetic
Victor J. Milenkovic
Carnegie-Mellon University
Pittsburgh, PA

Polygon Properties Calculated From the Vertex Neighborhoods
(to be presented by the Chair)

Thursday, July 23/8:45 AM
Minisymposium 12/Ballroom E
MESH GENERATION

Much development of transfinite interpolation techniques occurred at GM in the 60's. Today automatic 3-D mesh generation at GM has incorporated these techniques along with recent developments based on mathematical properties of Delaunay triangulations. This background serves to unify the first two presentation topics; recent mesh generation developments at GM, and powerful new mesh generation codes based upon transfinite interpolation and solutions to elliptic partial differential equations encountered in aerospace engineering. Also included in this minisymposium is research supported by GM on a totally different mesh generation approach motivated by octree's, and extremely efficient data structure for digital computers. Introductory and concluding remarks will be given by the minisymposium chairperson.

CHAIR AND ORGANIZER
David A. Field
General Motors Research Laboratories
Warren, MI

A New Automatic Node Placement Strategy for Graded Triangular Meshes
William H. Frey
General Motors Research Laboratories
Warren, MI

Automated Grid Generation for General 3D Regions
Joe F. Thompson
Mississippi State University
Mississippi State, MS

Mesh Generation by the Finite Octree Technique
Mark S. Shephard
Rensselaer Polytechnic Institute
Troy, NY

Friday, July 24/10:30 AM
Minisymposium 13/Ballroom E
DATA REDUCTION FOR SPLINES AND ITS APPLICATIONS

The number of coefficients used when describing a curve or surface in B-spline format, is often much greater than necessary. The computation time and storage requirements for the manipulation of such an overrepresented curve or surface, would be greatly reduced if an approximation with fewer parameters was used instead. A method for accomplishing such a data reduction, without perturbing the curve or surface more than a given tolerance, has been developed. Both the theoretical and practical aspects of this method will be described, and illustrated with industrial examples.

CHAIR AND ORGANIZER
Tom Lyche
University of Oslo
Oslo, Norway

Data Reduction for Splines
(to be presented by the chair)

Data Reduction Combined with Recursion and Iteration in Intersections
Tor Dokken
Center for Industrial Research
Oslo, Norway

Knotline Removal on Box-Spline Surfaces
Morten Daehlen
Center for Industrial Research
Oslo, Norway

Friday, July 24/10:30 AM
Minisymposium 14/Ballroom C
DIGITAL GEOMETRY

Digital geometry can be described as the study of geometric properties of subsets of digital images. It has proved to be an important tool in computer vision. Among the general concepts which intervene in this investigation are connectedness, curvature and convexity. Of continuing interest has been the problem of characterizing digital straight lines. The generalization of certain theorems from the plane to three-dimensional space remains an open question. Specialization of the classical program of distance geometry, e.g., the determination of metric bases, to the digital case yields results of mathematical interest.

CHAIR AND ORGANIZER
Robert A. Melter
Long Island University
Southampton, NY

Digital Geometry: A Survey
Azriel Rosenfeld
University of Maryland
College Park, MD

Continuous Representations of a Digital Image
Chung-Nim Lee
The University of Michigan
Ann Arbor, MI
and
Azriel Rosenfeld
University of Maryland
College Park, MD

On Digital Topology and Thinning Algorithms
T. Yung Kong
Ohio University
Athens, OH

Matrices in Digital Geometry
(to be presented by the chair)

Friday, July 24/10:30 AM
Minisymposium 15/Ballroom A-B
PARALLEL METHODS IN GEOMETRY

The availability of parallel processors has prompted several questions about geometric modeling, two of which are: (1) are commonly used mathematical models appropriate for parallel processing? and (2) is there an opportunity to develop new modeling techniques which are implementable on, and can take advantage of, parallel machines? Both of these questions will be discussed.

CHAIR AND ORGANIZER
Harry W. McLaughlin
Rensselaer Polytechnic Institute
Troy, NY

Affine Maps and Parallel Methods
Craig Shelly
Rensselaer Polytechnic Institute
Troy, NY

Experimental Results
Richard Mastro
Boeing Computer Services
Seattle, WA

Mathematical Morphology
Michael M. Skolnick
Rensselaer Polytechnic Institute
Troy, NY

Friday, July 24/10:30 AM
Minisymposium 16/Ballroom D
SHAPE CONTROL IN SURFACE DESIGN

The shape of surfaces representing geometric models or measured data is often more important than proximity to particular points. For example, when modeling an airfoil cross section or when modeling drag characteristics of aircraft, the shape (convexity or monotonicity) is more important than fidelity to the defining data. Similar problems arise with higher dimensional surfaces. This minisymposium will present three views on the problem of controlling shape while still reasonably reproducing the data. One presentation will concentrate on constructing convex surfaces, another will discuss problems in modeling data and the third will cover methods based on smoothing shape.

CHAIR AND ORGANIZER
David R. Ferguson
Boeing Computer Services Seattle, WA

The Automatic Generation of Convex Surfaces
Roger Andersson
Volvo Data, AD
Goteborg, Sweden

Modeling Multivariate Data Using Shape Control
(to be presented by the chair)

Surface Interpolation and Shape Control Using Tension Parameters
Thomas Foley
Arizona State University, Tempe, AZ

Monday, July 20/4:00 PM
Contributed Presentations 1/Ballroom D
SURFACE METHODS

Recursive Surface Smoothing for Random Grid Displacements of Discrete Measurements
Roy Ho and C. N. Shen, Rensselaer Polytechnic Institute, Troy, NY

Interpolation to Large Data Sets Using Bezier Curves and Surfaces
Ardeshir Goshtasby, University of Kentucky, Lexington, KY

A Trivariate Powell-Sabin Interpolant
Andrew J. Worsey, University of North Carolina at Wilmington, Wilmington, NC

An Improved Monotone Bivariate Interpolation Algorithm
F. N. Fritsch and R. E. Carlson, Lawrence Livermore National Laboratory, Livermore, CA

An Efficient Algorithm for Computing the Geometric Features of Parametrized Surfaces
Su-shing Chen, University of North Carolina, Charlotte, NC and Michael Penna, Purdue University, Indianapolis, IN

Application of Diparabolic Interpolation to Surface Modeling
Edward L. Copeland, Rockwell International, Houston, TX

Monday, July 20/4:00 PM
Contributed Presentations 2/Ballroom A-B
SOLID MODELING

Halfspace Representation of 2½ D Parts
Donald P. Peterson, Sandia National Laboratories, Albuquerque, NM

Solid Modeling with Ruled Surfaces
Per-Olof Fjällström, IBM Svenska AB, Stockholm, Sweden

Constructive Solid Geometry with Surface-Constraint
Yasumasa Kawashima, Tomotoshi Ishida and Shinji Tokumasu, Hitachi Research Laboratory, Ibaraki-ken, Japan

High Level Representations and Algorithms for Extended Geometrical Modelling
Jaroslaw R. Rossignac and Michael A. O'Connor, IBM-T.J. Watson Research Center, Yorktown Heights, NY

Solid Modeling for Automated Tolerance Analysis
Joshua U. Turner, IBM Corporation, Poughkeepsie, NY and Michael J. Wozny, Rensselaer Polytechnic Institute, Troy, NY

Automated Constant-Radius Blending in a Boundary-Representation Solid Modeler
Mark Mummy, Boeing Computer Services, Seattle, WA

Solids by Blending Parametric Contours
U. G. Gujar, V. C. Bhavsar, and N. N. Datar, University of New Brunswick, Fredericton, Canada

Monday, July 20/4:00 PM
Contributed Presentations 3/Ballroom E
COMPUTATIONAL GEOMETRY 1

Voronoi Diagrams on the Sphere
John Dolan and Richard Weiss, University of Massachusetts, Amherst, MA

Conjugate Indicator Algorithms for Two and Three Dimensional Delaunay Triangulation
Charles Edward Buckley, Integrated Systems Laboratory, ETH-Zurich, Switzerland

A New Data Structure for Nearest Neighbor Searching
Owen Murphy, University of Vermont, Burlington, VT and Stanley Selkow, Worcester Polytechnic Institute, Worcester, MA

Detecting and Computing the Intersection of Convex Objects
David P. Dobkin, Princeton University, Princeton, NJ and Diane L. Souvaine, Rutgers University, New Brunswick, NJ

Criterion for Terminating Subdivision in the Surface/Surface Intersection Problem. The X Algorithm
Yves de Montaudouin, Lehigh University, Bethlehem, PA

Intersection Problems in Polygon Overlay
Jose Armando Guevara, Environmental Systems Research Institute, Redlands, CA

Monday, July 20/4:00 PM
Contributed Presentations 4/Ballroom C
GENERAL TOPICS

The Geometry of Form Closure
Xanthippi Markenscoff, University of California, Santa Barbara, CA, Luqun Ni, Institute of Mathematics, Beijing, China and Christos H. Papadimitriou, Stanford University, Stanford, CA

Interactive Design with Rational Overhauser Curves
Jeffrey J. Jortner and John A. Brewer, III, Louisiana State University, Baton Rouge, LA

On the Global Properties of Motion of Kinematics
Subhas Desa, Carnegie Mellon University, Pittsburgh, PA

EZ-SURF Package for Sculptured Surface Fit and Numerically Controlled Machining
Lena Fishman and Prashant Kurdukar Bridgeport Machines Inc., Willow Grove, PA

Tuesday, July 21/3:15 PM
Contributed Presentations 5/Ballroom E
MATHEMATICAL METHODS 1

On Some Topological Problems in Robotics Motion Planning
Mladen Luksic, The University of Texas at San Antonio, San Antonio, TX

Polyharmonic Cardinal Splines
W. R. Madych, University of Connecticut, Storrs, CT and S. A. Nelson, Iowa State University, Ames, IA

Hermite Interpolation by C^1 Piecewise Polynomials on Triangulations
Edmond Nadler, IBM-T.J. Watson Research Center, Yorktown Heights, NY

Free-Form Curve Modeling by Polycurve Codes
Chang Y. Choo, Worcester Polytechnic Institute, Worcester, MA

The Unit Circle as the Mathematical Model for the Space and Time Measurements of Special Relativity Theory
Herbert J. Nichol, Drexel University, Philadelphia, PA

Elastically Deformable Geometric Models
Demetri Terzopoulos, Schlumberger Palo Alto Research, Palo Alto, CA, John Platt and Alkan Barr, California Institute of Technology, Pasadena, CA and Kurt Fleisher, Schlumberger Palo Alto Research, Palo Alto, CA

Tuesday, July 21/3:15 PM
Contributed Presentations 6/Ballroom D
ROBOT PATH PLANNING 1

Optimal Path Planning by Cost Wave Propagation in Configuration Space
Leo Dorst, Philips Laboratories, Briarcliff Manor, NY

Polar Morse Functions and Exact Robot Navigation
Daniel E. Koditschek, Yale University, New Haven, CT

Path Planning for Mobile Robots in Unexplored Terrain
Baba Prasad S. Chikballapur and S. K. Mohapatra, University of Hyderabad, Hyderabad, India

Manipulator Workspace Geometry By the Monte Carlo Method
David Perel and Jahangir S. Rastegar, Manhattan College, Riverdale, NY

A Probabilistic Approach to the Design of Robot Arms
Jahangir S. Rastegar and Behruz Fardanesh, Manhattan College, Riverdale, NY

The Application of Quintic Splines to Kinematic Design Problems
Bartholomew MacCarthy, Oxford University Computing Laboratory, UK

Tuesday, July 21/3:15 PM
Contributed Presentations 7/Ballroom C
GENERAL TOPICS

A Characterization of Octree Behavior
Donald T. Kasper, Northrop Advanced Systems Division, Pico Rivera, CA

A Pattern-Theoretic Formulation of Shape
Ulf Grenader and Daniel MacRae Keenan, Brown University, Providence, RI

A Construction of Non-Periodic Tilings
Seymour Haber and James F. Lawrence, National Bureau of Standards Gaithersburg, MD

On A Class of Geometric Packing Problems
R. Chandrasekaran, University of Texas at Dallas, Richardson, TX and Santosh N. Kabadi, University of New Brunswick, New Brunswick, Canada

Identification of Industrial Objects from Video Images Based on Their B-Rep Solid Models
Farhad Towfiq, R. Curt Grove and H. R. Keshavan, Northrop Research and Technology Center, Palos Verdes Peninsula, CA

Graphics Representation of Implicitly Defined Surfaces
Timothy S. Norfolk and Phillip H. Schmidt, The University of Akron, Akron, OH

Simplifying Polygonal Curves
Michael Werman, Brown University, Providence, RI

Tuesday, July 21/3:15 PM
Contributed Presentations 8/Ballroom A-B
COMPUTATIONAL GEOMETRY 2

A Calculus for Reasoning about Polygons, Polyhedra and Complexes Made from Them
Don J. Orser, National Bureau of Standards, Gaithersburg, MD

On the External Contour of the Union of a Set of Polygons and Applications
Jean Daniel Boissonnat, INRIA, Valbonne, France

Using Prolog For Gometric Intersection
Peter Y. F. Wu, Rensselaer Polytechnic Institute, Troy, NY

An Optimal Visibility Algorithm for a Simple Polygon with Star Shaped Holes
Esther M. Arkin and Joseph S. B. Mitchell, Cornell University, Ithaca, NY

Wednesday, July 22/2:00 PM
Contributed Presentations 9/Ballroom E
SURFACE APPLICATIONS

Approximating Molecular Surfaces by Spherical Harmonics
Nelson L. Max, Lawrence Livermore National Laboratory, Livermore, CA

Geometric Modeling of Complex Surfaces in Turbomachines
B. Ozell and R. Camarero, Ecole Polytechnique, Montreal, Canada

Surface Geometry Requirements for Finite-Difference Aerodynamic Calculations
G. David Kerlick, Sterling Software Inc., Moffett Field, CA

Probing Convex Polygons with X-rays
Herbert Edelsbrunner and Steven S. Skiena, University of Illinois, Urbana, IL

The Use of Tensor Product Splines for the Approximation of The Sea Bed Surface
D. C. Handscomb and B. L. MacCarthy, Oxford University Computing Laboratory, UK

Fast Frontal and Drag Area Computations in Space Vehicle Design and Analysis
Vish Dixit, Rockwell International, Downey, CA

Geometrical Analysis of Gastric Emptying
R. Ech, A. Abutaleb, Z. Delalic and J. Siegel, Temple University, Philadelphia, PA

Wednesday, July 22/2:00 PM
Contributed Presentations 10/Ballroom D
IMAGE PROCESSING

The Gray-Scale Version of the Matheron Representation Theorem for Tau-openings
Edward R. Dougherty, Fairleigh Dickinson University, Teaneck, NJ

Gray-Scale Morphology as an Extension of Matheron-Hadwiger Two-valued Theory
Edward R. Dougherty, Fairleigh Dickinson University, Teaneck, NJ and Charles R. Giardina, The Singer Company-Kearfott Division, Little Falls, NJ

A Gaussian Localized Image Processing Model
Joseph Shu, NYNEX Corporation, White Plains, NY

Minimal Curves in Image Segmentation
Jayant M. Shah, Northeastern University, Boston, MA

An Integral Measure Signature for Recognition of Plane Curves and Surfaces Using Cylindrical Multivalued Transform
Y. J. Tejwani, Southern Illinois University, Carbondale, IL

Determining Object Posture from Dense Range Maps
B. C. Vemuri and J. K. Aggarwal, The University of Texas at Austin, Austin, TX

Wednesday, July 22/2:00 PM
Contributed Presentations 11/Ballroom C
ROBOT PATH PLANNING 2

Real-Time Adaptive Motion Planning
Bruce G. Hartleben, MTS Systems Corporation, Minneapolis, MN

Sensor Fusion: The Quest for Autonomous Robots
Bruce Moxon, BBN Advanced Computers, Inc, Cambridge, MA

Towards a Global Navigation and Positioning System for Mobile Robots
Wayne D. Smith, Mississippi State University, Mississippi State, MS

Robot Kinematics Based Upon Simple Applied Geometric Notions
Vassilios D. Tourassis, University of Rochester, Rochester, NY

Generation of Planar Algebraic Curve with Tangent-Line Motion
A. H. Shirkhodaie and A. H. Soni, Oklahoma State University, Stillwter, OK

Using Fiducial Marks for Tracking a Robot Arm
Aram Falsafi, Lester A. Gerhardt and George Nagy, Rensselaer Polytechnic Institute, Troy, NY and Leila De Floriani, National Research Council, Genova, Italy

Wednesday, July 22/2:00 PM
Contributed Presentations 12
Ballroom A-B
ALGEBRAIC CURVES AND SURFACES

An Algorithm for Computing and Plotting on Implicitly Defined Surface
Stefan Gnutzmann, University of the Federal Armed Forces, Hamburg, W. Germany

Genus Is a Birational Invariant: Parameterizing Rational Space Curves
S. S. Abhyankar and C. Bajaj, Purdue University, West Lafayette, IN

Algebraic Varieties, Path-Following Methods and Stopping Times
Richard Wongkew, University of California at Berkeley, Berkeley, CA

Polynomially Parametrizable Planar Algebraic Curves
Miriam L. Lucian, Boeing Commercial Airplane Co., Seattle, WA

Finding the Defining Equation for a Rationally Parametrized Surface
Arthur J. Schwartz, University of Michigan, Ann Arbor, MI and Charles M. Stanton, Indiana University at South Bend, South Bend, IN

Convex Decompositions and Gaussian Approximations of Objects Bounded by Piecewise Algebraic Curves
Chanderjit Bajaj and Myung-Soo Kim, Purdue University, West Lafayette, IN

Thursday, July 23/10:45 AM
Contributed Presentations 13
Ballroom A-B
COMPUTATIONAL GEOMETRY 3

d-Neighbourhoods of Simple Externally Visible Polygons
Dolores Lodares and Manuel Abellanas, Universidad Politecnica de Madrid, Madrid, Spain

Application of 2-n Sorting in Computational Geometry
Jeffrey L. Posdamer, Washington University, St. Louis, MO

Scheduling Pattern of Points or Intervals on a Circle Line
Peter J. Brucker, Universitat Osnabrueck, W. Germany

On the Complexity of 3D Variational Geometry
Paula Beaty and Patrick Fitzhorn, Colorado State University, Ft. Collins, CO

Thursday, July 23/10:45 AM
Contributed Presentations 14/Ballroom C
ROBOT PATH PLANNING 3

A General Path Planning Algorithm for Kinematically Redundant Robots Using a Selective Mapping of Configuration Space
Pierre E. Dupont, and Stephen Derby, Rensselaer Polytechnic Institute, Troy, NY

Path Planning for Mobile Robots: An Elastic Band Approach
S. K. Mohapatra and Baba Prasad S. Chikballapur, University of Hyderabad, Hyderabad, India

Euclidean Shortest Path through Horizontal and Vertical Line Barriers in O(n log n) Time
Man-Tak Shing, University of California at Santa Barbara, Santa Barbara, CA

Active Zones in Constructive Solid Geometry for Redundancy and Interference Detection
Jaroslaw R. Rossignac, IBM-Thomas Watson Research Center, Yorktown Heights, NY and Herbert B. Voelcker, Cornell University, Ithaca, NY

Collision Avoiding Paths for Robots
Prabhakar M. Ghare, Northern Virginia Graduate Center, Falls Church, VA

Separability and Order
Ivan Rival, University of Ottawa, Ottawa, Canada

Thursday, July 23/10:45 AM
Contributed Presentations 15/Ballroom D
CURVES

Computing Approximating Spline Curves with Few Pieces
Michael Kallay, University of California, Davis, CA

The Sorting of Points on a Curve
John K. Johnstone, Cornell University, Ithaca, NY

Interpolatory Curves which Preserve the Sign of Curvature
John A. Roulier, University of Connecticut, Storrs, CT

A Heuristic Method for Data Parametrization
E. T. Y. Lee, Boeing Commercial Airplane Co., Seattle, WA

An Algorithm for Constrained Approximation
Lars-Erik Andersson, Linkoping University, Linkoping, Sweden

A 4-Point Interpolatory Subdivision Scheme for Curve Design
N. Dyn, Tel Aviv University, Tel-Aviv, Israel, J. Gregory, Brunel University, Middlesex, UK and D. Levine, Tel Aviv University, Tel-Aviv, Israel

Thursday, July 23/10:45 AM
Contributed Presentations 16/Ballroom E
GRAPHICS AND IMAGE PROCESSING

Circle Averages and Probabilities in the Hexagonal Lattice
Peter Waksman, University of Rochester, Rochester, NY

Boundary Tracking in Multidimensions and Some Discrete Topologic Problems
Jayaram K. Udupa, Hospital of the University of Pennsylvania, Philadelphia, PA

Ray Intercept Determination and Characterization Using Linear Programming and Convex Polyhedra
H. Ric Blacksten, Human Resources Research Organization, Alexandria, VA

Ray-Tracing Fractal Surfaces
David L. Wells, Texas Instruments, Dallas, TX and Stephen L. Stepoway, Southern Methodist University, Dallas, TX

Codes for Straight Lines in N-Space
Jerome Rothstein, Ohio State University, Columbus, OH

A New Model of Texture Based on Substitution Sequences
Pierre Michel, Universite de Bretagne Occidentale, Brest Cedex, France, Christian Roux, and Moncef Daoud, Ecole National Superieure des Telecommunications de Bretagne, Brest Cedex, France

Thursday, July 23/4:00 PM
Contributed Presentations 17
Ballroom A-B
MESH GENERATION

Finite Element Mesh Optimization Using Distributive Lattice Processing
Joseph M. Juarez, OAO Corporation, El Segundo, CA

Algebraic Grid Generation in Patched Mesh Systems
Raymond Ching-Chung Luh and C. K. Lombard, PEDA Corporation, Palo Alto, CA

An Algorithm for the Automatic Decomposition of Octal Cells Into Finite Elements
Mukul Saxena and Renato Perucchio, University of Rochester, Rochester, NY

Vertex Planting in Solid Finite Element Mesh Generation
Timothy Thomasma, University of Michigan, Dearborn, MI

Refining Simplicial Meshes for Finite Element Problems
Woody Lichtenstein, Culler Scientific Systems Corporation, Goleta, CA

Mesh Generation for Arbitrarily Shaped Regions
R. E. LaBarre and B. J. McCartin, United Technologies Research Center, East Hartford, CT

Thursday, July 23/4:00 P.M.
Contributed Presentations 18/Ballroom C
COMPUTATIONAL GEOMETRY 4

Line Integral Computation of Geometrical Properties of Plane Faces and Polyhedra
Howard B. Wilson, University of Alabama, Tuscaloosa, AL

Graph Based Scheme for Recognition of Polyhedral Features From a 3-D Solid Model
Sanjay Joshi, T. C. Chang and Vijaya Chandru, Purdue University, West Lafayette, IN

Tetrahedral Recursive Decomposition of Free-Space from Boundary Points
Stephane Aubry and Vincent Hayward, McGill University, Montreal, Canada

Medial Axis Transform Using Ridge Following
R. Mark Volkmann, University of Missouri, Rolla, MO and Karl G. Kempf, FMC Corporation, Santa Clara, CA

Vectorized Conjugate Gradient Projection Methods
Ron S. Dembo and Patrick Henaff, Goldman, Sachs & Co. New York, NY

A Sympletic Approach to Graph Theory
Max Garzon, Memphis State University, Memphis, TN

Thursday, July 23/4:00 PM
Contributed Presentations 19/Beverwyck Room
APPLICATIONS AND IMPLEMENTATIONS

Applications of Differential Geometry to Structural Mechanics
Philip Samuels, Hatfield Polytechnic, England

Metal Die Design Using Orthogonal Volume Preserving Coordinates in R^3
Maija Kuusela, Helsinki University of Technology, Finland

Application of the CORDIC Algorithm to Robot Navigational Computations
Wayne D. Smith, Mississippi State University, Mississippi State, MS

Robochess the Intelligent Robot Chess Player
A. R. Nekovei and M. T. Musavi, University of Maine, Orono, ME

A Central Computer Scheme for Controlling Several Small Educational Robots
A. R. Nekovei, M. T. Musavi and M. T. Noori, University of Maine, Orono, ME

Applications of Mathematical Logic to Robotics and Automation
Paul P. Botosani, Bridgeport Engineering Institute, Bridgeport, CT

Thursday, July 23/4:00 PM
Contributed Presentations 20/Ballroom D
MATHEMATICAL METHODS 2

Geometric Encounters of the Bayesian Kind: What is Likely to be Seen
Richard A. Vitale, Claremont Graduate School, Claremont, CA

Symbolic Management of Solid Modeling For Hidden Surface Removal: The Chieng-Hoeltzel Algorithm
Wei-Hua Chieng and David A. Hoeltzel, Columbia University, New York, NY

Robust Utilities for Geometric Modelling with Natural Quadrics
Michael A. O'Connor and Jaroslaw R. Rossignac, IBM-Thomas J. Watson Research Center, Yorktown Heights, NY

Closed Curves, Regions and Boundaries in Integer and Digital Spaces
Efim Khalimsky, City University of New York, Staten Island, NY

Jordan Pushing and Pulling
Pierre Rosensthiel, Ecole des Hautes Etudes en Sciences Sociales Paris Cedex, France

Integration Constraints in Parametric Design of Physical Objects
Alberto Paoluzzi, Universita di Roma La Sapienza, Rome, Italy

Thursday, July 23/4:00 PM
Contributed Presentations 21/Ballroom E
PATH PLANNING PLUS GEOMETRIC MODELING

Two; -dimensional Robot Arm Motion Planning
Boris Aronov and Colm O'Dunlaing, Courant Institute, New York, NY

Minimum Speed Motions
Boris Aronov, Courant Institute, New York, NY, Steven Fortune and Gordon Wilfong, AT&T Bell Laboratories, Murray Hill, NJ

An Uniform Approach to Geometric Modeling
Mingn-ming Wang and Shui-Shen Chern, Tufts University, Medford, MA

Solid Modelling in C
Eugene Loch and Shui-Sheng Chern, Tufts University, Medford, MA

Geometric Representation of Swept Volumes for Polyhedral Objects
John D. Weld and Ming C. Leu, Cornell University, Ithaca, NY

Collision-free Trajectory Planning: Computational Geometry and Splines in Space-Time
Kamal Kant and Steven W. Zucker, McGill University, Montreal, Canada

POSTER PRESENTATIONS

Tuesday, July 21/3:15 PM
Poster Session 1/Beverwyck Room

General Curvature Formulae for Implicit Surfaces
Mark A. Stuff, Environmental Research Institute of Michigan, Ann Arbor, MI

Surface Model for Laser Ranging System
Jacques Lemordant, Grenoble University, St. Martin d'Heres, France

Spline Curve Fitting for Interactive Design
Christine Potier and Christine Vercken, Ecole National Superieure des Telecommunications, Paris-Cedex, France

Romboy Homotopy and Etruscan Venus: An Experiment in Computer Topology
George K. Francis, Donna J. Cox and Ray L. Idaszak, University of Illinois, Urbana, IL

Analytic Functions of Conic Sections in a Computer-Aided Design System
Joshua Zev Levin, Design System, Pacer Systems Inc, Horsham, PA

UPCOMING CONFERENCES

October 12–15, 1987
SIAM Annual Meeting and 35th Anniversary
Marriott Hotel—City Center
Denver, CO

December 1–4, 1987
Third SIAM Conference on Parallel Processing for Scientific Computing
The Westin Bonaventure Hotel
Los Angeles, CA

May 23–26, 1988
Third SIAM Conference on Linear Algebra
The Concourse Hotel
Madison, WI

TRANSPORTATION INFORMATION

By Air

MEETING AND TRAVEL CONCEPTS, INC., have been selected to be the official agent for the conference and will guarantee the lowest fares available to Albany. Calling hours are 8:30 am–5:30 pm (EST) Monday through Friday. Call toll-free from the U.S. 1-800-533-0071. If calling from abroad, phone 1-612-941-1511. Be certain to mention that you are attending the July SIAM Conference in Albany. If you purchase your airline ticket through M&TCI, you will also receive; $100,000 in flight insurance, a 24 hour emergency 800 number, lost luggage control, and lost credit card alert. M&TCI will mail you your tickets upon flight confirmation.

SPECIAL DISCOUNTS

American and Eastern Airlines have been chosen as the official carriers for the conference and they have agreed to offer 5% off any fare including all of the new super discounted fares, or 40% off of Full Coach fares. These fares are available to you should you choose to deal with the airlines directly or use your own travel agency. However, even when using your own travel agency you should call these numbers to get the pre-negotiated rates. AMERICAN: 1-800-433-1790; EASTERN: 1-800-327-8376. Even though these discounted rates are available to you directly, it may be easier just to call M&TCI. **In order to get the flight of your choice, we suggest making reservations as soon as possible.**

By Car

FROM THE AIRPORT

When leaving the airport, make a left on to Albany Shaker Road. Continue straight for approximately 8 to 9 miles until you intersect with Broadway. Make a right and proceed for approximately 10 blocks on Broadway until you intersect with State Street. Make a right on to State Street. You will go up a hill. As soon as you pass the second set of lights, you will make a right on to Lodge Street. The Hilton will be on your right.

FROM NEW YORK CITY AND THE TURNPIKE

Take Route 87 to Exit 23 and proceed to Route 787 North. Follow 787 North to the Empire State Plaza exit. Go thru the tunnel onto Swan Street to State Street. Turn right on State and the Hilton will be three blocks on the left.

FROM THE AIRPORT

TAXI $10.00

COURTESY VAN. Should you wish to be greeted at the airport by the courtesy van, be sure to fill out your arrival time, date, airline and flight number on the Hotel Reservation card. There will also be a courtesy phone to the hotel available at each baggage claim area.

CAR RENTAL

The official car rental agency selected for the SIAM Conference on Applied Geometry is Budget Rent-A-Car. The specially discounted rates for cars are:

	Daily	Weekly
Compact	$18.95	$110.00
Intermediate	$21.95	$150.00
Full-Size 2-Door	$34.95	$215.00
Full-Size 4-door	$37.95	$225.00
Luxury	$39.95	$250.00

You must have an advance reservation to qualify for the discounted rate. Call 1-518-456-8561. Be certain to identify yourself as an attendee at the SIAM Conference on Applied Geometry.

- Cars must be picked up and dropped off at the airport.
- You must call at least one week in advance to guarantee availability and to qualify for the discounted rate.
- You must have one of the following credit cards to rent a car: AMEX MC, VISA, DC, and Sears.
- You must be at least 21 years of age, and have a valid driver's license.
- If you make a reservation at least two weeks prior to the conference, Budget will send you a confirmation.
- 100 free miles a day, 700 free miles a week. Additional miles will be charged at twenty cents per mile.

HOTEL INFORMATION

Albany Hilton
State and Lodge Streets
Albany, NY 12207
518-462-6611

SIAM is holding a block of rooms at the Albany Hilton which have been specially discounted for our exclusive use. **However, these rooms will only be held until July 5, 1987, after which time availability cannot be guaranteed.** The rates are $55/Single and $65/Double.

It is advised that you make your reservations promptly by calling 1-518-462-6611, or by mailing in your Albany Hilton Reservation Request Form, located in the back of this program. When making your reservation via phone, please be certain to identify yourself as an attendee at the SIAM Conference on Applied Geometry in order to acquire the discounted rate.

Late Arrival Policy: If you plan to check in after 6:00 pm, you must guarantee your room for late arrival by making payment in advance for one night. Payment can be made either by Diner's Club, AMEX, MC, VISA or check.

Check in time is 3:00 pm and Check out time is 1:00 pm. If you need to change or cancel your reservation, be certain to contact the hotel by 3:00 pm Albany time on your stated date of arrival.

Courtesy Van: Should you desire to have the hotel courtesy van meet you at the airport, please be certain to fill in the arrival date, time and flight number information on your Hotel Reservation Request Form.

REGISTRATION INFORMATION

The registration desk will be located in the Prefunction Area on the Ballroom Level of the hotel and will be open as listed below:

Saturday, July 18/5:00 PM–10:00 PM
Sunday, July 19/7:00 AM–10:00 PM
Monday, July 20/7:00 AM–6:00 PM
Tuesday, July 21–Thursday, July 23/8:00 AM–6:00 PM
Friday, July 24/8:00 AM–12:00 NOON

NON SIAM MEMBERS

Non-member registrants are encouraged to join SIAM in order to obtain the member rate for conference registration and enjoy all the other benefits of SIAM membership.

		SIAM Member	Non Member	Student Member	Student Non-Member
Short Course Fees	Advance	$ 75	$ 90	$30	$40
	On-site	$90	$105	$40	$50
Conference Fees	Advance	$110	$140	$20	$30
	On-site	$135	$165	$20	$30

Beer Party
Monday, July 20, 6:15 pm
Prefunction Area, Ballroom Level
Albany Hilton
$10.00

Dinner and Ballet
Wednesday, July 22, Buses leave the hotel at 5:00 pm. for the Saratoga Springs Performing Arts Center $34.00

Special Note

There will be no prorated fees. No refunds will be issued once the conference has started.

Telephone Messages

The telephone number at the Albany Hilton is 1-518-462-6611. The Hilton will either connect you to the SIAM desk or forward a message.

SIAM CORPORATE MEMBERS

Non-member attendees who are employed by the following institutions are entitled to the SIAM member rate.

Aerospace Corporation
Amoco Production Company
AT&T Bell Laboratories
Bell Communications Research
Boeing Company
Cray Research, Inc.
Culler Scientific Systems Corporation
E.I. Du Pont de Nemours and Company
Eastman Kodak Company
Exxon Production Research Company
Exxon Research and Engineering Company
General Electric Company
General Motors Corporation
Giers Schlumberger
GTE Laboratories, Inc.
Hollandse Signaalapparaten B.V.
IBM Corporation
Institute for Computer Applications in Science and Engineering (ICASE)
IMSL, Inc.
MacNeal-Schwendler Corporation
Marathon Oil Company
Martin Marietta Energy Systems
Mathematical Sciences Research Institute
Standard Oil Company of Ohio (SOHIO)
Supercomputing Research Center, a division of Institute for Defense Analyses
Texaco, Inc.
United Technologies Corporation

CREDIT CARDS

SIAM is now accepting credit cards for the payment of registration fees and special functions. When you complete the Advance Registration Form, please be certain to indicate the type of credit card, the number and the expiration date.

To Advance Registrants

Please be certain to process your advance registration form yourself. If this task is delegated to an employee, quite often the form does not reach SIAM by the deadline and oftentimes not at all.

If SIAM does not receive your advance registration form by the stated deadline, you will be asked to give us a check or a credit card number at the conference. We will not process either until we have ascertained that your registration form has gone astray. In the event that we receive your form after the conference, we will return your check or credit card slip.

ALBANY HILTON RESERVATION REQUEST FORM

SIAM Conference on Applied Geometry

PLEASE SEND ME A CONFIRMATION NOTICE.

Specially discounted rooms will be held for our exclusive use only until July 5, 1987. After that, reservations will depend on availability. Your reservation is not confirmed until acknowledged in writing by the hotel or verified by phone.

When making reservations by phone, be certain to identify yourself as an attendee at the SIAM Conference on Applied Geometry. Telephone: 1-518-462-6611.

Name _____ Phone _____
(please print)
Address _____

City _____ State _____ Zip _____
Please reserve: ☐ Single ($55) ☐ Double ($65) ☐ Guarantee my room for late arrival ☐ Yes ☐ No

Arrival Date _____ Arrival Time _____ Check-out Date _____
☐ DINERS CLUB ☐ AMEX ☐ MC ☐ VISA Deposit $_____ (late arrival only)

Card Number _____ Expiration Date _____ Signature _____

Courtesy Van ☐ Yes ☐ No Flight #_____ Arrival Time _____ Airline _____

If you list your credit card number, please enclose this card in an envelope and mail to: Reservations, Albany Hilton, State and Lodge Streets, Albany, New York, 12207. You only need to list your credit card number if you want to guarantee your room for late arrival.

ADVANCE REGISTRATION FORM

SIAM Conference on Applied Geometry

** Advance registration form must be received at the SIAM office by July 16, 1987.* If paying by check, please make check payable to SIAM.

		SIAM Member	Non Member	Student Member	Student Non-Member
Short Course	Advance	$ 75	$ 90	$30	$40
	On-site	$ 90	$105	$40	$50
Conference Fees	Advance	$110	$140	$20	$30
	On-site	$135	$165	$20	$30
Short Course		$_____	$_____	$_____	$_____
Conference		$_____	$_____	$_____	$_____
Beer Party, $10.00		$_____	$_____	$_____	$_____
Dinner and Ballet $34.00		$_____	$_____	$_____	$_____
TOTAL		$_____	$_____	$_____	$_____

☐ Please send me information about membership in SIAM.
Detach card and enclose with payment in the envelope provided (domestic mail only), or mail to: SIAM, 117 South 17th Street, 14th floor, Philadelphia, PA 19103-5052. Telephone: 215-564-2929

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From: _____

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Albany Hilton At Ten Eyck Plaza
State and Lodge Streets
Albany, NY 12207

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