

Society for Industrial and Applied Mathematics

Preliminary Program

SIAM Conference on Geometric Design

November 6 – 10, 1989

Sheraton Mission Palms Hotel
Tempe, Arizona

CONFERENCE THEMES

Curve and Surface Design
Solid Modeling and Manufacturing
Geometric Complexity
Computer Graphics
Supercomputing and Graphics

AND

Short Course on

**Visualization
Techniques for
Graphic Design**

November 5, 1989

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ORGANIZING COMMITTEE

Robert E. Barnhill (Chair),
Arizona State University;
Gerald E. Farin,
Arizona State University;
Ronald N. Goldman,
University of Waterloo;
Harry W. McLaughlin,
Rensselaer Polytechnic Institute;
Ramon F. Sarraga,
General Motors Research Laboratories;
Michael A. Wesley,
IBM-T.J. Watson Research Center;
Michael Wozny,
Rensselaer Polytechnic Institute

DEADLINE DATES

Hotel Reservations:
October 16, 1989

Advance Conference Registration:
October 30, 1989

SHORT COURSE

SHORT COURSE ON VISUALIZATION TECHNIQUES FOR GEOMETRIC DESIGN

November 5, 1989
Sheraton Mission Palms Hotel
Tempe, Arizona

Organizers:
Thomas A. Foley and Gregory M. Nielson
Computer Science Department
Arizona State University

This course will emphasize the use of 3D interactive computer graphics in Geometric Design. The course will include coverage of 3D viewing models, lighting and shading models, ray tracing, transparency, contouring, 3D interaction, rendering of multivariate functions, volume visualization and surface interrogation. Also included will be an interactive demonstration on a state of the art graphics workstation. The speakers will present enough practical details so that the attendees can implement many of the concepts, while other topics will be covered at a higher level with appropriate references given. The speakers include faculty from leading universities, the Editor-in Chief and an Associate Editor of ACM Transactions on Graphics and a researcher from a leading manufacturer of graphics workstations.

PROGRAM

| | |
|----------|---|
| 9:00 AM | Introduction to 3D Computer Graphics Gregory Nielson Arizona State University |
| 10:00 AM | Coffee Break |
| 10:30 AM | Smooth Shaded Rendering of Surfaces John Beatty University of Waterloo |
| 11:30 AM | Multivariate Rendering, Interaction and Interrogation Thomas Foley Arizona State University |
| 12:30 PM | Lunch |
| 2:00 PM | Volume Visualization Techniques Stephen Pizer University of North Carolina Chapel Hill |
| 3:00 PM | Coffee |
| 3:30 PM | Will Smoothly Shaded Surfaces Supersede or Compliment Wire Frame Surfaces? Rosemary Chang Silicon Graphics Computer Systems Mountain View, CA |
| 4:30 PM | Discussion |
| 5:15 PM | Adjournment |

INVITED PRESENTATIONS

Monday, November 6/8:30 AM
Invited Presentation 1

The Decline and Renaissance of Geometry

Starting in the middle of the 19th century, geometry suffered a loss of independence and integrity, having been "subsumed" by other mathematical disciplines, among them algebra and analysis. In the last two decades, under the impact of the digital computer and computer graphics, geometry has blossomed forth, exhibiting many new ideas, problems, methodologies and points of view.

The decline and the renaissance will be described, and speculations will be offered as to where this leaves geometry in the mathematics curriculum and in the history of mathematics.

Philip J. Davis
Division Applied Mathematics
Brown University

Monday, November 6/9:15 AM
Invited Presentation 2

Visualization? Or Merely Geometry and Computer Graphics?

The term scientific visualization describes the process of extracting meaningful information, interactively, from a graphics representation of a model of a real world phenomenon, for the purpose of enhancing understanding of the underlying phenomenon.

Generally, the phenomenon is so complex, or not amenable to experiment that relationships between variables are not understood. Computer graphics, with sufficient computer power, provides a virtual environment to model phenomena and search interactively for intuitive insight about possible dependencies.

Scientific visualization requires not only computer graphics, but more fundamentally, a total modeling environment. Graphical representation of data derived from inadequate mathematical models is meaningless. Models must be specifically designed to answer particular questions about the underlying phenomenon.

This presentation will motivate the subject via several representative examples, describe existing capabilities, and present new graphics architectures for accommodating NURBS geometry in the pipeline.

Michael J. Wozny
Department of Computer Graphics
Rensselaer Polytechnic Institute

Monday, November 6/2:00 PM
Invited Presentation 3

Geometry In Conceptual Design

Conceptual design is the most critical stage of the product development cycle. Decisions made during conceptual design commit major resources in the remainder of the product development cycle. At the same time, few computational tools exist for conceptual design. Most existing CAD tools are dedicated to the analysis or documentation stages of design and provide little help during the conceptual stages of design.

The speaker will discuss some recent research activities directed toward new computational tools for conceptual design. These will include systems for the preliminary design of assemblies, systems to generate advice about manufacturability, and systems to analyze incompletely specified designs.

David C. Gossard
Department of Mechanical Engineering
Massachusetts Institute of Technology

INVITED PRESENTATIONS

Tuesday, November 7/8:30 AM

Invited Presentation 4

Parametric Curves and Surfaces in Computer Aided Geometric Design

Parametric curve and surface representation continues to be an active area of research in geometric design. Free-form surface modelers traditionally use parametric representations which typically generate a complex of rectangular surface patches. Recent developments in parametric representations will be reviewed, especially with regard to the development of more general surface patch networks. Here, the concept of 'geometric continuity' becomes an essential tool in the study of such surfaces.

John A. Gregory
Department of Mathematics
Brunel University

Tuesday, November 7/9:15 AM

Invited Presentation 5

NURBS: Theoretical and Practical Issues

Nonuniform rational B-splines have become a de facto industry standard for the representation of rectangular (possibly trimmed) surfaces. On the practical side, however, few algorithms exist that exploit the nonpolynomial aspects of these curves and surfaces. The speaker will point out possible areas for such algorithms. In addition, some of the as yet unresolved aspects of NURBS will be addressed, such as problems involving reparametrizations.

Gerald Farin
Department of Computer Science
Arizona State University

Wednesday, November 8/8:30 AM

Invited Presentation 6

Numerical Stability of Geometric Algorithms and Representations

Extensive numerical calculations are often mandatory in the modeling of artifacts bounded by algebraic curves and surfaces, and the accumulation of arithmetic round-off error thus poses a fundamental limitation on the reliability of practical applications which call upon such models.

The speaker will survey standard notions of numerical conditioning and error-propagation analysis in the context of geometric modeling procedures, describing how they may be used to identify numerically stable forms among competing representations, to monitor and/or subdue error accumulation in iterative algorithms, and to provide appropriate feedback to algorithm control structures if possible.

Rida T. Farouki
IBM Thomas J. Watson Research Center

Wednesday, November 8/9:15 AM

Invited Presentation 7

Algorithms for Computing Intersections of Parametric Surface

The problem of computing intersections of free-form geometric entities is fundamental to computer aided geometric design and graphics. Various algorithms have been developed, using such techniques as subdivision, polynomial resultants, and Newton iteration.

The speaker will review current intersection algorithms. Several recent advances will be discussed which significantly enhance speed and robustness. Specific attention will be paid to new algorithms for intersecting planar curves, space curves, curves and surfaces, and parametric surfaces. New methods for detecting closed loops in surface/surface intersections will also be discussed.

Thomas W. Sederberg
Department of Civil Engineering
Brigham Young University

Thursday, November 9/8:30 AM

Invited Presentation 8

Images of Matrices—Mathematical Visualization

Many algorithms in scientific computation produce sequences of matrices. Examples include direct and iterative algorithms in computational linear algebra and time marching and iterative algorithms for partial differential equations. Insight into both the algorithms and the physical phenomena being modeled is gained by interrupting the matrix sequence as a time varying surface defined on a uniform grid, and rendering this surface with three dimensional, color, animated computer graphics. Additional matrices can be used to define nonuniform grids and supply color derived from other functions.

Cleve Moler
Arden Computer and The MathWorks

Thursday, November 9/9:15 AM

Invited Presentation 9

Teleological Modeling: A New Approach For Representing Objects

Scientific computer graphics consist of two main activities: MODELING, which is the science of making mathematical abstractions of objects, and RENDERING or VISUALIZATION, in which images are made from the mathematical abstractions. A new approach to modeling is introduced for creating abstractions and mathematical representations of physically realistic and time-dependent objects. In the approach, geometric constraint properties, mechanical properties of objects, the parameters representing an object, and the control of the object are incorporated into a single conceptual framework.

A TELEOLOGICAL model incorporates time-dependent goals of behavior or "purpose" as the fundamental abstraction and representation of what the object is. The term is derived from the Greek word "teleos," for end, goal, or purpose. A teleological model IMPLIES geometry rather than prescribing or specifying geometry directly. It takes a geometrically "incomplete" specification of the motion, position, and shape of an object, and produces a complete description of the object's shape and behavior as a function of time. Intuitively, it is a representation which calculates the object's behavior from what the object is "supposed" to do.

Teleological modeling techniques provide an extension of the current notions about how to make mathematical models of objects; the approach utilizes forces, torques, internal stress, energy, and other physically derivable quantities which allow us to simulate many of the fundamental properties of the shapes, combining-operations, and constraints which govern the formation and motion of objects.

Alan H. Barr
Computer Science Department
California Institute of Technology

Friday, November 10/8:30 AM

Invited Presentation 10

Using Domain Processing for Solid Modeling

Domain processing and manipulation refers to computations one makes about geometrical objects in preparation for further processing. Examples of such computations are partitioning into sub domains, overlaying with grids, and mapping into simpler shapes. Examples of further processing include solving partial differential equations, plotting functions, approximating functions, and determining relationships between objects. We may view these computations as creating a data structure that contains useful information about the object using the object's basic definitions. Currently, these computations usually are not viewed as an independent phase of problem solving and their details are intertwined with the rest of the problem solving. The lack of a clean separation between the geometric processing and later phases leads to complex programs and the inability to easily try new techniques. The speaker will review some generally useful domain processing and manipulation methods and illustrate their use in simplifying problem solving involving complex geometry.

John R. Rice
Computer Science Department
Purdue University

Friday, November 10/9:15 AM

Invited Presentation 11

Geometrical Aspects of PDES

The Product Data Exchange Standard (PDES) is an emerging standard for the electronic exchange of intelligent product definition data between CIM systems. At the end of 1988 this was raised to ISO Draft Proposal status under the unofficial acronym of STEP. A major portion of the specification is concerned with the geometry necessary to describe the shape of a product.

Unlike previous standards in this area, PDES is looking forward to the CIM systems of the 90's rather than the current CAD systems. In some sense it is more a research project than a standardization activity.

The speaker will briefly describe the methodology used in developing PDES/STEP, the criteria used in the geometry model development, and an overview of the specific geometric forms selected.

Peter R. Wilson
Rensselaer Polytechnic Institute

GET-TOGETHERS

SIAM Welcoming Reception

Sunday, November 5th,
7:00 PM - 9:00 PM
Cash Bar

SIAM Beer Party \$15

Monday, November 6th,
6:45 PM - 8:00 PM

This is a great time to just get together with your colleagues. The party will consist of make your own tacos, burritos and nachos. Beer and assorted sodas will also be available.

Rustlers Cookout \$32

Wednesday, November 8th,
4:15 PM - 9:00 PM

Board the buses in front of the hotel lobby at 4:15 PM and join in on one of the best barbecues in town. From 4:30 PM - 6:30 PM relax with a cool beer or soda while enjoying the panoramic view of the Arizona valley. Dinner will consist of an old fashioned steak cookout consisting of a tossed salad, 6 oz. sirloin steak and 1/2 barbequed chicken, corn on the cob, western beans, rolls and apple pie. After dinner we will board the bus and head back to Gammage Theater to see the opening preview night of Leonard Bernstein's musical masterpiece of West Side Story. This musical tells the story of gang warfare on New York City's Westside.

Geometric Design

MINISYMPOSIA

Monday, November 6/10:30 AM

Minisymposium 1

Geometry and Numerical Analysis

Standard numerical analysis techniques for monitoring and suppressing arithmetic error can significantly enhance the reliability of practical geometric algorithms operating in finite-precision arithmetic. Conversely, geometric perspectives on familiar numerical analysis problems often yield fresh insights into their fundamental nature, and alternate approaches to their solution. This symbiotic relationship between geometry and numerical analysis - currently in a state of neglect - offers a fertile research paradigm with the promise of both practical and theoretical results.

Organizer: Rida Farouki
IBM T. J. Watson Research Center, Yorktown Heights, NY

Towards Robust Geometric Computations
Deborah Silver, Rutgers University, Piscataway, NJ

Using Geometry to Explain and Ameliorate I11-Conditioning
James Demmel, Courant Institute of Mathematical Sciences, New York University

On Subdivision Algorithms in Finite-Precision Arithmetic
R.T. Farouki and C.A. Neff, IBM Thomas J. Watson Research Center

Robust Geometry: Using Rounded Arithmetic Correctly
Victor Milenkovic, Harvard University

Monday, November 6/10:30 AM

Minisymposium 2

Interpolation and Modeling in Three or More Dimensions

Engineers and scientists are finding an increasing number of problems where there is a need to model phenomena arising from data in three or more dimensions. For example, surface on surface approximation can be viewed this way and, in design problems, recent results based on contouring trivariate quadratics have been successfully used. In general, the aim is to construct and then analyze a smooth interpolant to prescribed scattered data. In this minisymposium the speakers will focus on some of the issues, methods, and algorithms used in all the steps involved in solving such problems. Particular emphasis will be given to the three-dimensional case.

Organizer: Andrew J. Worsey
University of North Carolina, Wilmington

Multivariate Interpolation at Scattered Points
Peter Alfeld
University of Utah, Salt Lake City

Tessellations for Multivariate Interpolants
Bruce Piper
Rensselaer Polytechnic Institute

Contouring Trivariate Polynomials Over Tetrahedra
(To be presented by organizer)

Monday, November 6/4:30 PM

Minisymposium 3

The Use of Mathematical Methods in Cad/Cam for Car Body Design and Manufacturing

A survey will be given about CAD/CAM functionality which is necessary in the automobile industry. The examples occur in the practical use of the CAD/CAM system SYRKO at Mercedes Benz along the so called process chain i.e. the flow of CAD/CAM data from styling the shape to milling the dies. Further we want to discuss the following topics: smoothing curves and surfaces, mathematical representation of curves and surfaces, the role of approximation methods to create surfaces, methods to test the quality of surfaces, NC-techniques, the use of interfaces for data exchange, advantages of Bezier and B-spline methods. Finally, the speakers will discuss problems, methods and new trends concerning the future role of applied mathematics in car body design.

Organizer: R. Klass
Daimler-Benz AG Sindelfingen, W. Germany

Surface Design through Computer Graphics
Roger K.E. Andersson, Volvo Data AB Corporation Sweden; and Bjorn E.J. Dalhberg
Washington University

Flow of CAD/CAM Information for Free-Form Surface Geometry in Carbody Design
Werner Dankwort and Thomas Reuding, Bayerische Motoren Werke AG., W. Germany

Monday, November 6/4:30 PM

Minisymposium 4

Advances in Automatic Finite Element Meshing

The speakers will address the problem of generating automatically valid 3-D Finite Element (FE) meshes from solid models. Genuinely automatic meshing is a crucial step towards the automation of the entire FE analysis process and, as such, is of critical importance for the development of automatic procedures for mechanical CAD/CAE. Existing algorithms for automatic meshing can be broadly classified as domain triangulation, element extraction, or recursive spatial decomposition. Although various algorithms have been implemented in existing Solid Modeling Systems (SMS), important limitations remain (e.g., human assistance is still required to resolve ambiguous cases or to pre-process data not explicitly available in the SMS). Participants in the minisymposium will review the status of automatic meshing and present current developments in generating finite element meshes.

Organizer: Renato Perucchio
University of Rochester, Rochester

A New Technique for Smoothing Triangular Meshes
William Frey and David Field, GM Research Laboratories, Warren, MI

No More Meshes
Thijs Sluiter, Structural Dynamics Research Corporation, Milford, OH

Integration of Recursive Spatial Decomposition and Element Extraction for Automatic Meshing
Renato Perucchio and Mukul Saxena, University of Rochester, NY

Tuesday, November 7/10:30 AM
Minisymposium 5

Surfaces on Surfaces

The surface on surface problem is: Given N arbitrary points p_i on a closed surface D and associated real values f_i , find a smooth function $F(p)$ defined over all of D which satisfies $F(p_i) = f_i$, for $i = 1, \dots, N$. For example, the domain D may be a sphere and the given f_i represent temperature; or the domain D may be a space craft and the f_i represent pressure at various points on the surface of the craft. Solutions to the surface on surface problem have appeared only recently.

This minisymposium will contain solutions to the problem together with applications to geometric modeling and volume visualization.

Organizer: Thomas A. Foley
Arizona State University, Tempe Arizona

Geometric Modeling and Volume Visualization Techniques Based upon Surfaces on Surfaces
Thomas A. Foley, David Lane, and Gregory M. Nielson, Arizona State University

Scattered Data Interpolation on Surfaces
H. Pottmann, Zentrum für Praktische Mathematik, W. Germany

Interpolation to Arbitrarily Located Data on a Convex Surface

Robert E. Barnhill, Suisheng Ou, and Stephen H. Watson, Arizona State University

Tuesday, November 7/10:30 AM
Minisymposium 6

Geometric Problems in Manufacturing

This minisymposium covers the computational aspects of some of the geometric problems that arise in manufacturing of discrete products. In particular, computational problems in Numerical Control (NC) Machining and Computerized Inspection of products are considered. Both these areas are key components of a Computer Integrated Manufacturing (CIM) system for production of discrete mechanical components. Present day methods for production of many mechanical components do not completely integrate their design, manufacturing, and inspection. The speakers will describe computational algorithms that can improve integration of design, manufacturing and inspection.

Organizer: Bahram Ravani
University of California-Davis

Generalized Planar Sweeping of Polygons
K. Sambandan, K. Kedem and K. K. Wang, Cornell University

Non-isoparametric Tool Point Trajectories for NC Machining of Sculptured Surfaces
B. Ravani, University of California, Davis, and Y. J. Chen, Adapco Engineering, Melville, LI, NY

Simulated Gaging of Measured Parts Using Solid Modeling Systems
Faryar Etesami, Portland State University, Oregon

Computerized Inspection of Gear Tooth Surfaces
F. L. Litvin, Y. Zhang, and J. Kieffer, University of Illinois-Chicago

Creation of a Geometric Feature with Exact Geometric Tolerance Values
H.A. ElMaraghy, McMaster University, Ontario, Canada

Tuesday, November 7/2:00 PM
Minisymposium 7

Engineering Geometry

This minisymposium addresses applications of geometric modeling and computational geometry in engineering. A range of important issues extending from geometric design of functional surfaces, data structures for non-manifold models, to processing (interrogation) of geometric models for design of complex objects and performance evaluation are covered. Lectures on the following specific problems are envisioned: Geometric modeling of blending surfaces subject to a set of boundary conditions and other technological constraints; distance function computation and its application in shape representation and interrogation; computer representation of geometric models of mixed dimensionality and their interrogation, and processing of geometric models to allow shape idealization and discretization for automated analysis.

Organizers: Joseph Pegna, University of California, Irvine, CA; and Nicholas Patrikalakis, Massachusetts Institute of Technology

Distance Computations for Curves and Surfaces
Franz-Erich Wolter
Massachusetts Institute of Technology

Blending Functional Surfaces

Joseph Pegna
University of California, Irvine

Features and Mixed Dimensional Structures for Interrogating CAD Models

Jarek Rossignac and Michael O'Connor, IBM T.J. Watson Research Center, Yorktown Heights, NY; and Paul Borrel, LAMM-USTL, France

Shape Interrogation for Automated Analysis
Nicholas Patrikalakis and H. Nebi Gursoy, Massachusetts Institute of Technology

Tuesday, November 7/2:00 PM
Minisymposium 8

Recent Developments in Knot Removal Techniques

The number of knots used when describing a curve or surface in B-spline format, is often much greater than necessary. Recently, a method for removing knots without perturbing the curve or surface more than a given tolerance has been developed. In this minisymposium we will discuss some recent extensions of this knot removal or data reduction process. These include local knotline removal on tensor product surfaces, triangular surfaces, and natural splines. Some industrial applications will also be presented.

Organizer: Tom Lyche
University of Oslo, Norway

Local Data Reduction for Tensor Product B-spline Surfaces
Morten Daehlen
University of Oslo, Norway

Knot Removal for Scattered Data
Alain J. Y. Le Mehaute
Universite' des Sciences et Techniques de Lille, France

Knot Insertion for Natural Splines
Kyrre Strom
University of Oslo, Norway

Smoothing and Data Reduction by Knot Removal: Some Industrial Applications
Per Evensen
Center for Industrial Research, Oslo, Norway

Tuesday, November 7/4:30 PM
Minisymposium 9

Rational Curve and Surface Schemes

New developments in the theory of rational curves and surfaces will be presented. Special emphasis will be on topics such as geometric continuity of rational objects or their relationship to blossoming.

Organizer: Gerald Farin
Arizona State University, Tempe

A Hitchhiker's Guide to Steiner Surfaces
A. Schwartz, University of Michigan, Ann Arbor, and C. Stanton, Indiana University, South Bend

Rational Bezier Triangles
Tony D. DeRose, University of Washington, Seattle

Rational Curves and Surfaces
Wolfgang Boehm
Technical University, Braunschweig, W. Germany

Tuesday, November 7/4:30 PM
Minisymposium 10

Box Spline Modeling

Recently, multivariate splines have received considerable attention. Tensor product B-spline surfaces are regarded as a powerful representation form in CAGD, but suffers restrictions because of its rectangular nature. The multivariate splines provide generalizations giving rise to the construction of surfaces defined over more general non-rectangular domains.

Although a beautiful theory of multivariate B-splines has been created the development of practical applications has been more difficult. We will consider some applications of box splines to modeling. Including: interpolation with linear combinations of box splines, efficient methods for the evaluation of box splines, problems related to an imbedding of box spline surfaces within a tensor product framework, and modeling of box spline surfaces with special emphasis on non-rectangular surfaces.

Organizer: Tom Lyche
University of Oslo, Norway

Box Spline Interpolation and Computations
(To be presented by organizer)

Grid Point Interpolation on Finite Regions by Box Splines
Erlend Arge
University of Oslo, Norway

Modeling with Box Spline Surfaces
Morten Daehlen
University of Oslo, Norway

Tuesday, November 7/8:00 PM
Minisymposium 11 (Format: Round table panel discussion, including public)

Solid Modeling; Where to Now?

Solid modeling was a much publicized subject first in R/D and soon after in commercial CAD/CAM systems, in the early '80s. The subject seems less popular now. Is it being studied in the quieter academic world? Is its use progressing or not? Related to these questions are many more. Come hear the panelists reactions and suggestions.

Organizer and moderator: Michel Bercovier, Hebrew University, Jerusalem, Israel

Panelists:
I. Braid
J.M. Brun
C. Hoffmann
M. Pratt
R. Sarraga

Wednesday, November 8/10:30 AM
Minisymposium 12

Geometry Processing

Geometry Processing is the determination of geometric properties of an already constructed curve, surface, or volume. Among the many important problems in this subject are offset curves and surfaces, surface/surface intersections, and the conversion of surface forms from one representation to another. The relevant mathematics, algorithms, and graphics implementations for these topics will be presented by the speakers.

Organizer: Robert E. Barnhill
Arizona State University

Fundamental Properties of Plane Offset Curves
Rida T. Farouki, and C. A. Neff, IBM T. J. Watson Research Center

A Marching Method for Parametric Surface/Surface Intersection

Robert E. Barnhill and Scott N. Kersey, Arizona State University

Conversion Algorithms for Spline Curves and Surfaces

Josef Hoschek
Technische Hochschule Darmstadt, W. Germany

Wednesday, November 8/10:30 AM
Minisymposium 13

Computational Algebraic Geometry and Geometric Modeling

The speakers will report on recent progress in geometric modeling using algebraic curves and surfaces of arbitrary degree. Drawing on the fields of algebraic geometry and numerical approximations, they will emphasize constructive and robust solutions to fundamental geometric operations, using the implicit representation of algebraic surfaces. These solutions also provide new insights for parametric curve and parametric surface manipulations. The highlights of the talks will include: new characterizations for the geometric continuity of meshing algebraic surfaces, efficient algorithms for exact and approximate algebraic surface fitting, fast methods for computing the irreducible complex (and real) components of an algebraic curve, and various techniques for computing the resultant of several polynomials, via sparse matrix operations.

Organizer: Chanderjit Bajaj
Purdue University, West Lafayette, IN

Surface Fitting Using Algebraic Surfaces
(To be presented by organizer)

Multipolynomial Resultant Algorithms
John Canny, University of California, Berkeley

Decomposing an Algebraic Curve
Erich Kaltofen, Rensselaer Polytechnic Institute

Geometric Continuity for Implicit Surfaces
Joe Warren, Rice University

Wednesday, November 8/2:00 PM
Minisymposium 14

Design for Functionality

The design of curves and surfaces remains a difficult problem in many areas. Simple questions such as "What is a fair surface?" still prove to be stumbling blocks. One source of difficulty is that often the methods used do not take functionality into account. Hence, one possible solution is to make better use of functionality and engineering knowledge in design methods. This minisymposium is directed toward accomplishing this goal. Three presentations will be concerned with constructing curves and surfaces

having particular functional requirements. The fourth will deal with the linear algebra necessary to continue this work.

Organizer: David R. Ferguson
Boeing Computer Services, Seattle, WA

Methods for Off-line Robot Trajectory Planning
Samuel P. Marin, GM Research Laboratories, Warren, MI

Surface Design Using Visual Curves

Roger Andersson, Volvo Data AB, Sweden; and Bjorn E.J. Dahlberg, Washington University, St. Louis, MO

A Posteriori Modeling and Engineering Design
Thomas A. Grandine, Boeing Computer Services

Solving Sparse Rank-Deficient Problems in CAD/CAM

John Lewis and Dan Pierce, Boeing Computer Services

Wednesday, November 8/2:00 PM
Minisymposium 15

Recent Advances in Surface-Surface Intersection as Used in the Cadcam Industry

A system is presented to obtain an efficient surface-surface intersection for use in solids modeling. Algorithms presented in the last 20 years have several limitations: there is no guarantee that all the curves are found, critical cases such as touch point/line are missed, and lack of accuracy and numerical stability. Instead of presenting just one algorithm, we present a set of algorithms as a possible method to obtain all the intersection curve accurately and reliably. The symposium includes an overview and global system description. The speakers will discuss using a plane vector field to obtain all the intersection curves, matching algorithms to trace intersection curves, and geometric methods for special case intersections. A performance evaluation and open research problems are also presented.

Organizer: Les Piegl
University of South Florida, Tampa, FL

Surface-Surface Intersection for Solids Modeling

Wayne Tiller, Structural Dynamics Research Corporation, Milford, OH

Finding All the Intersection Curves Using a Plane Vector Field

Koun-Ping Cheng, Intelligent Modeler Co., San Diego, CA

Tracing the Intersection Curves of Parametric Surfaces

Eugene Lee, Boeing Commercial Airplanes, Seattle, WA

Geometric Methods for Special Case Intersections

(To be presented by organizer)

Thursday, November 9/10:30 AM
Minisymposium 16

N-Sided Surface Patches

Many geometric modeling applications currently employ tensor product methods such as non-uniform rational B-splines or tensor product Bezier surfaces. It is now widely recognized that situations commonly occur where tensor product methods break down either because of an irregular topological connection of the surface patches or because non-rectangular surface patches are desired. In this minisymposium the use of non-rectangular surface patches will be addressed, with

special emphasis on patch representations that admit any number of boundary curves. The desirability of such patch forms will be motivated, current methods will be discussed, and directions for further research will be outlined.

Organizer: Tony D. DeRose
University of Washington, Seattle, WA

An Introductory Survey of N-Sided Patches

Gary Herron, Colorado State University, Fort Collins

The Basic Results of S-patches

(To be presented by organizer)

N-sided Spline Surfaces

Charles Loop, University of Washington, Seattle

Thursday, November 9/10:30 AM
Minisymposium 17

Solid Modeling: Nurbs and Non-Manifold Issues

Current issues in solid modeling include the modeling of objects with free form surfaces and non-manifold characteristics. This symposium will first introduce the concept of boundary models including definitions, data structures and algorithms. Two talks will follow discussing the advantages and problems associated with modeling NURBS surfaces in a solid model. The first talk will deal with implementation problems from a geometry standpoint and the second will discuss performing Boolean operations with trimmed surfaces. The final talk will outline the definitions and techniques used in non-manifold modeling. This last topic is especially important for analysis applications requiring models which meet at a face, edge or vertex in a non-manifold manner including finite element mesh representations.

Organizer: Mark Henderson
Arizona State University

Solid Modeling: Architectures and Boundary Representations

James Miller, University of Kansas, Lawrence

Boolean Operations on 3-D Objects Defined as Collections of Trimmed Surfaces

David Hook, Structural Dynamics Research Corporation, Milford, OH

NURBS-Modeling and ALPHA 1

Richard Riesenfeld, University of Utah, Salt Lake City

Non-Manifold Topology

Peter Wilson, Rensselaer Polytechnic Institute

Thursday, November 9/2:00 PM
Minisymposium 18

The CAGD Workstation: Research Projects

What is a good graphics workstation for CAGD? To design, implement, test, evaluate, and very importantly, to sell CAGD methods, the researcher needs good graphical tools. The speakers in the first of two minisymposia address this question by describing research projects underway in CAGD at Silicon Graphics. Our purpose is to develop techniques that support dynamic interaction between the researcher and the visualization with algorithms that span both software and hardware.

The speakers will discuss fast display of trimmed NURBS surfaces, finding roots of Bernstein-Bezier triangular patches from the applications point of view.

At the conclusion we present features of a good CAGD graphics workstation. Visualization tools is the theme of the second minisymposium.

Organizer: Rosemary Chang
Silicon Graphics Computer Systems, Mountain View, CA

Fast Display of Trimmed NURBS Surfaces
Derrick Burns, Stanford University and Silicon Graphics Computer Systems

Finding the Real Roots of a Bernstein-Bezier Curve

Alyn Rockwood, Silicon Graphics Computer Systems

Triangular Bernstein-Bezier Patches: Real-time Rendering Tool for Scattered Data
(To be presented by organizer)

Thursday, November 9/2:00 PM
Minisymposium 19

Visualizing Multi-Dimensional Geometry & Some Applications

By means of a Multi-Dimensional system of *Parallel Coordinates*, subsets of R^N are represented by (i.e. mapped non-projectively onto) subsets of R^2 . A duality between $point \leftarrow \rightarrow line$, and a new duality for convex sets are induced for $N = 2$ giving rise to optimal convexity algorithms. Representations of lines and hyperplanes in R^N are obtained enabling some geometrical constructions and the representation of polyhedra in R^N . The representation of certain convex and non-convex hypersurfaces is known. There is an algorithm for constructing and displaying interior/exterior or surface points (together with proximity information), for this class of hypersurfaces, with potential applications in *Intelligent Instrumentation and Process Control*. Talks describing the applications of this methodology for *Automatic Conflict Detection and Resolution in Air Traffic Control*, *Exploratory Data Analysis in Statistics* and *Phase-Space Analysis of Multi-Dimensional Bifurcations and Chaos* will be given.

Organizers: Alfred Inselberg, IBM Scientific Center, Los Angeles, CA; and Bernard Dimsdale, University of Southern California, Los Angeles

Finding Structure in Large Multi-Dimensional Data Sets

E. Wegman
George Mason University

Phase-Space Analysis for Multi-Dimensional Chaos and Bifurcations

Juan Rivero, IBM Scientific Center, Caracas, Venezuela

Collision Avoidance in Robotics

Paolo Fiorini
Jet Propulsion Laboratory, Pasadena, CA

Thursday, November 9/4:30 PM
Minisymposium 20

The CAGD Workstation: Visualization Tools

The visualization, diagnostic, and interrogation tools provided in the graphics workstation are important to the success of CAGD projects. The second minisymposium focuses on the existing and newly developed tools that can assist CAGD research. Demonstrations on workstations using the projects in the first minisymposium will accompany the presentations.

The first speaker describes a basic development environment that includes dynamic 3D rendering of smoothly shaded and lighted surfaces and interactive debugging. He continues with a user interface for viewing and manipulating 3D objects. This is followed by a discussion of surface curvatures and a shape interrogation aid. The next speaker explores techniques for visualizing 3D functional data. The final speaker describes ConMan, a high-level visual language that allows users to build and modify graphical applications dynamically.

Organizer: Rosemary Chang
Silicon Graphics Computer Systems, Mountain View, CA

User Interfaces for Viewing and Manipulating Three Dimensional Objects

Tom Davis, Silicon Graphics Computer Systems

Simple Tools for Surface Interrogation
Derrick Burns, Stanford University and Silicon Graphics Computer Systems

Volumetric Visualization Using Surface Projection Techniques

James Winget, Silicon Graphics Computer Systems

ConMan: A Visual Programming Language as Applied to Geometric Design

Paul Haeberli, Silicon Graphics Computer Systems

Thursday, November 9/4:30 PM
Minisymposium 21

Geometric Continuity

Four different aspects of geometric continuity will be reviewed. The first three talks will deal with geometric continuity for parametric curves; the last talk with geometric continuity for parametric surfaces.

First, piecewise polynomial spaces defined by connection matrices will be introduced and their relation to geometrically smooth parametric curves will be analyzed. Second, parametric curves which are not smooth, but which become smooth under projection will be discussed. Third, the algebraic structure of sets of functions with fixed connection matrices will be examined, and the invariance of geometric continuity and shape parameters under projection will be studied. The fourth and final talk will concentrate on first order geometric continuity for parametric surfaces.

Organizer: R.N. Goldman
University of Waterloo, Ontario, Canada

High Order Conditions for Joining Low-Order Patches with Tangent Continuity

Richard Bartels, University of Waterloo

Geometric Continuity: Piecewise Polynomial Spaces Determined by Connection Matrices

Charles Micchelli, IBM T. J. Watson Research Center, Yorktown Heights, NY

The Algebraic Structure of Sets of Functions with Fixed Connection Matrices
(To be presented by organizer)

Geometric Continuity Constraints Rational Parametric Curves

Brian Barsky, University of California, Berkeley

Friday, November 10/10:30 AM
Minisymposium 22

Geometry and Computing about Physical Objects

The minisymposium elaborates on the role of geometry in computing with models of physical objects. This is an emerging theme in a variety of fields, including computational science, computer aided engineering, and robotics. The directions represented include high-level planning, e.g., for robotic applications, physical simulations based on geometry, control strategies, mesh generation, and phenomena such as deformations. In each case, the technical ideas presented can be applied in a variety of situations and to a number of applications even outside the immediate theme of the minisymposium. The minisymposium chair will present an overview of Project Newton and its interface with finite element codes. See also Cremer's abstract.

Organizer: Christoph Hoffmann
Purdue University, West Lafayette, IN

Grid Generation with the EAGLE System
Joe Thompson, Mississippi State University

Control Strategies in Newton
Jim Cremer, Cornell University

Deformable Models and Applications
Demetri Terzopoulos, Schlumberger Laboratory for Computer Science, Austin, TX

Artificial Intelligence Applied to Robot Planning

Alberto Segre, Cornell University

Friday, November 10/10:30 AM
Minisymposium 23

Generation of Smooth Surfaces

Surfaces designed in a computer graphics environment have many applications, including the design of cars, aircraft, ship bodies and modeling robots. The generation of smooth surfaces from a set of three-dimensional data points is a key problem in the field of Computer Aided Geometric Design.

The purpose of this minisymposium is to present new results based on algebraic methods, manifold theory, and calculus of variation approaches.

Organizer: Hans Hagen
Universitat Kaiserslautern, W. Germany

Algebraic Interpolation, Approximation and Blending

Josef Hoschek, Technical University Darmstadt, W. Germany

Transfinite Interpolation of Contour Curves

Alan K. Jones, Boeing Computer Services, Seattle, WA

Smoothing by Means of Energy Minimization

Guido Schulze, University Kaiserslautern, W. Germany

Global Surface Deformations on Smooth Networks of Parametric Surfaces

Thomas Jensen, Chip Petersen, and Mark Watkins, Evans & Sutherland Computer Corporation

Friday, November 10/10:30 AM
Minisymposium 24

Minisystems for Automatically Shaping Surfaces

The speakers will present a sampling of industrial minisystems—a system developed in-house for automating a significant portion of the surface shaping and modeling operations that designers typically must perform. These minisystems employ more sophisticated data structures and mathematical algorithms than the average large CAD/CAM system and, consequently, they support user interfaces that appear to be more "intelligent". On the other hand, minisystems are usually focused on specific classes of engineering design problems and, hence, are limited in their applicability to general CAD/CAM problems.

Organizers: Ray Sarraga (Chair), General Motors Research Laboratories, Warren, MI, and David R. Ferguson, Boeing Computer Services, Seattle, WA

Constrained Spline Approximations

David R. Ferguson and Richard A. Mastro, Boeing Computer Services, Seattle, WA

Feature-Based Design of Surfaces

James C. Cavendish and Samuel P. Marin, General Motors Research Laboratories, Warren, MI

The Geometric Modeling of Airfoils

Ernest J. Mintel and Leon H. Seitelman, Pratt and Whitney, Hartford, CT

Minisymposia continued on page 10

PROGRAM-AT-A-GLANCE

CONFERENCE ON GEOMETRIC DESIGN

Saturday, November 4

6:00 PM-9:00 PM
Registration for Short Course

Sunday November 5

8:00 AM
Registration Opens for Short Course

9:00 AM-10:00 AM
Introduction to 3D Computer Graphics
Gregory Nielson
Arizona State University

10:00 AM-10:30 AM
Coffee

10:30 AM-11:30 AM
Smooth Shaded Rendering of Surfaces
John Beatty
University of Waterloo

11:30 AM-12:30 PM
Multivariate Rendering, Interaction and Interrogation
Thomas Foley
Arizona State University

12:30 PM-2:00 PM
Lunch

2:00 PM-3:00 PM
Volume Visualization Techniques
Stephen Pizer
University of North Carolina
Chapel Hill

3:00 PM-3:30 PM
Coffee

3:30 PM-4:30 PM
Will Smoothly Shaded Surfaces Supersede or Complement Wire Frame Surfaces?
Rosemary Chang
Silicon Graphics
Mountain View, CA

4:30 PM-5:15 PM
Discussion

5:15 PM
Short Course Adjourns

6:00 PM-9:00 PM
Registration Opens for Conference

7:00 PM-9:00 PM
Welcoming Reception

Monday November 6

7:15 AM
Registration Opens

8:15 AM-8:30 AM
Welcoming Remarks

8:30 AM-9:15 AM
**Invited Presentation 1
The Decline and Renaissance of Geometry**
Philip J. Davis
Brown University

9:15 AM-10:00 AM
**Invited Presentation 2
Visualization? Or Merely Geometry and Computer Graphics!**
Michael J. Wozny
Rensselaer Polytechnic Institute

10:00 AM-10:30 AM
Coffee

10:30 AM-12:30 PM
**Minisymposium 1
Geometry and Numerical Analysis**
Chair: Rida Farouki
IBM Thomas J. Watson Research
Center, Yorktown Heights, NY

10:30 AM-12:30 PM
**Minisymposium 2
Interpolation and Modeling in Three or More Dimensions**
Chair: Andrew J. Worsey
University of North Carolina,
Wilmington

10:30 AM-12:30 PM
**Contributed Presentations 1
Curves 1**
Chair: T.N.T. Goodman
University of Dundee, Scotland

10:30 AM-12:30 PM
**Contributed Presentations 2
Solid Modeling 1**
Chair: Fujio Yamaguchi
Waseda University, Japan

12:30 PM-2:00 PM
Lunch

2:00 PM-2:45 PM
**Invited Presentation 3
Geometry in Conceptual Design**
David C. Gossard
Massachusetts Institute of
Technology

2:45 PM-3:00 PM
Federal Agency Panel
(titles and panelist to be
announced)

4:00 PM-4:30 PM
Coffee

4:30 PM-6:30 PM
**Minisymposium 3
The Use of Mathematical Methods in CAD/CAM for Car Body Design and Manufacturing**
Chair: R. Klass
Daimler-Benz AG Sindelfingen,
W. Germany

4:30 PM-6:30 PM
**Minisymposium 4
Advances in Automatic Finite Element Meshing**
Chair: Renato Perucchio
University of Rochester, NY

4:30 PM-6:30 PM
**Contributed Presentations 3
Parametric Surfaces 1**
Chair: Richard Franke
Naval Postgraduate School

4:30 PM-6:30 PM
Poster Session

6:45 PM
Beer and Taco Party

Tuesday November 7

8:30 AM-9:15 AM
**Invited Presentation 4
Parametric Curves and Surfaces in Computer Aided Geometric Design**
John A. Gregory
Brunel University, England

9:15 AM-10:00 AM
**Invited Presentation 5
NURBS: Some Theoretical and Practical Issues**
Gerald Farin
Arizona State University

10:00 AM-10:30 AM
Coffee

10:30 AM-12:30 PM
**Minisymposium 5
Surfaces On Surfaces**
Chair: Thomas A. Foley
Arizona State University

10:30 AM-12:30 PM
**Minisymposium 6
Geometric Problems in Manufacturing**
Chair: Bahram Ravani
University of California, Davis

10:30 AM-12:30 PM
**Contributed Presentations 4
Geometry Processing**
Chair: Jeffrey A. Bloom
Worcester Polytechnic Institute

12:30 PM-2:00 PM
Lunch

2:00 PM-4:00 PM
**Minisymposium 7
Engineering Geometry**
Chair: Joseph Pegna, University of
California, Irvine and Nicholas
Patrikalakis, Massachusetts
Institute of Technology

2:00 PM-4:00 PM
**Minisymposium 8
Recent Developments in Knot Removal Techniques**
Chair: Tom Lyche
University of Oslo, Norway

2:00 PM-4:00 PM
**Contributed Presentations 5
Parametric Surfaces 2**
Chair: Charles K. Chui
Texas A & M University

2:00 PM-4:00 PM
**Contributed Presentations 6
Solid Modeling 2**
Chair: Warren N. Waggenspack, Jr.
Louisiana State University, Baton
Rouge

4:00 PM-4:30 PM
Coffee

4:30 PM-6:30 PM
**Minisymposium 9
Rational Curve and Surface Schemes**
Chair: Gerald Farin
Arizona State University

4:30 PM-6:30 PM
**Minisymposium 10
Box Spline Modeling**
Chair: Tom Lyche
University of Oslo, Norway

Wednesday November 8

4:30 PM - 6:30 PM
**Contributed Presentations 7
Parallel Computation**
Chair: N. Chandrasekhar
Rensselaer Polytechnic Institute

4:30 PM - 6:30 PM
**Contributed Presentations 8
CAD/CAM**
Chair: Ramesh Srinivasan
IBM T.J. Watson Research Center

8:00 PM - 10:00 PM
**Minisymposium 11 (Panel
Discussion)
Solid Modeling: Where to Now?**
Chair: Michel Bercovier
Hebrew University, Jerusalem,
Israel

8:30 AM - 9:15 AM
**Invited Presentation 6
Numerical Stability of
Geometric Algorithms and
Representations**
Rida T. Farouki
IBM T. J. Watson Research Center

9:15 AM - 10:00 AM
**Invited Presentation 7
Algorithms for Computing
Intersections of Parametric
Surfaces**
Thomas W. Sederberg
Brigham Young University

10:00 AM - 10:30 AM
Coffee

10:30 AM - 12:30 PM
**Minisymposium 12
Geometry Processing**
Chair: Robert E. Barnhill
Arizona State University

10:30 AM - 12:30 PM
**Minisymposium 13
Computational Algebraic
Geometry and Geometric
Modeling**
Chair: Chanderjit Bajaj
Purdue University,
West Lafayette, IN

10:30 AM - 12:30 PM
**Contributed Presentations 9
Symbolic Geometry**
Chair: Dov Dori
University of Kansas

10:30 AM - 12:30 PM
**Contributed Presentations 10
Curves 2**
Chair: Dieter Lasser
Technische Hochschule
Darmstadt, West Germany

12:30 PM - 2:00 PM
Lunch

2:00 PM - 4:00 PM
**Minisymposium 14
Design for Functionality**
Chair: David R. Ferguson
Boeing Computer Services

2:00 PM - 4:00 PM
**Minisymposium 15
Recent Advances in Surface-
Surface Intersection as Used
in the CAD/CAM Industry**
Chair: Les Piegl
University of South Florida, Tampa

2:00 PM - 4:00 PM
**Contributed Presentations 11
Multidimensional**
Chair: Peter Alfeld
University of Utah

2:00 PM - 4:00 PM
**Contributed Presentations 12
Graphics**
Chair: Adrian Sfarti
Evans & Southerland, Mountain
View, CA

4:30 PM - 9:00 PM
Western Barbeque Cookout

Thursday November 9

8:30 AM - 9:15 AM
**Invited Presentation 8
Images of Matrices—
Mathematical Visualization**
Cleve Moler
Ardent Computer, Sunnyvale, CA

9:15 AM - 10:00 AM
**Invited Presentation 9
Teleological Modeling: A New
Approach for Representing
Objects**
Alan H. Barr
California Institute of Technology

10:00 AM - 10:30 AM
Coffee

10:30 AM - 12:30 PM
**Minisymposium 16
N-Sided Surface Patches**
Chair: Tony D. DeRose
University of Washington, Seattle

10:30 AM - 12:30 PM
**Minisymposium 17
Solid Modeling: NURBS and
Non-Manifold Issues Chair:
Mark Henderson**
Arizona State University

10:30 AM - 12:30 PM
**Contributed Presentations 13
Curves 3**
Chair: F.N. Fritsch
Lawrence Livermore National
Laboratory

10:30 AM - 12:30 PM
**Contributed Presentations 14
Computational Geometry 1**
Chair: Renato Perucchio
University of Rochester

12:30 PM - 2:00 PM
Lunch

2:00 PM - 4:00 PM
**Minisymposium 18
The CAGD Workstation:
Research Projects**
Chair: Rosemary Chang
Silicon Graphics Computer
Systems, Mountain View, CA

2:00 PM - 4:00 PM
**Minisymposium 19
Visualizing Multi-Dimensional
Geometry & Some
Applications**
Chair: Alfred Inselberg
IBM Scientific Center, Los Angeles
and Bernard Dimsdale, University
of Southern California, Los Angeles

2:00 PM - 4:00 PM
**Contributed Presentations 15
Surface/Surface Intersection**
Chair: Joshua Turner
Rensselaer Polytechnic Institute

2:00 PM - 4:00 PM
**Contributed Presentations 16
Computational Geometry 2**
Chair: Geovan Tavares
Pontificia Universidade Catolica,
Brazil

4:00 PM - 4:30 PM
Coffee

Friday November 10

8:30 AM - 9:15 AM
**Invited Presentation 10
Using Domain Processing for
Solid Modeling**
John R. Rice
Purdue University

9:15 AM - 10:00 AM
**Invited Presentation 11
Geometrical Aspects of PDES**
Peter R. Wilson
Rensselaer Design Research Center

10:00 AM - 10:30 AM
Coffee

10:30 AM - 12:30 PM
**Minisymposium 22
Geometry and Computing
About Physical Objects**
Chair: Christoph Hoffmann
Purdue University

10:30 AM - 12:30 PM
**Minisymposium 23
Generation of Smooth Surfaces**
Chair: Hans Hagen
Universitat Kaiserslautern,
W. Germany

10:30 AM - 12:30 PM
**Minisymposium 24
Minisystems for Automatically
Shaping Surfaces**
Chairs: Ramon F. Sarraga, General
Motors Research Laboratories and
David R. Ferguson, Boeing
Computer Services

10:30 AM - 12:30 PM
**Contributed Presentations 19
Algebraic Geometry**
Chair: Joe Warren
Rice University

12:30 PM - 2:00 PM
Lunch

2:00 PM - 4:00 PM
**Minisymposium 25
Geometry, Accuracy, and
Robustness**
Chair: Christoph Hoffmann
Purdue University

2:00 PM - 4:00 PM
**Minisymposium 26
Symbolic Geometry Theorem
Proving**
Chair: Beat Bruderlin
University of Utah, Salt Lake City

2:00 PM - 4:00 PM
**Contributed Presentations 20
Parametric Surfaces 4**
Chair: Arthur J. Schwartz
University of Michigan, Ann Arbor

4:00 PM
Conference Adjourns

MINISYMPOSIA

Friday, November 10/2:00 PM
Minisymposium 25

Geometry, Accuracy, and Robustness

Implementing geometric algorithms robustly raises many research questions, both pragmatic and foundational in nature. The central difficulty is the interplay between imprecise numeric computations and exact symbolic deductions from it, e.g., whether a point is on a plane, whether four planes intersect in a common point, and so on. The minisymposium focuses on the foundational problems that arise, presenting several paradigms on how to structure an implementation such that the resulting program is both correct and robust.

Organizer: Christoph Hoffmann
Purdue University, West Lafayette, IN

Laying More Stress on Topological Structures than on Numerical Values in Finite-Precision Geometric Computation

Kokichi Sugihara and Masao Iri, University of Tokyo

e-Geometry: Building Robust Algorithms from Imprecise Computations

David Salesin, Jorge Stolfi, and Leo Guibas, Stanford University

A Paradigm for Robust Geometric Algorithms

Peter Kahn, Cornell University

Friday, November 10/2:00 PM
Minisymposium 26

Symbolic Geometry Theorem Proving

This minisymposium gives an overview on some recent advances in the new domain of symbolic geometric reasoning. Previous approaches by Tarski (1951), and Collins (1975), have been undertaken to mechanically prove (or disprove) general first order theorems in elementary geometry. The problem with these approaches is that they may become intractable, even in the case of very simple theorems.

Recent developments based on the Ritt-Wu or the Groebner-Buchberger method made it possible to prove certain types of (universally quantified) theorems with remarkable efficiency.

The first talk gives an overview on these algebraic theorem proving methods which have been successfully applied to a large number of non-trivial theorems in elementary geometry. More recently this method has been enhanced to prove theorems in differential geometry. This will be the topic of the second talk. The third presentation contrasts these algebraic methods with an axiomatic and purely geometric approach for constructively proving geometry theorems and automatizing the construction of geometric objects from their specification by constraints.

The speakers will discuss the theoretical aspects of geometry theorem proving as well as some practical applications to interactive Computer Aided Geometric Design.

Organizer: Beat Bruderlin
University of Utah, Salt Lake City

Automated Reasoning in Ordinary Geometries

Shang-Ching Chou, University of Texas, Austin

Mechanical Theorem Proving in Differential Geometries

Xiaoshan Gao, University of Texas, Austin and Academia Sinica, Beijing, China

Axiomatic Geometry Theorem Proving

(To be presented by organizer)

CONTRIBUTED PRESENTATIONS

Monday, November 6/10:30 AM
Contributed Presentations 1

Curves 1

A Shape Preserving Curve Interpolation Scheme Using Parametric Rational Cubic Splines

T.N.T. Goodman and K. Unsworth, University of Dundee, Scotland

Minimal Energy Splines

Emery D. Jou, University of Maryland

Characterizing Properties of Variation Diminishing Algorithms

Gerd Schmeltz, Technische Hochschule Darmstadt, West Germany

Curve and Surface Interpolation Using Weighted Quintic Tau-Splines

David A. Neuser, McDonnell Douglas Helicopter Company, Mesa, AZ

Limits of Weighted Splines

L. Bos and K. Salkauskas, University of Calgary, Canada

Algorithms for Geometric Spline Curves

Matthias Eck, Technische Hochschule Darmstadt, West Germany

Monday, November 6/10:30 AM
Contributed Presentations 2

Solid Modeling 1

An Adaptive, Error-free Computation Based on the 4x4 Determinant Method

Fujio Yamaguchi, Kenji Toshimitsu, and Hiroaki Sato, Waseda University, Japan

Binary Space Partitioning Trees an Alternative Representation of Polyhedra

Bruce F. Naylor, AT&T Bell Laboratories

Application of Binary Notation for Set Operations to the Constructive Solid Geometry of the Trihedron

Douglass J. Wilde, Stanford University

Modeling Natural Objects via Volumetric Representation

Irene Gargantini and Xiaolin Wu, University of Western Ontario, Canada

Definition and Approximation Problems in Geometric Modeling

James D. Emery, Allied-Signal Aerospace, Kansas City, MO

Geometric Modeling Interface for Product Description

Kazuya Kobayashi, Yasushi Yamaguchi, Hiroshi Nakajima and Fumihiko Kimura, University of Tokyo, Japan

Monday, November 6/4:30 PM
Contributed Presentations 3

Parametric Surfaces 1

Iterative Solutions for Radial Basis Function Approximation

Richard Franke, Naval Postgraduate School

A New C^m ($m \geq 0$) Local Kriging Interpolation Scheme for n-Dimensional Scattered Data

Pierre Montes, Montreal, Quebec, Canada

Smooth Surface Modeling from Level Contours

Daniel T. L. Lee, Hiromi Tanaka and Yukio Kobayashi, ATR
Communication Systems Research Laboratories, Kyoto, Japan

Optimal Twist Vectors As A Tool For Interpolation: A Network Of Curves With A Minimum Energy Surface

Michael Kallay, Electronic Data Systems, Bellevue, WA; and Bahram Ravani, University of California, Davis

Sets of Surface Patches with Geometric C^1 - and C^2 -Continuity

Peter Wassum, Technische Hochschule Darmstadt, West Germany

Different Methods for Curve and Surface Modeling with B-splines; Application to Developable Surface Modelling

Marc Daniel, Ecole Nationale Supérieure de Mécanique, France

Tuesday, November 7/10:30 AM
Contributed Presentations 4

Geometry Processing

Location of Feature Lines from Surface Models

Jeffrey A. Bloom and Chang Y. Choo, Worcester Polytechnic Institute

Non-iterative Curve and Surface Offset Methods

John M. Eisenlohr and Joseph Discenza, Schlumberger Technologies, Ann Arbor

Computation of Minimum Distances Between Geometries

K.Y. Wang, GE Research and Development, Schenectady

Curvature Continuous Extensions for Rational B-spline Curves and Surfaces

Sharat Shetty and Phillip R. White, University of Toledo

Optimal Triangulations

Robert E. Barnhill and Christopher House, Arizona State University

Tuesday, November 7/2:00 PM
Contributed Presentations 5

Parametric Surfaces 2

A General Framework for Local Interpolation and Its Applications

Charles K. Chui, Texas A & M University, College Station; and Harvey Diamond, West Virginia University, Morgantown

Geometric Modeling with Polynomial B-splines on Triangles

Helmut Schaeben and Stephen Auerbach, University of Bonn, West Germany

From Rigid Frameworks to the Geometry of Bivariate Splines

Walter Whiteley, Champlain Regional College, St. Lambert, Canada

Subdivision of Piecewise Surfaces

Fuhua Cheng, University of Kentucky

Non-negativity of a Bivariate Quadratic Function on a Triangle

Edmond Nadler, Wayne State University

B-Splines Over Triangular Domains (Preliminary Results)

Louis J. Nachman, Oakland University, Rochester, MI

CONTRIBUTED PRESENTATIONS

Tuesday, November 7/2:00 PM
Contributed Presentations 6
Solid Modeling 2

A Topological Subdivision Approach for Extracting Surface Topologies From Wireframe Models

Sharat C. Agarwal and Warren N. Waggenspack, Jr., Louisiana State University, Baton Rouge

Constraint-Based Geometric Models for Computer-Aided Design

Gerald M. Raddack and Leon S. Sterling, Case Western Reserve University

Hierarchical Interference Check Algorithm for Computer Modeling of Object Assembly

Amitava Maulik, Rensselaer Polytechnic Institute

Parsing Features in Solid Geometric Models

Scott A. Safier and Susan Finger, Carnegie Mellon University

A Linear-time Algorithm for Detecting Collision of Moving Bodies

Lee A. Barford, Hewlett-Packard Laboratories, Palo Alto

Incorporating Dimensioning and Tolerancing into Solid Modelers

Dov Dori and James R. Miller, University of Kansas

Tuesday, November 7/4:30 PM
Contributed Presentations 7
Parallel Computation

Parallel Algorithms for Geometric Computing

W.R. Franklin, N. Chandrasekhar, and M. Kankanalli, Rensselaer Polytechnic Institute

Massively Parallel Algorithms for Surface Manipulation

Bryant W. York, Richard Brower, and Merrill Ebner, Boston University

Experiments in Parallel Processing for B-spline Intersection Calculation

Jonathan Yen, Mark Smith, Susan Spach, and Fred Kitson, Hewlett Packard Laboratories, Palo Alto

A Parallel Algorithm for Surface Intersection Using Subdivision

Wolfgang W. Bain and Long C. Chang, University of New Mexico

Tuesday, November 7/4:30 PM
Contributed Presentations 8
CAD/CAM

Local Geometric Conditions for Manufacturability by 3-Axis Machining Process

Ramesh Srinivasan, IBM T.J. Watson Research Center

A System for Creating and Manipulating Mechanical Part Models Using the Product Data Exchange Specification (PDES)

James Fowler, National Institute of Standards and Technology

Data Conditioning from Design to Manufacturing

K.Y. Wang, W.P. Wang and J.M. Beck, GE Research and Development, Schenectady

CREMONA: A Graphical Editing System for Algebraic Boundary Models

Chanderjit Bajaj, Tamal Dey, Insung Ihm, Steven Klinkner, and Andrew Royappa, Purdue University, West Lafayette

Wednesday, November 8/10:30 AM
Contributed Presentations 9
Symbolic Geometry

Rule-based Definition of Geometric Models

Jack Gordon Gregory, ICAD, Inc., Cambridge, MA

Symbolic Analysis of Planar Drawings

Guy Cherry and Philip Todd, Tektronix Inc., Beaverton, OR

Molecular Modeling Applications of Graph Theory, Computer Graphics, and Computational Geometry

Dennis Farr, Polygen Corporation, Waltham, MA

A Symbolic Description of Geometry and Text Interaction in Engineering Drawing Annotation

Dov Dori, University of Kansas

Matrix Element Enumeration as a Compact Geometry Knowledge Base Representation

Dov Dori, University of Kansas

Lie Groups as the Basis for Aesthetic Satisfaction in Geometric Design

William C. Hoffman, Sierra Vista, AZ

Wednesday, November 8/10:30 AM
Contributed Presentations 10
Curves 2

B-spline-Bezier Representation of Rational Geometric Spline Curves

Dieter Lasser and Armin Purucker, Technische Hochschule Darmstadt, West Germany

Rational Cubic Spline Curves

Richard R. Patterson, Indiana University-Purdue University, Indianapolis

Representation of NURBS Curves and Surfaces Using deBoor-Fix Functionals

Richard D. Fuhr, Electronic Data Systems, Bellevue, WA

Algebraic Characterization of Piecewise Cubic Interpolation Using Bezier Representation

Robert W. Conley, Jr., U.S. Air Force, Kirtland AFB, NM

Near-best Polynomial Approximation of B-splines

Michael A. Lachance, University of Michigan, Dearborn

Procedural Splines in R2 and R3

Leon A. Shirman and Carlo H. Sequin, University of California, Berkeley

Wednesday, November 8/2:00 PM
Contributed Presentations 11
Multidimensional

Catmull-Rom Spline Surfaces

Marshall Walker, York University, Canada

Piecewise Linear Hypercube Interpolation of Scalar Fields

Alan L. Vogel, The MITRE Corporation, Bedford, MA

Visualization of Solutions to Parameterized Problems

Phillip H. Schmidt and Kuo Shan Wang, University of Akron

Solid Modeling in Hyperspace

C. Cattani and A. Paoluzzi, Università degli Studi di Roma "La Sapienza", Italy

A New General-Purpose Geometric Computing System

Pradeep Sinha and T.K. Srikanth, XOX Corporation, Minneapolis

Wednesday, November 8/2:00 PM
Contributed Presentations 12
Graphics

Fast Shading Method

Adrian Sarti, Evans & Sutherland, Mountain View, CA

Shading: Fitting a Smooth Intensity Surface

Michael R. Kappel, Institute for Defense Analyses, Alexandria, VA

Geometry-Based View Factor Determination

Cornelius Skip G. Van Wyk, Jr., Ohio State University, Columbus

The Slicing Extent Technique of Space Subdivision While Ray Tracing

James R. Logan and Sudhanshu K. Semwal, University of Colorado, Colorado Springs

Radiation Matrix Formalism with Closure Dictated by Energy Conservation

Francisco Arumi-Noe, University of Texas, Austin

The STICKS Model: a New Representation Scheme for Managing and Rendering 3-D Volumes

Claudio Montani, Istituto Elaborazione dell'Informazione - Consiglio Nazionale delle Ricerche, Italy; and Roberto Scopigno, Istituto CNUCE - Consiglio Nazionale delle Ricerche, Italy

Thursday, November 9/10:30 AM
Contributed Presentations 13
Curves 3

On the Comparison of Parametric Curves

F.N. Fritsch, Lawrence Livermore National Laboratory; and G.M. Neilson, Arizona State University

Automatic Control Point Generation for Piecewise Bezier Curves

John A. Roulier, University of Connecticut, Storrs

Combining Research Results and Design Requirements for an Interactive 3D Curve Editor

Klaus-Peter Beier and Paul J. Stewart, University of Michigan, Ann Arbor; and Dimitris S. Papageorgiou, EDS Corporation, Troy, MI

Mobius Transformations of Rational Bezier Curves

Miriam Laura Lucian, The Boeing Co., Seattle

Thursday, November 9/10:30 AM
Contributed Presentations 14
Computational Geometry 1

Shape Preserving Triangulations of Arbitrary Planar Domains Based on Delaunay Triangulation

Nickolas Sapidis and Renato Perucchio, University of Rochester

Neutral Case for the Min-max Triangulation

Dianne Hansford, Arizona State University

Quadrilateral Tessellation

Thomas S. Hlaban, GE Medical Systems, Milwaukee

Automatic Delaunay Tetrahedrization of Objects Defined in a Solid Modeling System

Nickolas Sapidis and Renato Perucchio, University of Rochester

Spatial Polyhedronalization as a Generalization of Delaunay's Plane Triangulation

M.C. Leonardo Traversoni Dominguez, Universidad Autonoma Metropolitana, Mexico

Implementing an Algorithm for Three Dimensional Triangulations that Include Arbitrary Triangular Regions

Carol Hazlewood, Southwest Texas State University

CONTRIBUTED PRESENTATIONS*Thursday, November 9/2:00 PM**Contributed Presentations 15***Surface/Surface Intersection****Finding Seed Points for Tracing Parametric Surface Intersections**

Jeannine Mosely, ICAD, Inc., Cambridge, MA

A Hybrid Curve and Surface Intersection Method

Joshua Turner, Rensselaer Polytechnic Institute

On Parameterizing Surface-Surface Intersection Curves

Robert Markot, Bonny Doon, CA; and Robert Magedson, Automation Technology Products, Campbell, CA

Parametric Offset Surfaces

Robert E. Barnhill and T. M. Frost, Arizona State University

Curvature Computations for Surface-Surface Intersection Curves

Alex Belyaev and Isaac Lef, Schlumberger CAD/CAM Division, Billerica, MA

Solution of a Cutter Path Problem

E.T.Y. Lee, Boeing Commercial Airplanes, Seattle

*Thursday, November 9/2:00 PM**Contributed Presentations 16***Computational Geometry 2****Concordance Operations for Implicitly-Defined Manifolds**

Geovan Tavares, Pontificia Universidade Catolica, Brasil; and Jonas Miranda, Instituto de Matematica Pura e Aplicada, Rio de Janeiro, Brasil

Mesheres for Implicitly Defined Surfaces

Eugene L. Allgower, Colorado State University; and Stefan Gnutzmann, Daimler Benz AG, Berlin, West Germany

The Mathematics of Variational Geometry

James Hurt, Hardy, Hurt, and Coin, Inc., Chelmsford, MA

Tiling Polygons with Parallelograms

Sampath Kannan, University of California, Berkeley; and Danny Soroker, IBM Almaden Research, San Jose

A Convergent Convex Decomposition of Solid Objects

Yong Se Kim and Douglass J. Wilde, Stanford University

*Thursday, November 9/4:30 PM**Contributed Presentations 17***Parametric Surfaces 3****Map Making Based on Geometrical Modeling Techniques**

Paulo C.P. Carvalho, Instituto de Matematica Pura e Aplicada, Rio de Janeiro, Brazil

Free-form Surface Solid Modeler DESIGNBASE

Masaaki Kagawa, Tsuyosi Harada, and Hiroaki Chiyokura, Ricoh Corporation, Santa Clara

Generalized Swept Surfaces

Jack Gordon Gregory, ICAD, Inc., Cambridge, MA

Blend Surfaces from Partial Differential Equations

Malcolm I.G. Bloor and Michael J. Wilson, University of Leeds, United Kingdom

Generating Free-Form Surface Using Partial Differential Equations

Malcolm I.G. Bloor and Michael J. Wilson, University of Leeds, United Kingdom

*Thursday, November 9/4:30 PM**Contributed Presentations 18***Robotics****An Approach to Modeling, Analysis and Interpolation of 3D Motion Using Optimal Control**

Alade Tokuta, University of South Florida

DRAWEDIT: An Animation System for Visualizing 2D Motions

Elliot N. Pinson, AT&T Bell Laboratories

Finite Solid Representation of Robot Manipulation in Three-Dimensional Geometric Reasoning

Alexander Y.K. Chen, Scientific Research Associates, Inc., Glastonbury, CT

Autonomous Terrain Navigation Using a Visibility-Oriented Digital Terrain Model

C.N. Shen and G. Nagy, Rensselaer Polytechnic Institute

Applications of Mathematical Logic to Robotics, Automation and Manufacturing Systems

Paul P. Botosani, Bridgeport Engineering Institute, Fairfield, CT

Back to Using Geometry for Designing Linkages on the Computer

Edward N. Stevensen, Jr., University of Hartford

*Friday, November 10/10:30 AM**Contributed Presentations 19***Algebraic Geometry****Free-form Algebraic Surfaces**

Joe Warren, Rice University

Robust Adaptive Polygonalization of Implicit Surfaces

Joe Warren, Mark Hall, and Doug Moore, Rice University

Modeling with Piecewise Polynomial Implicit Surfaces

Dwight Freund, California State University, Sacramento; and Michael Kallay, Electronic Data Systems, Bellevue, WA

A Tractable Class of Surfaces for Modeling

John Johnstone, Johns Hopkins University

Representing Surfaces Geometrically

John Johnstone, Johns Hopkins University

Surface Patches with Low Algebraic Degree

Gary Herron, Colorado State University, Fort Collins

*Friday, November 10/2:00 PM**Contributed Presentations 20***Parametric Surfaces 4****Cyclides in Computer Aided Design**

Arthur J. Schwartz, University of Michigan, Ann Arbor

A Method for Composing Dupin Cyclides

Debasish Dutta, Purdue University, West Lafayette and University of Michigan, Ann Arbor

Generalized Rational B-spline Surfaces

David H. Hoitsma and Mansuk Lee, Grumman Aircraft Systems, Bethpage, NY

Interpolation of an Arbitrary Mesh Using Rational Boundary Gregory Patches

Teiji Takamura and Koichi Konno, Ricoh Company, Ltd., Japan; and Hiroaki Chiyokura, Ricoh Corporation, Santa Clara

Variational Geometry Using Rational B-splines

Paula Beaty, Patrick Fitzhorn, and Gary Herron, Colorado State University, Fort Collins

Exact Conversion of Trimmed Surfaces into Single Surface Representations

A. E. Vries-Baayens, Delft University of Technology, The Netherlands

POSTER SESSION*Monday, November 6/4:30 PM***Poster Session****Surface Approximation for 3-D Object Representation**

Tamikazu Nishida, Daniel Lee, and Yukio Kobayashi, ATR Communication Systems Research Laboratories, Kyoto, Japan

Integrating Geometric Design with Symbolic Processing

Hojjat Adeli, Ohio State University, Columbus

Evaluation of Bezier Surface Intersection Methods

Nadim M. Aziz, Clemson University

Generating Minimally Connected Faces from PADL2 Solids

Ross L. Burchard, Sandia National Laboratories

TRANSPORTATION

BY AIR



American Airlines has been chosen as the official carrier for this conference. You can fly to Tempe and save on travel from Nov 3-13, 1989 inclusive.

In a special arrangement with SIAM, American Airlines is offering you the services of their toll free convention reservation desk, along with a complement of discounts.

- 5% off any fare for which you qualify, including First Class and Ultra Saver fares. THE DISCOUNTS CAN RANGE FROM 40% - 70% OFF NORMAL COACH FARES!

OR . . . for those of you who do not qualify for the above discounts

- American Airlines will offer a minimum of 45% off regular coach fares. Those passengers originating in Canada will be offered a 35% discount off full coach fares. Both of these rates require a 7 day advance purchase.

To make reservations for one of the above discounted fares:

- Call American Airlines Convention Desk, at 1-800-433-1790, seven days a week 8:00 AM to 11:00 PM Eastern Time. Be sure to mention the SIAM account number: S16090. American Airlines will arrange to mail your tickets to your home or office.
- For those of you having to use a corporate or univer-sity travel agent, you may still purchase your ticket through the local agents, just be sure to mention to the agent the above discounts. Your local agent can call the American Airlines Convention Desk to make your reservation. Make sure that the agent uses the SIAM account number: S16090.

CAR RENTAL

Budget Rent A Car has been selected as the official car rental agency for the SIAM Conference on Geometric Design. The following rates will apply:

| Type of Car | Daily Rate | Weekly Rate |
|----------------|------------|-------------|
| Economy | \$25.00 | \$108.00 |
| Compact | \$27.00 | \$118.00 |
| Intermediate | \$29.00 | \$138.00 |
| Full-Size 2dr. | \$31.00 | \$148.00 |
| Full-Size 4dr. | \$32.00 | \$168.00 |
| Luxury | \$39.00 | \$239.00 |

These rates are valid Sept. 30th - Nov. 17th and are available at the airport location.

Daily and Weekly rates are limited to 125 miles per day or 1050 miles per week. There is a \$.25 charge for each mile over the limit.

Rental Requirements

- Cars must be picked up and dropped off at the same location.
- You must be 21 years of age and have a valid U.S. or International Driver's License
- You must have one of the following credit cards to rent a car: AMEX, MasterCard, VISA, Diners Club or Sears
- The prices quoted do not include refueling services, tax, optional collision damage waiver, and personal accident insurance

Reservations

We encourage you to make an advance reservation, as on-site availability cannot be guaranteed. Make reservations by calling: 1-800-772-3773. Be certain to mention that you are attending the SIAM Conference on Geometric Design, November 6-10 in Tempe, Arizona.

ABOUT THE HOTEL

Sheraton Tempe Mission Palms Hotel
60 East Fifth Street
Tempe, Arizona 85281
(602) 894-1400

SIAM is holding a block of rooms at the Sheraton Tempe Mission Palms Hotel on a first come first served basis at the specially discounted rates of \$72/Single and \$82/Double. There is a 6.5% occupancy tax that is added to your room rates. These rooms will be held for our exclusive use only until October 16, 1989, after which date reservations will depend on availability and the above rates may not be in effect. We urge you to make your reservations as soon as possible. You may do so by telephoning (602) 894-1400, or via the Hotel Reservation Form on the inside back page of this brochure (domestic mail only). When making reservations by telephone, be certain to obtain the discounted rate by identifying yourself as an attendee at the SIAM Conference on Geometric Design.

Arrivals and Departures: Your room will be reserved for you until 6:00 PM. If later arrival is anticipated, please guarantee your reservation by credit card or advance deposit. Check-out time is 12:00 noon.

Location: The hotel is located in the heart of historic Old Town Tempe, Arizona. It is just fifteen minutes from the Sky Harbor International Airport and twenty minutes from downtown Phoenix. Adjacent to Arizona State University, the hotel is only 150 yards from the Sun Devil Football stadium, home of the ASU football team, the NFL Phoenix Cardinals team and the renowned Fiesta Bowl. Across the street from the hotel is a shopping complex filled with quaint shops, galleries, restaurants and entertainment.

Hotel Facilities: The hotel is equipped with 2 lighted tennis courts, sundeck, health club with the latest exercise equipment, sauna and whirlpool, and heated swimming pool. There is a Concierge at the hotel who can assist you with any arrangements that you may need in seeing the area's attractions.

Courtesy Airport Transportation: The hotel does provide complimentary transportation to and from the hotel. In order to take the courtesy van, upon arriving at the airport, go to the baggage claim area where there will be a telephone that connects you directly with the hotel. Just let them know that you would like to be picked up and they will arrive in about 15-20 minutes. Transportation back to the airport after the conference can be acquired by signing up for the courtesy service at the bell stand, the night before your departure.

Restaurants and Lounges: The hotel has three restaurants to serve just about any thing that you may be looking for. The Arches serves breakfast, lunch and dinner. The Cloister, a gourmet dining room features superb continental cuisine, with selections prepared tableside. The Galeria Lobby Lounge is open Monday through Friday 4:30 PM - 12 PM. There are complimentary hors d'oeuvres and entertainment from 4:30 PM - 8:30 PM.

GROUND TRANSPORTATION FROM AIRPORT

BY CAR

1. When leaving airport, take the Hohokam Expressway heading north. (Directional signs overhead at airport.)
2. Continue on Hohokam until you come to Washington. Turn right (east) on Washington. Washington will merge into traffic onto the Mill Avenue Bridge.
3. After going over the bridge you will be traveling south on Mill Avenue.
4. The hotel is located on Mill and 5th Streets. Turn left (east) onto 5th Street. The Sheraton Tempe Mission Palms is on your left side after turning onto 5th Street.

Courtesy Airport Transportation: The Sheraton Tempe Mission Palms Hotel does provide complimentary transportation to and from the hotel. In order to take the courtesy van, upon arriving at the airport, go to the baggage claim area where there will be a telephone that connects you directly with the hotel. Just let them know that you would like to be picked up and they will arrive in about 15-20 minutes. Transportation back to the airport after the conference can be acquired by signing up for the courtesy service at the bell stand, the night before your departure.

REGISTRATION INFORMATION

Please complete the Advance Registration Form found on the back page of this brochure and return it in the envelope provided in the middle section of this program. We urge attendees to register in advance as the registration fee is lower for advance registrants. Advance registration must be received by October 30, 1989.

The registration desk will be open as listed below.

| | |
|------------------|-----------------|
| Saturday, Nov 4 | 6:00pm - 9:00pm |
| Sunday, Nov 5 | 8:00am - 9:00pm |
| Monday, Nov 6 | 7:30am - 5:30pm |
| Tuesday, Nov 7 | 8:00am - 5:30pm |
| Wednesday, Nov 8 | 8:00am - 5:30pm |
| Thursday, Nov 9 | 8:00am - 5:30pm |
| Friday, Nov 10 | 8:00am - 3:30pm |

GET-TOGETHERS

SIAM Welcoming Reception

Sunday, November 5th, 7:00 PM - 9:00 PM
Cash Bar

SIAM Beer Party \$15

Monday, November 6th, 6:45 PM - 8:00 PM

This is a great time to just get together with your colleagues. The party will consist of make your own tacos, burritos and nachos. Beer and assorted sodas will be available.

Rustlers Cookout \$32

Wednesday, November 8th, 4:15 PM - 9:00 PM

Board the buses in front of the hotel lobby at 4:15 PM and join in on one of the best barbeques in town. From 4:30 PM - 6:30 PM relax with a cool beer or soda while enjoying the panoramic view of the Arizona valley. Dinner will consist of an old fashioned steak cookout consisting of a tossed salad, 6 oz. sirloin steak and 1/2 barbequed chicken, corn on the cob, western beans, rolls and apple pie. After dinner we will board the bus and head back to Gammage Theater to see the opening preview night of Leonard Bernstein's musical masterpiece of West Side Story. This musical tells the story of gang warfare on New York City's Westside.

REGISTRATION FEES:

| | | SIAM Member | Non- Member | Student |
|-----------------|---------|----------------|----------------|---------|
| Short Course | Advance | \$105 | \$125 | \$55 |
| | On-Site | \$125 | \$145 | \$75 |
| Meeting | Advance | \$120 | \$150 | \$20 |
| | On-Site | \$150 | \$180 | \$20 |

Non-SIAM Members

Non-member registrants are encouraged to join SIAM in order to obtain the member rate for meeting registration and enjoy all the other benefits of SIAM membership. You can join SIAM by filling out a membership form at the SIAM Registration Desk located outside the Palm Ballroom of the Sheraton Tempe Mission Palms. If you join for this meeting, SIAM will retroactively give you the member rate for registration. The SIAM membership fee is \$60.00.

Special Note

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

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 destroy your check or credit card slip.

Telephone Messages

The telephone number at the Sheraton Tempe Mission Palms is 1-(602)-894-1400. The Sheraton will either connect you with the SIAM registration desk or forward a message.

Credit Cards

SIAM is now accepting VISA, MasterCard and American Express 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.

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
The Boeing Company
BP America
Cray Research, Inc.
E.I. duPont de Nemours and Company
Eastman Kodak Company
Exxon Research and Engineering Company
General Motors Corporation
GTE Laboratories, Inc.
Hollandse Signaalapparaten B.V.
IBM Corporation
ICASE-NASA Langley Research Center
IMSL, Inc.
MacNeal-Schwendler Corporation
Marathon Oil Company
Martin Marietta Energy Systems
Mathematical Sciences Research Institute
Schlumberger Industries
Supercomputing Research Center, a division of
Institute for Defense Analyses
Texaco Inc.
Topexpress Ltd.
United Technologies Corporation

UPCOMING CONFERENCES

December 11 - 13, 1989
Fourth SIAM Conference on Parallel Processing for Scientific Computing
Hyatt Regency Hotel
Chicago, IL

January 22 - 24, 1990
ACM/SIAM Symposium on Discrete Algorithms
Cathedral Hill Hotel
San Francisco, CA

March 5 - 7, 1990
SIAM Conference on Applied Probability in Science and Engineering
Clarion Hotel
New Orleans, LA

May 7 - 10, 1990
SIAM Conference on Applications of Dynamical Systems
Marriott Hotel
Orlando, FL

July 16 - 20, 1990
SIAM Annual Meeting
Hyatt Regency Hotel
Chicago, IL

November 5 - 7, 1990
SIAG/LA Conference Linear Algebra in Signal Systems and Control
Cathedral Hill Hotel
San Francisco, CA

HOTEL RESERVATION FORM

SIAM Conference on Geometric Design

Nov 6-10, 1989

Sheraton Tempe Mission Palms
Tempe, Arizona

PLEASE SEND ME A CONFIRMATION NOTICE

Specially discounted rooms are being held for our exclusive use until Oct. 16, 1989. After that date, 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 Geometric Design. Telephone: 1-(602)-894-1400

Name _____ Phone _____
First Last

Address _____

City _____ State _____ Zip _____

Please reserve ☐ Single (\$72) ☐ Double (\$82) Arrival Date _____

Arrival Time _____ Check-Out Date _____

Guarantee my room for late arrival (after 6:00 PM) ☐ Yes ☐ No

I choose to pay by: ☐ AMEX ☐ VISA ☐ MC ☐ Check

Credit Card Number _____

Expiration Date _____ Deposit \$ _____ (Late Arrivals Only)

Signature _____

If you list your credit card number, please enclose this card in an envelope and mail to: Reservations, The Sheraton Tempe Mission Palms Hotel, 60 East Fifth St. Tempe, AZ 85281.

* 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 Geometric Design

November 6-10, 1989

Sheraton Tempe Mission Palms Hotel, Tempe, Arizona

Advance registration form must be received at the SIAM office by October 30, 1989. If paying by check, please make check payable to SIAM.

REGISTRATION FEES:

| | | SIAM | Non | Student |
|--------------|---------|--------|--------|---------|
| | | Member | Member | |
| Short Course | Advance | \$105 | \$125 | \$55 |
| | On-Site | \$125 | \$145 | \$75 |
| Conference | Advance | \$120 | \$150 | \$20 |
| | On-Site | \$150 | \$180 | \$20 |

Registration Fee:

| | | | |
|----------------------|----------|----------|----------|
| Short Course | \$ _____ | \$ _____ | \$ _____ |
| Conference | \$ _____ | \$ _____ | \$ _____ |
| Beer Party \$15 | \$ _____ | \$ _____ | \$ _____ |
| Western Cookout \$32 | \$ _____ | \$ _____ | \$ _____ |
| Total | \$ _____ | \$ _____ | \$ _____ |

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_____ Last

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Department _____

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From _____

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