The Mathematical Association of America

Rocky Mountain Section

SPRING MEETING

April 15-16, 1994

FINAL PROGRAM AND BOOK OF ABSTRACTS

South Dakota School of Mines and Technology

Rocky Mountain Section MAA Conference Program

Friday, April 15, 1994 South Dakota School of Mines and Technology, Rapid City

12:00 - 1:00 Registration CB 328 Book Displays Friday Afternoon and Saturday Morning

1:00 - 1:20 Welcome Message President Gowen Announcements CB 204 E

Parallel Sessions

Time	Room CB 327	Room CB 309
1:25-1:45	Steve Rummel "The Greatest Deviation Correlation Coefficient, Rg"	John Weiss "Geometric Transformations in Image Restoration"
1:50-2:10	Rianto Djojosugito "A Cubic Spline Based Lack-of-Fit Test for Regression Models	Pete Morris "An Apology to G.H. Hardy"
2:15-2:35	Karen Whitehead "A Clustering Algorithm for Pattern Classification"	John Starrett "Control of Coupled Map Lattices"
2:40-3:00	Amy Vander Vorste "A Comparison of Newton's and Muller's Methods in the Complex Plane."	Bill Ramaley "Applications: Ready or Not, Here They Come"
3:00-3:20	Break Faculty Lounge	Break Faculty Lounge
3:20-3:40	Les Shader "Permutation Puzzles and Applied Algebra"	David Metz "Pitfalls in Graphing with the Graphing Calculator"
3:45-4:05	Beau Grande "Ancient Chinese Secrets"	David Metz continued
4:10-4:30	Timothy Moreland "Solution Manifold of the Functional Differential Equation $f'(x) = f(x+c) - f(x-c)$"	Panel Discussion (4:10-5:10) Tino Mendez, Chair "The New NCTM and MAA Assessment Standards and their Implications for Mathematics Higher Education."
4:35-5:10		Panel Discussion continued

5:30 - 6:30 No Host Cocktail Hour Lobby Rushmore Plaza Holiday Inn

6:30- Banquet Rushmore Plaza Holiday Inn Guest Speaker **Fernando Gouvea** "A Marvelous Proof"

Saturday, April 16, 1994

6:45 -7:45 Executive Committee Breakfast Landmark Restaurant, Hotel Alex Johnson

8:00-8:50 Business Meeting Chem 228

9:00-10:00 Keynote Address Chem 228 **Fernando Gouvea** "What Have Elliptic Curves Got to Do With It?"

10:00 - 10:20 Break Faculty Lounge

Parallel Sessions

Time	**Room CB 327**	**Room CB 309**
10:25-10:45	Ed Corwin "Discrete vs. Continuous Chaotic Systems"	George Donovan "Mathematica In the Curriculum"
10:50-11:10	Igor Szczyrba "How to Assess Students' Understanding of Mathematical Notions"	Rebekka Struik "Sophie Germain and Fermat's Last Theorem"
11:15-11:35	Szczyrba continued	Janet Barnett "How Should I Count the Ways?"
11:40-12:00	Jim Loats "Instructional Delights and Dilemmas: Our New Math for Prospective Elementary Teachers"	George Heine "Help for the Beleaguered Traveling Salesman"
12:05-12:25	Larry Johnson "Colorado State Wide Systemic Initiative and its Implications for Mathematical Departments"	Deborah Rummel "Studying Math Students Studying in Groups"

ABSTRACTS OF PAPERS PRESENTED TO THE
ROCKY MOUNTAIN SECTION OF THE
MATHEMATICAL ASSOCIATION OF AMERICA
APRIL 15-16, 1994

Talks are listed in the order of presentation.

The Greatest Deviation Correlation Coefficient, Rg. Steve Rummel, Black Hills State University. Rg is a robust measure of correlation computed from the ranks of the data. A description of this coefficient will be discussed and a computer algorithm for calculating Rg will be presented.

Geometric Transformations in Image Restoration. John Weiss, South Dakota School of Mines and Technology. An important area of computer graphics and image processing involves 2-D and 3-D geometric transformations. The basic 2-D transformations are rotation, translation, and scaling. Translation allows us to move a graphical object about the screen, rotation allows us to change its orientation, and scaling allows us to change its size.

These basic transformations are usually expressed in the form of transformation matrices. Any combination of these transformations (translation, scaling, and rotation) may be performed by composing the corresponding matrices. This is usually more efficient than applying each transform separately. The general transformation matrix is:

$$(x' \quad y' \quad 1) = (x \quad y \quad 1)\begin{pmatrix} a & d & 0 \\ b & e & 0 \\ c & f & 1 \end{pmatrix}$$

Transformations that are comprised solely of translations, scalings, and rotations are known as *affine transformations*. These transformations have the property of preserving parallelism of lines, but not lengths and angles.

Affine transformations are often used in image processing to resize and rotate images, and to remove geometric distortions from a variety of sources. Since the matrix coefficients $(a, b, c, \ldots)$ are not known in advance, they must be determined from the source (degraded) image and the target (restored) image.

In this talk, different approaches to the restoration of geometrically distorted images will be discussed. These approaches consider various mathematical models of the geometric "warping" that may degrade an image, and fundamentally different approaches to removing this distortion.

A Cubic Spline Based Lack-of-Fit Test for Regression Models. Rianto Djojosugito, South Dakota School of Mines and Technology. A method for testing parametric regression models for lack of fit is considered. The method uses cubic spline smoothing and is computationally practical. An example of how the method can be practically implemented will be presented.

An Apology To G. H. Hardy. Peter Morris, University of Wyoming. Due to the development of the computer, some forms of old mathematics have been revitalized. In particular, there is extensive research in Number Theory which provides a large part of the security in public key cryptography. This is a discussion of some of the underlying number theoretic and modern algebra concepts used in choosing the parameters for the RSA encryption scheme.

Clustering Algorithms for Pattern Classification. Karen Whitehead, South Dakota School of Mines and Technology. A variety of cluster analysis techniques have been applied to the problem of grouping feature vectors into clusters to facilitate classification. An overview of the relative merits of various techniques will be presented. This project formed the basis for a hierarchical neural network which was tested on multi-font character data as well as satellite images.

Control of Coupled Map Lattices. John Starrett, Metropolitan State College. There now exist several methods for controlling chaotic dynamical systems. Many of these new methods do not change the strange attractor of the system in any substantial way, but instead stabilize the system about one or more of the unstable periodic orbits embedded in the chaos. We can control one dimensional chaotic maps especially easily, so it is no surprise that we can control coupled map lattices, since they are just a system

of interconnected chaotic maps. I demonstrate the method of Ott, Grebogi and Yorke on the tent map, and then exhibit and control several types of coupled map lattices.

A Comparison of Newton's and Muller's Methods in the Complex Plane. Amy Vander Vorste, South Dakota School of Mines and Technology. Two well known rootfinding methods are applied to polynomials with real and complex roots. Convergence behavior is studied by a computer graphics approach. The well known fractal images associated with Newton's Method are compared with images generated in a similar way using Muller's method.

Applications: Ready Or Not, Here They Come. Bill Ramaley, Ft. Lewis College. Applications have been an essential part of mathematics courses. Historically, the applications came from the physical sciences, as did many of our students. Times have changed, as has the role played by applications. We are learning new applications. What does and what should lie ahead?

Permutation Puzzles and Applied Algebra. Leslie Shader, University of Wyoming. Permutation puzzles can be used effectively as the motivation for studying group theory in a junior level Applied Algebra (or Abstract Algebra) class. The properties of generators, cycles, conjugation, and commutators arise naturally, as well as the realization that much of mathematics is still experimental. Solution Algorithms for "Top Spin" and the "13" puzzle will be given.

Pitfalls In Graphing With A Graphing Calculator. David Metz, Western Wyoming Community College. Misleading (and sometimes bizarre) graphical displays are certain to occur on occasion, because of the discrete nature of the graphing calculator. Examples will be discussed, with implications for undergraduate mathematics education.

Ancient Chinese Secrets. Beau Grande, University of Wyoming. In an old Chinese card game, a player is asked to select four cards from a standard deck (with face cards removed). The object of the game is to use the face values of the selected cards to achieve a pre-determined number using the operations of addition, subtraction, multiplication, and division. Several combinatorial questions are imbedded in this game. These questions can be answered by using simple counting techniques and by computer analysis.

The Solution Manifold of the Functional Differential Equation $\mathbf{f'(x) = f(x + c) - f(x - c)}$. Timothy Moreland, University of Denver. For a fixed parameter c, a proof is outlined demonstrating that there exist an infinite number of real-valued linearly independent solutions of the functional differential equation $f'(x) = f(x + c) - f(x - c)$, of the form $f(x) = e^{ax}\sin(bx)$. We consider f to be a complex-valued function of the form $f(z) = e^{kz}$, with $k = a + bi$. Substituting into the functional differential equation, this yields the transcendental Characteristic Equation, $\frac{k}{2} = \sinh(ck)$. By an appropriate application of Rouche's Theorem, we can conclude that the Characteristic Equation has an infinite number of solutions, $k_1, k_2, k_3, \ldots$, which implies f as a complex-valued function has an infinite number of linearly independent solutions of the form $f(x) = e^{a_j x}\sin(b_j x)$.

Closed form values of a_j and b_j can be found only in a couple of special cases. For the general case, the use of Rouche's Theorem places each complex number $a_j + b_j i$ in an annulus about the origin. Asymptotically, for a fixed parameter c, it can be shown that as $a_j \to \infty$, $b_j \to e^{a_j c}$.

The functional differential equation is continuous in the parameter c; a small change in the value of c will cause a small change in the values of a and b. Starting with $c = 1$ and the numerically derived pair (a_0, b_0), c is perturbed by .01 to $c = .99$, and a new pair (a_1, b_1) is numerically derived. Then, in turn, c is set to .98, .97, and so on, down to $c = 0$. Each time c is perturbed, a new pair (a_i, b_i) is calculated. By plotting the pairs in the plane, we can see how the solutions vary as c varies.

The New NCTM and MAA Assessment Standards and their Implications for Mathematics Higher Education. Panel discussion chaired by Tino Mendez, Metropolitan State College.

Discrete vs. Continuous Chaotic Systems. Ed Corwin, South Dakota School of Mines and Technology. This paper investigates the difference between the dynamics of discrete systems and continuous systems that are able to produce chaotic behavior. The logistic map given by $x_{n+1} = 4x_n(1 - x_n)$ is used as

an example. This map is known to exhibit chaotic behavior. We show that there is no continuous map with bounded derivative that can be sampled to get the logistic map (even though there is a continuous map with unbounded derivative that can be so sampled). This is generalized as follows. Let $x_{n+1} = g(x_n)$ describe a chaos-producing difference equation in a bounded range. Assume that there is a differentiable model $y(t)$ such that $x_n = y(n\Delta t + c_0)$ for all n and all choices of x_0 as above and $y'(t)$ is bounded. Further assume there is a fixed point α [if $x_n = \alpha$ then $x_{n+1} = \alpha$]. These assumptions are shown to lead to a contradiction. This theorem means that we cannot assume that a discrete chaotic sequence has a nice continuous model. This theorem also has an impact in the field of neural networks that will be presented elsewhere.

Mathematica in the Curriculum. George Donovan, Metropolitan State College. A discussion of the benefits of introducing Mathematica in a one credit hour lab taught concurrently with Calculus II.

How To Assess Students' Understanding of Mathematical Notions. Igor Szczyrba, University of Northern Colorado. Some aspects of the assessment of students' understanding of mathematical notions are analyzed from a constructivistic point of view. These include: local versus global assessment, the role of hints and of the formulation of problems, and the measurability of the students' understanding at stages where a given notion is not fully structured. The design and results of some experiments are presented and discussed.

Sophie Germain and Fermat's Last Theorem. Ruth Rebekka Struik, University of Colorado. Sophie Germain (1776-1831) is credited with the following theorem: Let p be an odd prime such that $2p+1$ is an odd prime. Then if $x^p + y^p + z^p = 0$, with x, y, z integers, then p divides x, y, or z. This was proved in 1823, and was a major advance at that time. The talk will tell about the life of Sophie Germain and discuss this theorem.

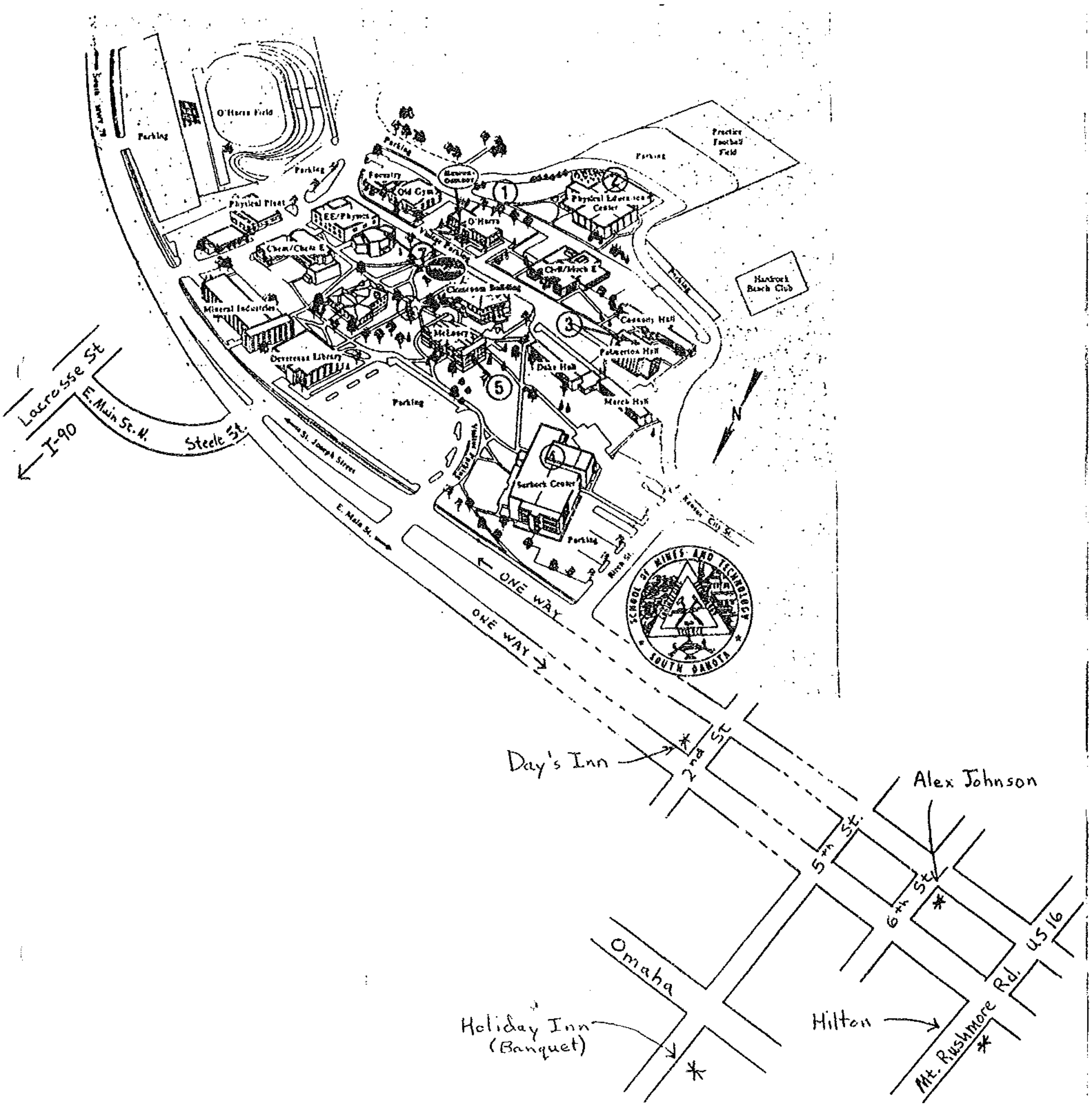
How Should I Count the Ways? Janet Barnett, University of Southern Colorado. To today's mathematician, combinatorial questions arise so naturally that it may be surprising how long it took for anyone to try to "count the ways." This talk looks at the early development of Combinatorics, both finite and infinite.

Instructional Delights and Dilemmas: Our New Math For Prospective Elementary Teachers. Jim Loats, Metropolitan State College. This talk will briefly outline the changes in content and classroom structure of a new version of this course being taught at MSCD. The main focus will be on the instructional dilemmas, both personal and professional, that have surfaced by teaching in concert with the "STANDARDS".

Help for the Beleaguered Traveling Salesman. George Heine, University of Colorado at Denver. Finding the shortest path connecting a set of nodes, the least number of colors needed for a graph, the largest number of objects that can fit in a fixed space: exact solution of problems like these takes impossibly long, even on the fastest computers. Yet solving such problems often has enormous practical value. What can we do? A random search technique called "simulated annealing" often gives good approximations. It has "solved" instances of the traveling salesman problem with hundreds of nodes. We discuss the history of this technique, explain what it has to do with annealing, and present some results of recent research.

Colorado State Wide Systemic Initiative and Its Implications for Mathematics Departments. Larry Johnson, Metropolitan State College.

Studying Math Students Studying in Groups. Deborah Rummel, Black Hills State University. Studies have shown that when students study in small groups outside of class their performance in class improves. Two independent studies performed by Dr. Richard Light of Harvard and Dr. Uri Treisman of Berkeley will be highlighted. Comments on math anxiety by Sheila Tobias and an orientation program at Minot State University will also be discussed with regard to small groups and why they are effective in assisting students' survival in college mathematics courses.


O'Harra Field
Parking
Practice Football Field
Physical Plant
EE/Physics
Chem/Chem E
Mineral Industries
Devereaux Library
Classroom Building
Old Gym
O'Harra
Physical Education Center
Civil/Mech E
Palmerton Hall
Surbeck Center
Hardrock Beach Club
St. Joseph Street
E. Main St.
Kansas City St.
SCHOOL OF MINES AND TECHNOLOGY
SOUTH DAKOTA
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Steele St.
I-90
ONE WAY
ONE WAY
Day's Inn
2nd St.
5th St.
6th St.
Alex Johnson
Omaha
Holiday Inn
(Banquet)
Hilton
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U.S 16