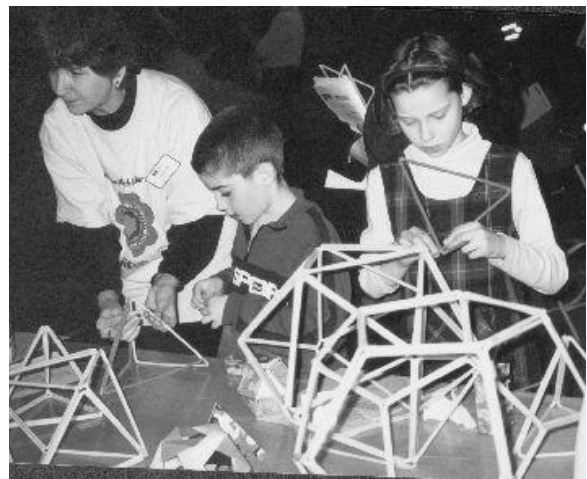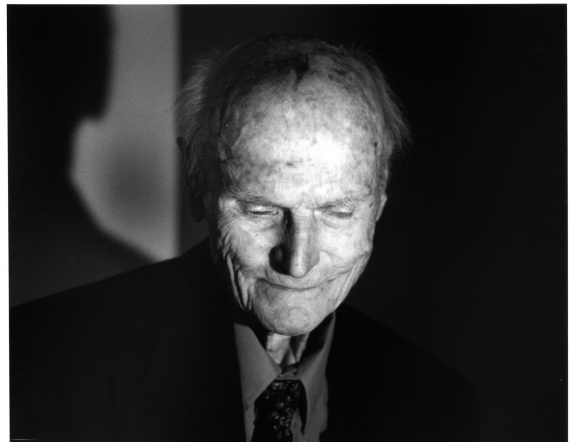# V.   MATHEMATICS EDUCATION PROGRAMME

Students at Sir James Douglas
enjoy Math Mania in 2001.

Students discuss with Akbar Rhemtulla (Univ. of Alberta)
during the 2001 PIMS Graduate Information Week.

H. S. M. Coxeter who spoke at
Changing the Culture 2000.

Initiatives for K-12 Students

PIMS is continuing to bring members of the scientific community and the community at large closer together through an increasing number and variety of events. Events have continued during the 2000/2001 academic year in both Alberta and British Columbia.

Activities for Elementary Schools

Math Mania

Math Mania is part of PIMS "Alternative Math Education" programme where Faculty and Staff from the PIMS Universities present "fun" methods for teaching math and computer science to children (and adults!) using games and art. It takes place at elementary schools in Victoria BC. Typically included in the presentations are soap bubble demonstrations, constellations as 2D networks, geometry and paper, the Set Game, a
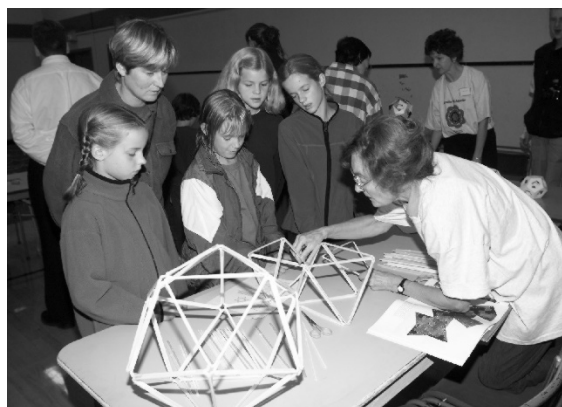

Photo courtesy of *Victoria Times Colonist.*

Pauline van den Driessche (PIMS-UVic) holds the attention of some Cordova Bay elementary students.

binomial probability experiment using pennies, and exciting geometrical models from straws and paper. Other demonstrations involve chess games, parallel algorithms of network sorts, and recursive methods in mathematical puzzles. These events attract around 300 students and parents each evening.

The Math Mania events in 2000/2001 were:

1. **Burnside Community School, Victoria** on March 1, 2000.

2. **Cordova Bay Elementary School, Victoria** on October 3, 2000.

3. **Sir James Douglas Elementary School, Victoria** on February 28, 2001.

Enthusiastic volunteers from faculty members and grad students provided a series of interactive displays, games, and art designed to show kids and teachers some fun ways to learn math and computer science in everyday devices and concepts. People who participated in these events include James Andersen, Peter Anderson, Kathy Beveridge, Charlie Burton, Jeff Campbell, Kelly Choo, Mike Crowle , Florin Diacu, Malgorzata Dubiel, Rod Edwards, Irina Gavrilova, Mike Fellows, Denton and Merilyn Hewgill, Elies Hoepner, Reinhard Illner, David Leeming,

Making bubbles with Dr. Denny Hewgill.

Shaun Pack, Jan and Paul Nienaber, Elena Prieto, Geoff Schmidt, Pauline van den Driessche and Julie Zhou.

Mathematics Unplugged

This annual event is a Student Mathematics Conference which takes place at Westwook Elementary School in Coquitlam BC, a school of approximately 250 students. All the students attend a full day math conference, including workshops chosen by themselves following a keynote address. Workshops are presented by all levels of instructors, including university professors, school district personnel, school staff, parents and Science World staff. Just as Eric Clapton and Rod Stewart "unplugged" their music, PIMS will provide students with an opportunity to see that mathematics can be an exciting and enjoyable topic, and that it is all around them! The goal of for the conference is to:

- utilize expertise from the community
- show students that Mathematics is in all aspects of everyday life, and other subject areas
- show students that Mathematics is more than what they can find in school textbooks
- give students lots of hands-on experience by keeping the number of students in workshops small (20 or less)

Five sessions of Mathematics Unplugged have been held and PIMS has supported this event since it began.

Westwood Elementary and Pamela Hagen, the originator and organizer of **Mathematics Unplugged,** were honoured in 2000 with *Educational Excellence in Innovative Planning* awards by the Ministry of Education of British Columbia.

Mathematics Unplugged IV, which was held on April 27, 2000, was given the theme *Mathematics in Our World* with particular focus on the blending of mathematics and social studies.

Prior to this year's event, students received a brochure with all activities described, and were given the opportunity to select their favourites.

On the day, kids arrived prepared with their conference packages and proceeded to their selected sessions, which had intriguing titles such as "All Aboard! Calling all Engineers!", "Measure, Measure, Measure!!!", "In A Giant's Footsteps!!", "Fly Across Canada!!", "Mathematical IMPOSSIBLITIES!", "The Lost Treasures" and "Simply Super Solids".

In the spirit of an "adult" conference, keynote lectures were delivered by Dr. Mike Fellows and Dr. Fran Roasamond about *Dots and Lines: How Scientists Use Dots and Lines for Just About Everything.* These lectures were made possible through the sponsorship of PIMS.
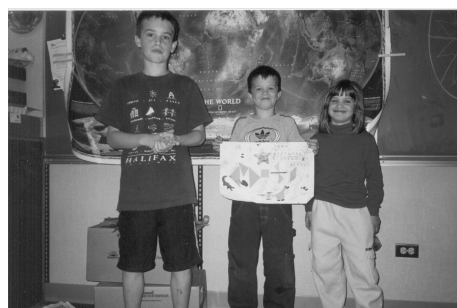
Christian Price (centre) with his siblings
Jordan and Christina at Math Unplugged V.

Mathematics Unplugged V took place on April 26, 2001. The event is styled just like an adult conference with a keynote speaker followed by workshops for the students to attend during the day. The keynote speaker has a difficult job to do as he/she needs to be able to hold the attention of students from K – G5 for at least 30 minutes and make it fun and interesting. This year every student went home with a tangram set, and a copy of the Tangram story.

The main goal of this event is to try to lay an enjoyable and fun foundation for further mathematical awareness and engagement, which can last a lifetime.

Klaus Hoechsmann, PIMS Education Coordinator, helped plan the conference and visited the school on the day. The conference was a success with the students who participated in it. One student replied when told it was time to go out to recess, "Oh, do we have to go out to recess, Math Unplugged is so much more fun!"

Elementary Math Nights

Elementary Math Nights are held at schools in the Calgary area. Volunteers from Mount Royal College and the University of Calgary assisted the teachers to guide participants through a variety of activities. Activities such as map colouring, games on graphs, dominating sets of graphs, Fibonacci numbers, binary numbers, patterns in Pascal's triangle, the travelling salesman problem, and finite state automita may be included.

The success of these evenings can be directly attributed to the volunteers: Rob Petzold, Jean Springer, Laura Marik, Peter Zizler, Scott Carlson, and Sharon Friesen.

- October 12, 2000 **Glamorgan School, Calgary**

- October 19, 2000 **Braeside School, Calgary**

- October 24, 2000 **Big Rock School, Calgary**

- February 13, 2001 **Science Alberta School, Calgary**

- February 22, 2001 **Sunnyside Community School, Calgary**

- May 15, 2001 **Westmount Elementary School, Strathmore**

At the Math Night at Sunnyside Elementary School in Calgary on May 25, 2000 students and parents gathered to play with coloured beads and learn some interesting mathematics in the process.

In five groups of about 20, children and adults constructed strings of coloured beads based on a Fibonacci-like sequence, modulo 10. For instance, if the starting numbers are 1 and 3, the sequence is 1, 3, 4, 7, 1, 8, 9, 7, 6, 3, 9, 2, 1, 3, and the sequence repeats.

Each colour bead represented a different number and the beads were threaded on a string according to the sequence until the starting point was reached. Then the string was tied into a loop to give a bracelet, necklace, a belt, or perhaps a belt for dad.

It did not end there however. Participants were challenged to find the longest or the shortest strings that keep on going and the number of possible different strings. The evening was a great success with those involved looking forward with anticipation to the next Math Night.

Activities with High School Students

The PIMS education panel is organizing a number of events aimed at high school students. Here we describe three such events, highlighting the breadth of activities that PIMS offers.

Junior High Math Nights

Supported by PIMS, these events were organised by Dr. Jean Springer of Mount Royal College, Calgary. In 2000 and 2001 on six consecutive Mondays, students, parents and teachers at Mount Royal College are provided with the opportunity to engage in mathematical exploration. This event happened January 31 – March 27, 2000 and January 29 – March 4, 2001. The emphasis of these evenings was to dispell the myths that mathematics is a set of facts innate to certain individuals and that mathematics is *not* an experimental discipline.

Discussions took place under the following titles: *Facts about Five, Map Colouring, Sorting out Sorting, The Secret of NIM,* and *Nothing But Zeros and Ones.* This event is biannual, resuming again in the fall.

Facts About Five: This evening was a potpourri of topics about the number five, including 5 by 5 magic squares, Pentagonal numbers, Tessalation of the plane using various polygons including pentagons, compass and straight-edge constructions, and Ramsey theory.

Map Colouring: This evening the question of how many colours are needed to colour a planar map was asked and also applications to some scheduling problems were investigated.

Sorting out Sorting: Sorting algorithms, their benefits, and their drawbacks were discussed.

The Secret of NIM: This evening, analysing NIM and similar games with a view towards developing winning strategies was the topic.

Nothing But 0's and 1's: This evening an exploration of number systems with different bases was on the agenda.

Evening of Mathematics

On March 2, 2000 the Department of Mathematics and Statistics, SFU and the Pacific Institute for the Mathematical Sciences hosted Grades 11 and 12 students, their teachers and parents, and other interested participants to an evening of lectures on some of the newest applications of mathematics. The most recent event took place Tuesday, March 2, 2000 at Fletcher Challenge Theatre, SFU at Harbour Centre. The first talk, on the Mathematics of Fuel Cells was given by Dr. Keith Promislow (Mathematics and Statistics, SFU and consultant to Ballard Power Systems). The talk explained mathematical models of fuel cells developed in conjunction with engineers at Ballard Power Systems. The second talk, *Mathematics and Literature: Beyond Alice in Wonderland,* was presented by Dr. Brett Stevens (Mathematics and Statistics, SFU, and PIMS/IBM Post Doctoral Fellow). The talk examined a connection between Samuel Beckett's "Quad" and Dante's "Divine Trilogy" that poses a very deep and hard combinatorial question about Gray Codes, and an application of Mutually Orthogonal Latin Squares by French Oulipoian author Georges Perec to the plot structure of his novel *Life: a Manual.* The evening was organized by Dr. Malgorzata Dubiel (Department of Mathematics and Statistics, SFU).

Master Class in Mathematics
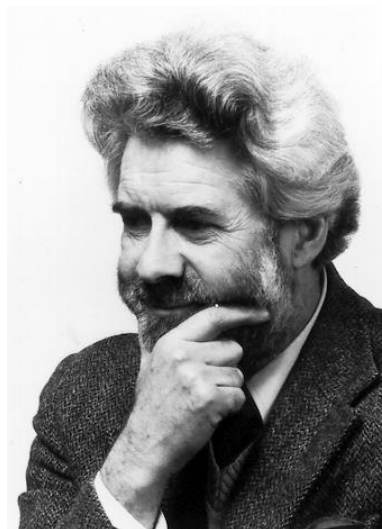
Sir Christopher Zeeman.

On March 22, 2000, the renowned British mathematician, Sir Christopher Zeeman gave a lecture at the University of Victoria. It was one of three lectures given by Sir Christopher during his week long visit to UVic. His lecture was entitled *Master Class for Thirteen-Year Olds.* The lecture was sponsored jointly by the University of Victoria and the Pacific Institute for the Mathematical Sciences. Forty-one attended the lecture, including twenty teens from the local school district.

The Mathematics Master classes in Britain have grown out of the Christmas Lectures given at the Royal Institution by Professor Zeeman in 1978. Now given in about 50 centers in the U.K., a typical master class lasts for 2–3 hours on Saturday morning and runs for ten weeks. Studies conducted four years later showed that the participants in the Master Classes demonstrated increased confidence and increased problem-solving skill in all branches of science. The objective of the Master Class program is to introduce topics not found in the school syllabus using an approach that allows these young teens access to some university level material.

In a one-hour presentation, Sir Christopher gave the audience a sample of some of the activities that take place in a Master Class. He demonstrated the proof of a theorem relating the sum

of angles of a spherical triangle to its area. He did a demonstration on perspective showing the existence and uniqueness of vanishing points and observation points. His demonstration on gyroscopes used an apparatus made from a bicycle wheel, which he brought all the way from England for the presentation. Finally, Sir Christopher demonstrated coupled oscillations using two keys hanging from a thread. His presentations were both informative and entertaining and he engaged many of the students in the audience to assist him with his demonstrations.

Mathematics Competitions

Traditionally, mathematics skill and interest can be uncovered in students by exposure to challenging mathematical exams and contests. PIMS sponsors Alberta and BC participation in a number of such national and internation competitions. A number of such are listed below:

MathCounts Vancouver Island Competition

MathCounts Vancouver Island is a regional competition, which is part of MathCounts British Columbia. Sponsored locally by the Association of Professional Engineers and Geoscientists of BC (APEGBC) and PIMS, it provides a combination of math coaching and a competitive programme for students in grades eight and nine.

The 2001 competition was held on Friday, February 9 at **Lambrick Park Secondary School** in Victoria. Teams of four students competed in various rounds to determine the team and individual winners. There were six grade eight and seven grade nine teams in this year's competition. The competition concluded with the exciting Countdown Round. This year, the top grade eight team was **Cedar Hill Junior Secondary (Green) Team** and the top grade nine team was **Lambrick Park Secondary**

(IBS) Team. The top grade eight individual was **Jeremy Li Foa Wing** of Cedar Hill and the top grade nine individual was **Kailyn Young** of Lambrick Park. The grade nine team from **Mt. Klitsa Junior Secondary School** in Port Alberni travelled the furthest to take part in the regional competition. David Leeming, UVic PIMS Education Coordinator, was the Site Coordinator and Leo Neufeld of Camosun College (retired) was the Head Judge. The event was co-hosted by James Bern Aldez and Jan Buermans of APEGBC along with the support of many volunteers from APEGBC, Camosun College and the University of Victoria.

CMS Regional Math Camps

To identify and nurture future members for the Canadian team for the International Mathematical Olympiad, the CMS, Esso, and PIMS sponsor this yearly event where students in grades 8 to 10, as well as exceptional elementary grade students are invited based on merit. Topics in Combinatorics, Number Theory, Algebra and Geometry will be covered at the difficulty level of the Olympiad. This is part of a long-range goal of the CMS to develop mathematical talent in Canadian students to compete on the world stage.

A math camp was held on August 16–23, 2000 at the University of Alberta. The feature event was be a media day on August 17, with Lieutenant Governor Lois Hole of Alberta attending.

The **2001 Esso-CMS-PIMS Summer Math Camp** was held at SFU on June 25–29, 2001. It was organised by Malgorzata Dubiel and Petr Lisonek (SFU) and was designed for students from grades 10–11. Participation in the Camp was by invitation only, based on recommendations from teachers, and results of various mathematics competitions.

Tournament of Towns

An international mathematics contest originating in Russia and held in the spring and fall each

year, is a challenging exam written around the world. PIMS provides support to Dr. Bill Sands of the University of Calgary to help encourage young Albertans to take part in the mathematical contest and introduce them to the wider mathematical community. Although the *Tournament of Towns* has been written in Edmonton for several years, Dr. Sands has been developing more Calgary participation. It is anticipated that Edmonton and Calgary will alternate hosting both the contest and awards ceremony for Alberta.

Alberta High School Contest

An annual two part competition taking place in November and February of each school year, with book prizes for the first part, and cash prizes and scholarships for the second part.

The 2000–2001 season took place on November 21, 2000 and February 7, 2001. The first part of the 2001-2002 season will take place on November 20, 2001.

PIMS provides funding to ensure participation for students across the province. The PIMS Awards Dinner for the 2000-2001 season was on April 11, 2001.

PIMS Elementary Grades Math Contest

The annual **PIMS Elementary Grades Math Contest** (**ELMACON**) is open to students in Grades 5 to 7. It provides an opportunity for them to experience mathematics as an exciting sport. The contest is modelled after the successful *MathCounts* competitions (which are also supported by PIMS). However, there are some important differences, because it is aimed at younger students, many of whom will likely "graduate" to MathCounts once they get to high school. There they will learn to work collaboratively in the Team Round, which has here been replaced by a Problem Solving Round. The latter not only relieves the competitive pressure for a while, but also affords an opportunity for learn-

ing some mathematics in a state of heightened awareness and motivation. The other rounds are designated Sprint, Target, and Countdown, each with their own special characteristics.

Both the 2000 and 2001 events were organized by PIMS under the guidance of Dr. Cary Chien of David Thompson Secondary School, in collaboration with the BCAMT and volunteers from Lower Mainland schools of all levels.

Last year, 180 students participated in the second ELMACON, which took place on May 13, 2000 at UBC.

The third annual ELMACON took place on May 26, 2001, at UBC. A total of 223 students attended the contest this year, a substantial increase from last year. We implemented an improved online registration procedure allowing students to sign up for the contest as well as to download their admission tickets.

The format of the contest followed the formula of previous years. Students competed in three divisions in the sprint, target and countdown rounds. The sprint and target rounds consisted of two sets of written questions which were evaluated immediately while contestants enjoyed refreshments and listened to a lively presentation of problem-solving strategies.
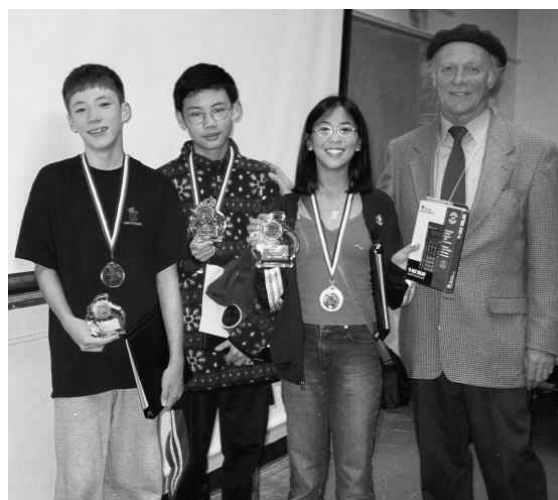
Klaus Hoechsmann (PIMS Education Facilitator) with the Grade 7 winners at the 2000 PIMS Elementary School Math Contest: #1 Irene Yu (Berkshire Park), #2 Michael Li (MacCorkindale), #3 Paul Collier (Kitchener)

In the countdown round, the top ten students in each division— determined by combined scores from Sprint and Target rounds (with correct answers in the latter counting double)— participated in individual competitions. The tenth ranking student competed against the ninth, the winner then faced the eighth, and so on. A projector displayed one question at a time, and the contestants were required to ring a buzzer—within a certain time limit—as soon as they had an answer. A correct answer, scored a point; otherwise the opponent had the rest of the time limit to come up with the solution. This was repeated several times to determine which of the two could advance. Eventually an overall winner was found.

The top ten finishers in each grade received a commemorative T-shirt and medal, together with a stylish binder donated by the BC Association of Mathematics Teachers. The top three also received a trophy, and an electronic calculator donated by **Sharp**.

About 50 on-site volunteers from the UBC Science Ambassadors Program, various schools throughout BC as well as some parents helped the organising committee stage the event.

PIMS Math Fair Programme

Once again PIMS is sponsoring a programme of developing mathematical exhibits in the framework of the Science Fair Foundation (BC). This is particularly suitable for students in Grades 7 to 12 who are looking for longer term projects, to get a feel for the adventure of a self-directed exploration.

Unlike, say, sports or music, mathematics does not offer many extracurricular activities in school, except for various kinds of contests, which — for all their admirable motivating qualities — stress just one side of mathematics: the quick grasp. And yet, most mathematical work could be more aptly likened to a marathon than to a sprint. The steadfast persevering quest, so vital to the subject, is minimally represented in the school environment.

The use of science fairs as a vehicle for popularising and teaching mathematics might eventually prove to be a way of filling this void. It is still in its infancy — the wheel has not yet been invented. Mathematics is traditionally not a showy subject. When we get a problem to work on, we retreat into a corner like a squirrel with a nut and come back into the light of day only when we have cracked it. Sure enough, we need some time for quiet concentration. But must it be unrelieved solitary confinement? There ought be a better way – and preparing projects for public display might help push us in the right direction.

The projects usually fall under one of the following three headings, although many will present a mixture of two or even all three of them.

Original Research: There are lots and lots of open problems in mathematics. However, most of them lie on the outskirts which can only be reached by air. Since the field is so old, most of the rocks near the centre have been turned over more than once, so finding something really new there is a very lucky break. Nevertheless it happens now and again — and, hey, you never know!

Applications: There is an inexhaustible supply of problems of all shapes and sizes in science, in technology, and even in the arts. Many of them are close to home. The challenge here is to tease out the interesting ones (say, the geometry of rose petals) and not get bogged down in mere routine (like counting them) or too engrossed in extraneous activities (like smelling them).

Exposition: Again and again it happens that somebody gives an old hat a brand-new twist — and most of the time, a new insight comes with it. There are hundreds of ready made proofs of the Pythagorean Theorem, but some people are still rolling their own. The area of the regular dodecagon inside a unit circle (3 square units) had been known for many centuries before recent beautiful proofs were found.

Whichever flag it sails under, a project should always aim at engaging the visitors' minds, not only their eyes. In this connection, a low-tech, home-spun implementation is sometimes more successful than a glitzy computerized one – which might impress without enlightening, unless special care is taken.

BC Science Fair Foundation

At the Greater Vancouver Regional Fair (GVRSF) PIMS supplies judges, mathematical expertise, and prizes. PIMS initiated the inclusion of a Mathematical Sciences exhibit category within the existing Science Fairs, which are organized and administered by the Science Fair Foundation of British Columbia. PIMS is committed to informing and involving mathematics teachers, giving presentations and workshops to groups of students, helping and providing assistance to students that have undertaken mathematics projects, judging the projects, and supplying the monetary awards.

Projects are judged as gold, silver or bronze based on a point system.

At the GVRSF on April 6–7, 2000, there were 25 projects exhibited within the Mathematical Sciences category. These consisted of 13 junior projects (grades 7 and 8), 7 intermediate (grade 9 and 10), and 5 senior (grades 11 and 12). University-Hill Elementary, Point Grey Mini School, and Killarney Secondary School were quite highly represented. Other participating schools were Windermere Secondary, Our Lady of Perpetual Help School, Albion Elementary, and Gladstone Secondary.

The 2001 GVRSF took place at UBC, April 5–7. It held 26 projects within the Mathematical/Computer Sciences exhibit category. Within this category, there were 2 computer science projects while all others were mathematical.

In terms of the grade-level distribution, there were 10 junior projects (grades 7, 8), 10 intermediate (grades 9, 10), and 6 senior (grades 11, 12). Projects came from the following schools: University-Hill Secondary, Point Grey Mini School, Britannia Secondary School, York House, Collingwood School, Sir William Osler Elementary School, Windermere Secondary, and Vancouver Technical.

Although participation did not increase (there were 26 math projects last year as well) we have witnessed a significant increase in the quality of projects. Two of the projects made it into the Canada Wide Science Fair in Kingston, Ontario,and won multiple awards even at this very top level. These projects were *"Trees A Math Lesson from Nature"* by **Christine Pop** from Sir William Osler Elementary and *"Calculating Equilateral Triangles within an Equilateral Triangular Grid"* by **Mahmoud Bazargan** from U-Hill Secondary.

The special award judges for PIMS were David Boyd, Klaus Hoechsmann, Leah Keshet, and Sandy Rutherford.

Forever Annual Mathematics Exhibition (FAME)

Students in the Greater Victoria School District took part in the third annual **FAME**, the **Forever Annual Mathematics Exhibition**, at S.J. Willis School on April 27, 2000. There were 65 mathematics-related exhibits, which showed off the accomplishments of 118 students from both elementary and secondary schools. The event was organized (for the third time) by **Wendy Swonnell,** a mathematics teacher at Lambrick Park Secondary School. It was sponsored in part by the Pacific Institute for the Mathematical Sciences. The purpose of FAME is to allow students to present math displays in the same way that science fairs allow students to put science projects on display.

The students chose a wide variety of subjects for their exhibits, including probability, cryptography, Fibonacci sequences, paradoxes, and mathematics and music. Others chose to showcase the accomplishments of such famous mathematicians as Daniel Bernoulli and John von Neumann.

Mathematicians from Camosun College and UVic as well as engineers judged the exhibits, which were split into three levels — intermedi-

ate (up to grade 7), junior (grades 8 and 9) and senior (grades 8–10). The top three exhibits in each category were awarded trophies.

The forth **FAME** was held at **S. J. Willis School** on April 21, 2001. This year, there were over eighty entries at three levels: Elementary (up to grade 7), Junior (grades 8-9) and Senior (grades 10-12). The event was organized by Wendy Swonnell, Betty Doherty, Betty McAskill and Tanis Carlow and was sponsored, in part, by PIMS.

The exhibits presented at **FAME** are judged for creativity, skill, dramatic value and mathematical thought. For the first time this year, every entrant was given an award — the categories being Distinction, First Class and Runner Up. A School trophy is presented at each level (Elementary, Junior and Senior) based on the best aggregate score of the top three projects. With more schools participating in **FAME** each year, this annual event will continue to attract outstanding mathematical exhibits from students in a wide range of grades.

Elementary Math Fairs in Edmonton

The yearly Math Fairs in elementary schools in the Edmonton area are gaining in popularity. Initiated upon requests by schools, and supported mainly by PIMS and the Edmonton Public School Board, the Math Fairs were held in previous years at Our Lady of Victories and Parkallen Elementary Schools. This year, Clara Tyner and Terrace Heights Elementary Schools were involved. Demand is growing with requests received from an additional six schools for next year. In fact, the Math Fairs are so popular that planning is underway for a Math Day where several schools can participate.

The Edmonton Math Fairs are unique in that all students in the school participate. This event is about problem solving, not winning and loosing. The schools themselves play a major role in the planning and thus the format can vary from school to school. In some Math Fairs, 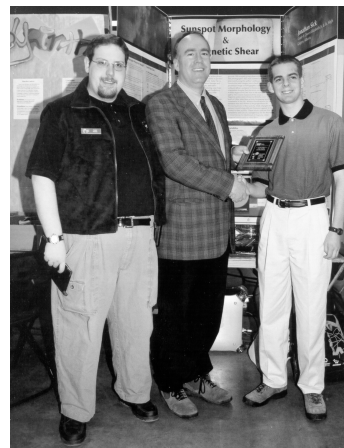Education students from the University of Alberta were available to help, primarily by providing a "model" for a Math Fair that students can emulate in planning their own event. The extensive involvement of students both in planning, staging and participating in the Math Fair may be one of the secrets of its success.

Prior to the Math Fair, students choose or are given problems to work on. They work in small groups to solve the problem and subsequently create a table-top display. On the day of the Math Fair, spectators are invited to tackle the problem, with hints and guidance provided by students in charge. The displays are not poster sessions. Rather, the students are actively involved in the presentations.

Calgary Youth Science Fair

PIMS provided a prize at the Calgary Youth Science Fair. On the morning of April 7, 2001 a $100 PIMS prize and a plaque will be awarded for "Secondary project making major use of mathematics in the project".

Michael Lamoureux (PIMS Deputy Director) presenting the plaque to the winner, Jonathan Sick.

The winner was Jonathan Sick, a grade 9 student as Queen Elizabeth Junior High School. The project was "Sunspot Morphology & Magnetic Shear", which explored how solar flare activity could be predicted based on observations of sunspots, which are dark, magnetically- active storms on the Sun. Jonathon went on to win the Intermediate level at the National Youth Science Fair.

Initiatives with K-12 Teachers

With new mathematics curricula being developed across Western Canada, PIMS scientists have found considerable demand for teacher training and retraining. Teachers are also interested in exchanging ideas with academics.

PIMS Conferences on Changing the Culture

Organized by M. Dubiel (SFU), P. Hagen (Westwood Elementary), K. Heinrich (SFU), B. McAskill (BC Ministry of Education), E. Perkins (UBC), these conferences are intended to forge closer ties between the mathematics community, mathematics teachers and the industry. Erasing barriers between these communities and looking for common ground is an essential step in any attempts at changing the mathematics culture.

Changing the Culture III, SFU at Harbour Center, April 28, 2000

The Third Annual Conference, organized and sponsored by PIMS, brings together mathematics researchers, educators and school teachers from all levels to work towards narrowing the gap between those who enjoy mathematics and those who think they don't. Its theme this time is Visualising Mathematics.

What is the question? The advent of affordable computers with huge storage and communication capabilities seems to promise a golden age of mathematical visualisation. The question is to what extent it can relieve us of the laborious doodling and imagining that has always been an integral part of mathematical activity.

When asked about the nature of his thinking, Einstein once replied that it was a mixture of visual and kinesthetic elements. The plausibility of that reply is corroborated by any observation of people grappling with mathematics — say, students taking an exam. When they are not busy writing or drawing, they tend to stare into space or at the ceiling, stab or stroke the air, drum or scribble with their fingers, and the like.

Our question therefore has two parts: (1) what exactly is going on there, and (2) how can computers be integrated into that process?

Programme:

- Keynote lecture by Walter Whiteley (York University): *Visual Work and the Mathematics Classroom*

- Three concurrent workshops: *Hi-tech, Lo-tech, No-tech.*

- Panel Discussion: What role can visualisation play in the teaching of mathematics? Panel: Peter Borwein, Chair (SFU), Sue Haberger (Centennial Secondary), Nancy Heckman (UBC), Susan Oesterle (Douglas College), Walter Whiteley (York University)

- Public lecture: H. S M. Coxeter (University of Toronto): *The Mathematics in the Art of M. C. Escher*

The Workshops:

Hi-tech: Cinderella is a new constructive geometry program along the lines of Geometer's Sketchpad but with an enlarged and differently

designed arsenal of tools. June Lester, University of New Brunswick, will give a demonstration of it and lead a couple of workshops for those interested in a closer acquaintance.

Lo-tech: Malgorzata Dubiel, SFU, is one of Canada's leading exponents in constructing geometric models on the crucial hands-on level. She is also the main organiser this conference. Her workshop will include pop-up fractals, origami, polyhedra, and more.

No-tech: The third workshop will re-examine high school geometry in the light of the Geometry Resource Package released by the BC Student Assessment and Program Evaluation Branch in September 1999. It will be led by Bill Casselman (UBC).

Changing the Culture IV, SFU at Harbour Center, May 11, 2001

The **Fourth Annual Changing the Culture Conference** was held at SFU, Harbour Centre on May 11 ,2001. This conference, sponsored by PIMS, brings together mathematicians, mathematics educators and school teachers from all levels to work together towards narrowing the gap between mathematicians and teachers of mathematics.

This year's theme was: *Writing, Speaking and Thinking Mathematics.* The conference participants - over 90 people from elementary and high schools, colleges and universities - explored connections between numeracy and literacy, mathematics and anguage, mathematics and literature, and how we can use language to teach mathematics.

There were two plenary talks:

Mathematics and Literature: Cross Fertilization by Brett Stevens, PIMS/IBM PDF, SFU.

Breaking the Cycle of Ignorance by John Mighton, NSERC postdoctoral fellow at the Fields Institute for Research in Mathematical Sciences.

Brett Stevens explored the mathematics in the works of Samuel Beckett, especially in his play Quad, inspired by the ideas of movement and freedom from Dante's Divine Trilogy; about Euler's work on Latin Squares and it's impact on the works of George Perec and other French writers connected to the group Oulipo; and about his own work on Gray Codes, inspired by the play Quad.

John Mighton is the founder and coordinator of JUMP, Junior Undiscovered Mathematical Prodigies, an educational no-cost outreach program for students who are doing badly in mathematics in school. This program has been very successful and is rapidly gaining momentum in Toronto. John talked about his experiences with JUMP and how to make math accessible for kids whom the standard methods have not reached. John is also a Governor's General award winning playwright. Robert LePage's latest film, Possible Worlds, was adapted from one of his plays, and he was a math consultant and actor in *Good Will Hunting.* He is also a professional mathematician at the Fields Institute. This talk was open to the general public.

Each participant was able to attend two of the following workshops:

1. JUMP: Junior Undiscovered Mathematical Prodigies program. Leader: John Mighton
2. Contextualizing Mathematics. Leader: Brett Stevens and Karen Meagher
3. Connecting Early Numeracy and Literacy. Leaders: Cynthia Nicol and Heather Kelleher

For further information, see the webpage **www.pims.math.ca/education/2001/ctc**. Both plenary lectures are available via streaming video from this webpage.

PIMS Technology Workshops

Using Graphing Calculators in the Classroom, University of Calgary, May 24–26, 2000

The use of graphing calculators in the K-12 classroom has been mandated by the govern-

ment. However, how this potentially useful tool can be effectively applied in a teaching environment is not necessarily self-evident. With this problem in mind, Professor Michael Stone and Galileo Network head Sharon Friese held a workshop on May 24–26, featuring Professor Stuart Moskowitz of Humboldt State University of California. The event was designed to bring together K-12 teachers, and College and University professors to explore ways that graphing calculators can be used in the classroom to effectively increase understanding of topics at hand. The mathematical content of the workshop ranged from introductory problems in graphing simple functions to application in university level calculus. The course also included calculator programming, use of TI Graph Link software, testing and pedagogical issues, and Internet information.

Cinderella Author's Workshop
SFU Burnaby Campus
June 16, 2000

In recent years the *Geometer's Sketchpad* has become the standard software for teaching geometry in the classroom. Now, however, there is a new program, Cinderella, which provides a useful alternative.

Developed in Germany, Cinderella implements features already familiar to Sketchpad users. In addition, Cinderella is capable of constructions in spherical and hyperbolic geometry. It also has a special theorem prover, and many animation features. Cinderella users can generates Java applets for pasting into web pages.

The author of Cinderella, Ulrich Kortenkamp from Berlin University, held the workshop. It was dedicated to giving an introduction to both classroom use and internet features of the software. The 20 participants were given the opportunity to test the software and create example web pages. There was a door price of a copy of the software which was won by Natasha Davidson from Douglas College.

Math Enrichment Activities in the UK: A talk by Chris Budd
SFU Burnaby Campus
August 8, 2001

Chris Budd is a professor of mathematics at the University of Bath and the Royal Institution, UK. The Royal Institution has been strongly involved in the popularization of mathematics and sciences in the UK by organizing public talks, contests and other activities. Chris himself, appart from being a distinguished researcher in applied mathematics, has been involved in many outreach events, including math camps, the UK Year 2000 poster campaign and what he calls "Mathematics Magic Show", which he says was inspired by our Math in the Malls. He recently received a large grant in support of the enrichment activities. Chris Budd is also a co-author (with C.J.Sangwin) of a book "Mathematics Galore!" recently published by the Oxford University Press, containing material for workshops designing to enthuse students (from the age 11 through high school) into mathematics. His talk on August 8 was about his work with high school student and how his workshops for students are organized.

Professional Development Day for High School Math Teachers
St. Francis School, Calgary
June 26, 2000

This workshop which was on creating and analysing mathematical fractals using familiar software tools was run by Michael Lamoureux. It was attended by some 35 enthusiastic math teachers from across the city. The new Western Canada Protocol for Mathematics includes a requirement for students to learn some of the basics of fractals, as a mathematically rich and aesthetically beautiful creation arising from recent mathematical research. Using simple and widely available computer tools such as Geometer's SketchPad(TM), it is possible for our junior high and high school students to explore this fascinating area by recursive renderings of really simple shapes or objects. Ms. Ellen Radomski,

Secondary Math Consultant for the Calgary Separate School System, organized the workshop.

Elementary School Teacher Meetings

Organized by Dr. Indy Lagu (PIMS Education Coordinator in Calgary) these meetings provide an opportunity for Calgary teachers to be exposed to interesting problem solving activities. The main goal of the programme is to improve the general attitude of teachers towards mathematics. **Due to the unanimous positive response, this event is rescheduled for the fall.** Two series of encounters are in progress:

Sunnyside Elementary School: A series of monthly meetings with the primary school teachers ran from January-May, 2000. The teachers themselves who participated in the meetings expressed frustration with the frequently encountered negative perceptions of the subject of mathematics and they were eager to participate as agents for change.

West Dalhousie Elementary School: The unexpected usefulness of mathematics as social mortar was also noticeable in the math workshop which filled an entire professional day (May 3, 2000) at West-Dalhousie Elementary in Calgary. Under the leadership of their principal **Judy Gray,** the teachers of that school have set themselves the task of developing a *perspective* on mathematics (as they have on other subjects), to give coherence and momentum to their teaching. At their request, PIMS supplied mathematician Indy Lagu to lead their workshop and help anchor their discussions. The event was so well received that a repeat is planned for next year. The contact between PIMS and West-Dalhousie was made through *MathWorks*, a remarkable experiment in professional development, invented and maintained by **Sharon Friesen,** a Calgary middle school teacher (and recent winner of the Prime Minister's Teaching Award) with a long-standing connection to the local PIMS team. Attended by teachers from several schools, each monthly meeting of MathWorks is built around a math workshop, which, whenever possible, involves a mathematician — usually from PIMS.

Guy Weadick Elementary: Dr. I. Lagu led a teacher workshop at this school on January 29, 2001.

Teacher Association Meetings

Annual meeting of teacher associations provide an important venue for connections between PIMS researchers and school teachers. Two recent events are highlighted here.

ATA Meetings

Dr. I. Lagu and Scott Carlson presented two workshops to teachers in 2000. On October 23 to Rockyview School District and on October 27 at Annual Meeting of the Math Council, Alberta Teachers' Association.

BCAMT Meetings

PIMS participated in the 2000 and 2001 big October meetings of the BCAMT. Both years PIMS had a table there, and in 2000 a presentation was made as well. Cynthia Nicol and Klaus Hoechsmann talked about *The sound of numbers*. This presentation used copper pipes, a make-shift harp and water filled test tubes to demonstrate the connection between musical scales and ratios. In 2000 the table was organised by Natasa Sirotic and in 2001 by Janet Martin.

Initiatives for Undergraduate Students

PIMS Graduate Weekends

The purpose of the weekends is to let the students know about many of the very exciting research projects and initiatives taking place in the Mathematical Sciences departments.

PIMS Graduate Information Weekend III, SFU-UBC, February 12–13, 2000

Organizers: Kori Inkpen (SFU), Randy Sitter (SFU), Denis Sjerve (UBC), Sandy Rutherford (PIMS)

The PIMS Graduate Weekend for 2000 was held at UBC and SFU on February 12–13. PIMS hosted 43 of the top undergraduates in mathematics, computer science and statistics from across Canada. The students attended a variety of lectures and presentations on graduate programmes in the mathematical sciences at the PIMS universities.

On Saturday, the students visited SFU. In the morning they attended presentations by Peter Borwein, Kori Inkpen, Luis Goddyn and Charmain Dean from SFU. Pauline van den Driesche spoke about the graduate programmes in the mathematical sciences at the University of Victoria and Michael Lamoureux presented information on graduate studies at the University of Calgary. In the afternoon the students toured some of the research facilities at SFU and ended the day with a buffet dinner at the Diamond University Club.

On Sunday, the students visited the University of British Columbia, where they were hosted at the PIMS-UBC facilities. Presentations were made to the students by Denis Sjerve, Goerge Bluman, Nassif Ghoussoub, Anthony Peirce, Robert Miura, Dave Boyd, Dale Rolfsen, Martin Barlow, Alan Wagner and Nancy Heckman. Samuel Shen, from the University of Alberta, gave a presentation on the benefits of doing graduate work at the University of Alberta. After lunch, the students broke up into small groups to tour the research facilities and discuss with faculty members.

PIMS Graduate Information Week, Universities of Alberta and Calgary January 9–12, 2001

The PIMS Graduate Student Information Week was a great success. Twenty-four top fourth year undergrads in mathematics, statistics, and computer science from universities all across Canada arrived in Calgary on the Tuesday afternoon.

After a welcoming student/faculty mixer that evening, students were treated on Wednesday

Visiting students attend a talk at the Univ. of Alberta.

to a full program of presentations about graduate studies at the University of Calgary, including talks by research groups in discrete math, analysis, industrial and collaborative mathematics, the math finance lab, computer graphics, quantum computing, and several others.

The Dean of Graduate Studies, James Frideres, outlined some of the many attractions in studying at Calgary, while the PIMS Deputy Director, Michael Lamoureux, described the advantages of joining the PIMS team of western universities. The departments' Director of Graduate Programs, John Collins, detailed the scholarship possibilities and amenities of each of the programs. Gary MacGillivray gave a presentation on programs at the University of Victoria. At a western-style dinner that evening, the Associate Dean of Science, Robert Woodrow, discussed additional funding opportunities from the Government of Alberta that make graduate study in the province particularly rewarding.

After further informative sessions and meetings with faculty members on Thursday morning, the students went by bus to Edmonton that afternoon. Dick Peter, Dean of Science, and Peter Steffler, Associate Dean of Graduate Studies, along with faculty and graduate students from the departments of Computing Science and Mathematical Sciences welcomed them to the University of Alberta campus at a banquet at the Faculty Club. Bryant Moodie, PIMS University of Alberta Site Director, gave a brief account of PIMS and its particular relevance to graduate studies in the mathematical sciences.

Friday morning activities were kicked off with a presentation by Bob Moody (U. Alberta) on "Graduate Studies in Mathematical Sciences: 2001". Jim Hoover (U. Alberta) talked about "The relationship between theoretical computer science and 'standard' mathematics". Presentations on graduate studies at PIMS universities were given by Denis Sjerve (UBC), Randy Sitter (SFU), Lorna Stewart (U. Alberta) and Jim Muldowney (U. Alberta).

After a lunch with local CS and MathSci faculty and graduate students, the visitors had a full afternoon of small group meetings, interviews and tours scheduled to address their individual interests. Over 100 meetings with local researchers and representatives of the other PIMS sites were arranged by PIMS staff. A farewell party and supper was held at the Varscona Hotel on Whyte.

Financial support for the seminar was provided by PIMS and each of the two host universities. Travel and accommodation for the whole event were arranged by John Collins, Sheelagh Carpendale and Marian Miles (PIMS Administrator, U. Calgary). Local arrangements in Edmonton were taken care of by Jim Muldowney, Lorna Stewart, Martine Bareil and Lina Wang (PIMS Administrator, U. Alberta).

IAM-PIMS Senior Undergraduate Industrial Math Workshop, UBC, February 18–20, 2000

Organizers: Anthony Peirce (UBC) and Michael Ward (UBC).
(See chapter on *Industrial and Scientific Training Programme.*)

IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop, UBC, February 17–18, 2001

Organizers: R. Russell (SFU) and B. Shizgal (IAM).
(See chapter on *Industrial and Scientific Training Programme.*)

PIMS/MITACS Undergraduate Industrial Case Study Workshop, COE, UBC, October 25–29, 2001

Organizers: M. Puterman (Commerce and Business Admin, UBC) and Stephen Jones (COE, UBC).
(See chapter on *Industrial and Scientific Training Programme.*)

Statistical Genetics and Computational Molecular Biology Workshop, University of Washington, December 16–18, 2001

Organizer: Elizabeth Thompson (U. Washington)
(See chapter on *Industrial and Scientific Training Programme.*)

Initiatives for Graduate Students

Graduate Industrial Math Modeling Camps

Each spring, the Pacific Institute for the Mathematical Sciences (PIMS) sponsors a five day workshop for graduate students on mathematical modeling. The goal of the Mathematical Modeling Camp is to provide experience in the use of mathematical modeling as a problem solving tool for graduate students in mathematics, applied mathematics, statistics, and computer science.

The Mathematical Modeling Camp is one of two components of the annual PIMS Industrial Forum. The other component is the Industrial Problem Solving Workshop. At this Workshop, industrial and academic mathematicians work together to solve particular problems posed by industrial sponsors. Graduate students who are accepted to the Mathematical Modeling Camp are also invited to this Workshop.

Students work together in teams, under the supervision of invited mentors. Each mentor poses a problem arising from an industrial or engineering application and guides his or her team of graduate students through a modeling phase to a resolution. At the end of the workshop, reports are presented and a written summary of conclusions is made available for distribution.

Outstanding graduate students at both the Masters and PhD level in the fields of mathematics, applied mathematics, statistics, and computer science, or related disciplines, are invited to apply.

**3$^{\text{rd}}$ PIMS Graduate Industrial Math Modeling Camp,
Simon Fraser University,
May 23–27, 2000**

Organizer: K. Promislow (SFU), M. Kropinski (SFU), S. Jungic (SFU)

(See chapter on *Industrial Training Programme.*)

**4$^{\text{nd}}$ PIMS Graduate Industrial Math Modeling Camp,
University of Victoria,
June 11–15, 2001**

Organizer: Chris Bose (U. Victoria)

(See chapter on *Industrial Training Programme.*)

**2$^{\text{nd}}$ PIMS Summer School in Fluid Dynamics,
University of Alberta,
July 30 – August 11, 2000**

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

(See chapter on *Industrial Training Programme.*)

**3$^{\text{rd}}$ PIMS Fluid Dynamics Summer School
PIMS at the University of Alberta,
May 27 – June 8, 2001**

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

(See chapter on *Industrial Training Programme.*)

A Glimpse at 2002

4th PIMS Graduate
Information Week,
UBC, SFU and UVic,
January 12–13, 2002

Junior High Math Nights at
Mount Royal College,
Calgary, January–March, 2002

The Alberta High School
Mathematics Competition,
Part II of 2001–2002 season,
Feb 6, 2002

Greater Regional Vancouver
Science Fair,
UBC, April 4–6, 2002

Calgary Youth Science Fair,
April 10–13, 2002

Changing the Culture V,
Harbour Centre, SFU,
April 26, 2002

PIMS Elementary Grades Math
Contest,
UBC, May 25, 2002

Summer Math Camp,
University of Alberta,
August 14–21, 2002

The Alberta High School
Mathematics Competition,
Part I of the 2002–2003 season
November 19, 2002