The University of Montana

Department of Mathematical Sciences

A Newsletter for Alumni, Faculty, Staff, and Friends **Fall 1998**

Popular President's Lecturer visits the Big Sky

by Mark Kayll

A mathematical event one would never expect to witness at UM took place on September 10th. Was the Riemann Hypothesis finally settled? Did it happen in Missoula? Well, no. . . but a mathematician delivered the first President's Lecture of the year, and it was a resounding success.

Ronald L. Graham of AT&T Labs and University of California - San Diego visited UM, in particular the mathematics department, for an action-packed day that included two interviews (KUFM radio & The Missoulian), a book signing, and two exciting lectures. He presented *Juggling Permutations of the Integers* in the departmental colloquium and *Computers and Mathematics: Recent Successes and Insurmountable Obstacles* later that evening. Both of these lectures attracted capacity crowds of mathematics and juggling enthusiasts. About 100 people attended the afternoon colloquium while the evening "town and gown" lecture nearly filled the 400+ seat Music Recital Hall! The organizers of the event - both in the mathematics department and in the President's Office - were delighted.

These lectures also comprised the kick-off for the 4th Annual Big Sky Conference on Discrete Mathematics, which ran from 10-12 September. 1998 marked the first year of three that the National Science Foundation (NSF) will provide support for the event. In addition to Ron Graham's lectures, there were 13 conference talks spread over two days. These included a terrific conference colloquium by Luis Goddyn from Simon Fraser University in Vancouver, BC: *Removing Circuits and Contracting Bonds in Graphs and Matroids.* The conference attracted participants from Montana and nearby states and provinces.

It is probably impossible to identify anyone in the mathematics community more instantly recognizable for his influence and accomplishments than Ron Graham. Presently, he shares his time between New Jersey, where he is Chief Scientist at AT&T Labs, and California, where he holds the Jacobs Endowed Chair of Computer and Information Science at UCSD. He is also a former President both of the American Mathematical Society and of the International Jugglers Association. (See also the reprinted Missoulian article on page 3.)

Photograph by Kurt Wilson/Missoulian

It is therefore not surprising that Professor Graham's lecture, *Juggling Permutations of the Integers*, offered generous doses of both mathematics and juggling. In the remainder of the article, we attempt to convey the flavor of our visitor's riveting talk. He began by introducing a natural notation to represent periodic juggling patterns. The familiar 3-ball cascade can be represented as 3333. . . To describe what this means, we'll take our standard unit of time to be one second. The first 3 means that the first ball to be thrown will be thrown again 3 seconds later. One second after the first ball is thrown, a second ball is tossed in the air. The second 3 means that this second ball also will be thrown again 3 seconds after it is first thrown. One second after the second ball is thrown (so 2 seconds after the first ball), a third ball is thrown. The third 3 means that the third ball also will be thrown again 3 seconds after it first becomes airborne. One second after the third ball is thrown (so three seconds after the first ball) a ball is again thrown. Note that the timing exactly fits so that this ball is physically the first ball, now being thrown for the second time - as required by the first 3 in 3333. . . It is now clear that the pattern will repeat, and 3333. . . describes a 3-ball periodic juggling pattern. This can be shortened to just 3, with the convention that the pattern is to be repeated indefinitely, or as long as one cares to juggle!

Some other feasible patterns are 4, 51, 234, 345, 441, 5551, 7562 and 51414. In general, a periodic juggling pattern (with period n) can be described by a finite sequence $a_0a_1 \ldots a_{n-1}$ of nonnegative integers a_i. For example, 3 describes the period-1 pattern introduced as the 3-ball cascade, while 5551 describes a period-4 pattern. A few questions about such sequences immediately jump to mind. (1) Given a feasible sequence, how many balls would be used in juggling that pattern? (2) Which sequences are even feasible? (3) How many different period-n juggling patterns use b balls?

Professor Graham answered each of these questions with deceptive ease. He first explained why the answer to

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Notes from the Chair's Desk

We encourage our readers to keep in contact with us and we solicit your ideas about articles you would like to see included in the departmental Newsletter. We are very interested in hearing about you and about what you are doing. To make it easier for you to respond to us, we are including a brief form for you to complete and return to us.

The changes that have occurred within the Department of Mathematical Sciences have made a tremendous difference in the morale of both students and faculty members:

♦ Most of the renovation projects on the Mathematics Building are complete. I told you in the Fall 1997 issue about the accomplishments of Summer 1997 and that Summer 1998 would see a concentration on the classrooms. Only one classroom remains to be renovated and that will be completed next summer. All the rest (including our new mathematics education classroom in the Liberal Arts Building) have now been painted, given acoustical ceilings, variable lighting, ceiling mounted projectors, two pull-down screens and a locking cabinet to house a computer and VCR. Further, padded chairs and

trapezoidal tables have replaced the old desk chairs.

♦ We are grateful for the Dean's generosity in helping us financially to give the Mathematics Office a new look with custom built furnishings. We have also been fund-raising to refurbish the Undergraduate Study Room. More gratitude goes to the Dean for using his budget to provide the remainder of the funds we needed to complete that task. The new sofa, donated by the late Barbara Reiman, is no longer alone. It occupies a corner of the room together with two side arm chairs, a lazy boy with hassock and an oak table. The remainder of the room has oak tables (three boat-shaped and one octagonal) and padded chairs. It seems now that the room has picked up in use. Just today, I looked in and the room was full of students.

♦ The most important changes of all involve the substantial awards we were able to give to students through the George and Dorothy Bryan Endowment Fund. The Undergraduate Mathematics Scholars Program is now in full operation. New awards we were able to make included summer research scholarships for two graduate students, two graduate student distinguished teaching awards, and an Undergraduate Technical Communication Scholarship award. A special feature article appears in this Newsletter about the Mac Johnson Endowment Fund.

My office is on the third floor and overlooks the construction of a new wing for the School of Pharmacy and a new underground lecture hall. The noise level is very high and makes it difficult to concentrate. I try to have a special understanding however, since I am sure that one day the Mathematics Building will be getting a new wing to solve the space problems of the Department and others will have to endure that noise.

We appreciate the visits some of you have made to the department this year. You are always welcome.

Gloria C. Hewitt

Faculty:
Gloria C. Hewitt, *Chair*
David Patterson, *Assoc. Chair*

Rick Billstein, *Mathematics Education*
Mary Jean Brod, *Secondary Mathematics*
William Derrick, *Applied Mathematics*
Rudy Gideon, *Statistics*
Jonathan Graham, *Statistics*
Gloria C. Hewitt, *Algebra*
James Hirstein, *Mathematics Education*
Leonid Kalachev, *Applied Mathematics*
Mark Kayll, *Operations Research*
Libby Krussel, *Mathematics Education*
Don Loftsgaarden, *Statistics*
Johnny Lott, *Mathematics Education*
Jennifer McNulty, *Operations Research*
George McRae, *Operations Research*
David Patterson, *Statistics*
Greg St. George, *Functional Analysis*
Karel Stroethoff, *Complex/Functional Analysis*
Thomas Tonev, *Complex/Functional Analysis*
Nikolaus Vonessen, *Algebra*
George Votruba, *Functional Analysis*
Keith Yale, *Complex/Functional Analysis*

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Please send address changes to Michelle Johnsen, Secretary, at the above address or e-mail

1997-98 Undergraduate Degrees Awarded in Mathematics

* * * * * *

Leslie Odette Berg
Landon Jay Bideaux
Kathy Lynne Breland
Vicki Jean Bryant
Corey Alan Christiaens
Roslyn Marie Denny
Kendra Rae Eyer
Michele Rachel Heyn
Allen Philip Hild
Kelly Eileen Hill
Elizabeth Lundkvist
Daniel Edwin McGuire
Mary Ellen Milton
Lisa Michelle Morgan
Ross Earl Nickerson
Sheryl Lynn Schopfer
Jenny Marie Skillicorn
James Robert Stokes
Travis Togo
Andrew Joseph Zauner

Lecturer *(Continued from page 1)*

(1) is given by taking the average. Thus, 234 is a 3-ball pattern since the average of $a_0 = 2$, $a_1 = 3$ and $a_2 = 4$ is 3. Similarly, 7562 is a 5-ball pattern, and of course, 3 is a 3-ball pattern. With question (1) answered, we are led to a necessary condition in question (2); namely, if a sequence $a_0a_1 \ldots a_{n-1}$ is a pattern that can be juggled, then the average $\sum a_i/n$ must be an integer since it counts the number of balls.

Any hopes that this simple necessary condition is also sufficient are dashed as soon as one considers the sequence 354: it has an integral average, 4, but is not a feasible juggling pattern. This can be seen by noticing that balls 2 and 3 must be thrown simultaneously (5 seconds and 4 seconds after they are first thrown, respectively), a situation jugglers must avoid! Nevertheless, the answer to question (2) is elegant in its simplicity. Dr. Graham showed that a sequence $a_0a_1 \ldots a_{n-1}$ is a period-n juggling pattern if and only if $a_i + i \bmod n$, for $i = 0, 1, \ldots, n\text{-}1$, is a permutation of $\{0, 1, \ldots, n\text{-}1\}$. This explains, for example, why the 3-ball sequence 441 can be juggled: adding i to the i-th term and reducing modulo 3 yields 120, which is a permutation. It also explains why 354 cannot be juggled, since the same process now leads to 000, which is not a permutation.

The answer to question (3) is also surprisingly simple. Professor Graham even had time to outline a proof that there are exactly $(b+1)^n - b^n$ period-n juggling patterns that use b balls. The proof involved *Eulerian numbers, Worpitzky's Identity* and *drops & descents*. For more details, see [**1**], the main source for this article.

It would be amazing if we could end this article as memorably as our visitor concluded his lecture. Against the backdrop of a computer simulation juggling 15 or 20 balls (see [2]), he proceeded to juggle about a dozen of the patterns he had used as mathematical examples during the talk. Needless to say, he left the crowd wanting more!

References

[1] J. Buhler, D. Eisenbud, R. Graham and C. Wright, Juggling drops and descents, *Amer. Math. Monthly* **101** (1994), 507-519.

[2] Juggling Information Service, URL: *www.juggling.org*

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Ron Graham was the first Distinguished Visitor in the Fall semester's President's Lecture Series; the Department of Mathematical Sciences gratefully acknowledges the support of the Series.

Juggling math with passion - Renowned mathematician begins UM lecture series

by Gary Jahrig of the *Missoulian*

Don't tell Ron Graham there's a difference between his profession, mathematics, and his passion, juggling.

"Juggling is just like math, " said Graham, a world renowned mathematician and juggler. "Math is described as the science of patterns. Juggling is the art of controlling patterns in time and space."

Graham, the chief scientist at AT&T Labs in New Jersey, spent part of his day Thursday at the University of Montana talking to faculty members about the connections between juggling and mathematics. He also delivered the first installment of the 1998-99 President's Lecture Series, a speech entitled "Computers and Mathematics: Recent Successes and Insurmountable Obstacles."

The links between juggling and math have historically interested mathematicians, Graham said in an interview. He himself took an intense liking to both juggling and math in his early teens.

"So many people in juggling are interested in math and computers," said Graham, a former president of the International Jugglers' Association. "Both areas have unbounded challenges. In math, you can't solve all the problems. In juggling, you can't do all the tricks. And both activities are not much in the way of a team sport."

At 62, Graham still spends two- to four hours per week juggling up to five balls at a time. A former trampoline acrobat who performed in circuses, Graham also spends time on his backyard trampoline, which is equipped with a suspended harness he uses to perform complex acrobatic maneuvers.

"A trampoline is like juggling, too," he said. "Only you're the object so you don't want to drop."

Along with working for AT&T, Graham also teaches at Rutgers University and the University of California San Diego and sits on the editorial boards of more than 40 math journals.

He said he has used his juggling skills many times in his 36 years at AT&T. For instance, the task of routing telephone calls through a global communications web of cables, microwaves and satellites is a form of juggling in its own right.

"We have to juggle 200 million long-distance calls per day in the United States," Graham said.

On college campuses, administrators are forced to juggle on a regular basis. Graham said setting up a final exam schedule is a definite example of juggling at the college level.

"Juggling is a form of scheduling. When a university tries to schedule exams, they only have so many time periods and rooms. They don't want students having more than one exam scheduled at the same time," Graham said. "In juggling, you may have a lot of balls, but you only have two hands. You can only juggle so many balls because you have to have one hand waiting while the other one juggles."

Graham also believes that juggling may provide clues that could be used to expand mathematical horizons.

"By using juggling patterns, you can create lots of patterns that you've never thought of before," Graham said. "Juggling can get you thinking about problems that you've never thought of. Once you're thinking, you may be able to come up with new mathematical tools."

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This article appeared in the Missoulian on 9/11/98. Reprinted with permission.

Thank you Mac and Virginia Johnson

by Gloria Hewitt

James and Virginia Johnson

In August, Vickie Mikelsons from The University of Montana Foundation and I traveled to Butte, MT. We had lunch with Mrs. Virginia Johnson, her son James and his wife Diane. I wanted to personally thank Mrs. Johnson and let her know how appreciative we are that so many of our students received valuable support through the Mac Johnson Family Endowment Fund. I asked her, "Do you tell your age?" and she simply replied, "No". So we settled down to a lunch of salad, tomato soup and wonderful conversation.

Late in 1991, Mac and Virginia Johnson of Helena, MT established an endowed fund with a $50,500 stock gift. They stipulated that 80% of the annual proceeds were to provide scholarships for mathematics students and 20% of the proceeds were to benefit the Library. Then in late 1996, Mrs. Johnson added another $10,000 to this endowed fund and $20,000 towards the endowment of the Undergraduate Mathematics Scholars Program. The Mac Johnson Family Endowment Fund has now grown to $98,000 and with $200,000 invested in the George and Dorothy Bryan Endowment Fund, the Undergraduate Mathematics Scholars Program has grown to $258,000. This includes a growth of $35,000 and $12,000 respectively for the two funds.

Mac received his bachelor and master's degrees in 1931 and 1961 from The University of Montana. Virginia attended UM for two years during which time she met Mac. She graduated from Northern Montana College. Their son James received both his bachelor's and law degrees here and is an attorney with Legal Services in Butte. Since none of the family majored in mathematics, I sought to find out more about Mac and Virginia. In explaining the motivation for his assistance to the Department of Mathematical Sciences, Mac has been quoted as saying, "Math is important no matter what you do in life; I made my living because of it." At lunch, Virginia added that Mac always told his students, "You have to learn mathematics; you won't get out of my class without learning mathematics."

Mac's work experience was varied. He co-owned and operated the Billings Flying Service (now Lynch Flying Service) which he sold in 1945. He moved to Cut Bank, MT and taught math at Cut Bank High School for 12 years (1945-57). He was instrumental in getting the aviation programs going at the Vocational Technical Colleges in Havre and Helena. In fact, he taught math and aviation at Northern Montana College in Havre. He worked with the state to establish the education division of the Montana Aeronautics Commission, on which he served two terms. At some point, he was also a pilot for the Forest Service. His other business ventures included a Ford garage in Big Timber and a wholesale gasoline supply in Billings.

Mac liked fly fishing and owned a cabin on the Boulder River, 40 miles south of Big Timber. James told us how delighted they were to receive a note from one of the Mac Johnson Family Scholarship recipients who had a tie to Big Timber. He said that wherever they lived, they always returned to the cabin on the Boulder River. Mac died in July 1994 and his remains were buried in Big Timber. Virginia has now moved to Butte where she is close to James and Diane.

Graduate Mathematics Courses for Summer '99

by Jim Hirstein and Libby Krussel

The Mathematics Education faculty will continue to offer courses in the redesigned Master of Arts in Teaching (MAT) program begun last year. Teachers may complete a Master's program in two summers and one academic year. (Note: Summers only is still an option.) Students in the program will be strongly considered for academic year Teaching Assistantships and are encouraged to apply.

Last summer, 12 teachers from middle school through high school took our courses. We welcome teachers of all levels who are interested in improving the teaching of mathematics.

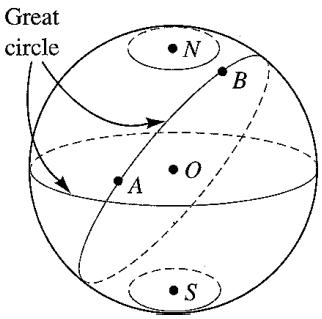
This summer ('99), the Department is offering three 3-credit graduate MAT courses on a **Tuesday - Friday** schedule, taught by Jim Hirstein and Libby Krussel:

MATH 540 *Probability and Statistics for Teachers.* June 15 - July 30. This class will meet for 90 minutes each day, in the afternoons.

MATH 530 *Geometries for Teachers.* June 15 - July 7. This class will meet for 3 hours each day in the mornings.

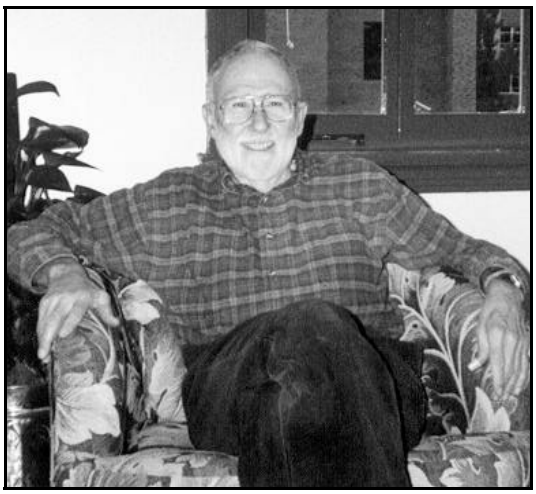
MATH 520 *Algebra for Teachers.* July 8 - July 30. This class will meet for 3 hours each day in the mornings.

For more information about the MAT program in general, or about these courses, please contact Jim Hirstein at 406/243-2661, e-mail *hirstein@selway.umt.edu* , or Libby Krussel at 406/243-4818, e-mail



Profile of a Mathematician - Bill Ballard

by Rudy Gideon



Bill Ballard was born in Yakima Washington on 1 February 1926. He attended Toppenish High School and was Valedictorian graduating in 1942. He was in the high school choir and worked on the year book. Bill says he was not an athlete because he was on the chubby side. However, he now weighs less than he did in high school.

Bill was awarded a scholarship to attend Whitman College in Walla Walla where he majored in Chemistry and Mathematics. He received a full $200 tuition waiver for the first year and a one-half tuition waiver after that. At one time he and his older brother, older sister, and younger brother were all attending Whitman at the same time.

Whitman had a Navy V12 program; students were in the Navy, wore uniforms, but attended college. After graduation, students received Navy assignments. There were many V12 students in Bill's chemistry and mathematics classes through differential equations. Not many students took post-calculus so Bill took his upper level courses by independent study. He graduated summa cum laude in 1946.

Upon graduation Bill applied to graduate schools at Princeton, Harvard, and the University of Chicago. Only Chicago was willing to give him financial help, $390 a year to grade papers. Bill hitchhiked to Chicago with a friend. It was on this trip he visited Missoula for the first time.

In 1946-47, Bill graded papers for Graves, an analyst, Lane, and Saunders MacLane, his eventual advisor. He took Algebra, Topology (from Kelley), and Analysis. After nine courses in one year (Quarter System) Bill passed his Masters Examination (a thesis was not required). Bill's Masters degree was in mathematics, with examinations in algebra, geometry (projective and differential, having taken a course from E.P. Lane) and analysis.

After his Masters degree, Bill began work in the Fall of 1948 at Washington State College (now University) as an instructor; he made $3300 the first year and $3600 the second. He saved much of it for his return to school. The second year he taught a graduate algebra course and Howard Reinhardt was one of his students. As many of you know, Howard and Bill taught together at UM for many years.

In the Fall of 1950, Bill returned to University of Chicago in a 1941 Oldsmobile that cost him $900. He now had a teaching assistantship with no fees excused. He taught calculus. His second year he worked as a research assistant under MacLane and started on his dissertation, *Cohomology in Fields*. In the summer of 1951 Bill met his wife, Lee, who worked as a part-time student in social services and lived in International House. In 1952, Bill had not yet graduated but he married Lee in Chicago. From the summer of 1952 to April of '53 Bill worked at the Institute for Air Weapons Research (IAWR) doing research on a full time basis.

Bill was now 1A for the Korean War and so he became a 2nd Lieutenant in the Air Force at Lackland Air Force Base in Texas. During this time Lee became pregnant and stayed with her parents in Massachusetts, giving birth without Bill present. At the time of the birth, Bill was assigned to the office in the Armament Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio which administered the IAWR contract.

Bill transferred to the Air Force Institute of Technology in Dayton and taught there from 1954 to 1957. He taught calculus, differential equations, and Laplace transforms to engineering students. He was still working on his thesis and went occasionally to Chicago to visit with his advisor, MacLane. He was discharged from the Service in 1957 and had a job lined up in Missoula, as he had worked with a friend in Dayton who knew Ted Ostrom at UM. Bill liked the idea of living in a mountainous region and had applied for positions at universities in Wyoming, Utah, and Montana. At that time he was offered $5400 in Wyoming, $5700 in Utah, and $5500 in Montana. No institution required an interview. He finished his thesis under MacLane in the summer of 1957 and passed orals to complete the Ph.D. requirements.

Upon his arrival in Missoula there were 2700 students on campus and 10 faculty with Ph.D.'s in the Mathematics Department. In 1957-58 he taught an upper division algebra course similar to our 400 level course. Long time physics professor Randy Jeppesen was in one of his first classes. Student Keith Yale (now on the mathematics department faculty) was the departmental secretary. Bill had been promised a living place in the X's but there was a mishap and Lee and Bill lived on the corner of Maurice and Beckwith for one year at $75 per month. In 1958 they bought their current house in the Rattlesnake valley.

Bill has had many good students over the years including George McRae, Keith Yale and Merle Manis (all became professors here), but says Jack Silver was the most spectacularly brilliant. Bill remembers making McRae prove some details of one of his lectures that was possibly an unreasonable expectation, and that Manis resisted writing details. One year Bill taught topology and complex variables to ensure that the essential graduate courses were available. Chicago had instilled a broad sense of mathematics

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Ballard *(Continued from page 5)*

in Bill and he was able to function as a sort of a "utility infielder".

During his time in the UM Mathematics Department, Bill has always been interested in the quality of instruction and the curriculum and has tried to bring about improvements. There had been very limited course offerings and Bill promoted the upper division algebra offerings and advanced calculus implementation. He worked on improved offerings for primary and secondary school teachers. In the late 50's and early 60's the department experimented with different offerings at the freshman level. The old freshman algebra, trigonometry, and analytical geometry were replaced by a quicker road to calculus. In the process, analytical geometry got short-changed and Bill did not like this. This deficiency has persisted to the present time. Bill thinks that in today's department with all of its disconnected teachers, visitors, part-timers, etc., it is difficult to pay adequate attention to freshman offerings. He believes we have lost ground! Bill likes strong degree programs and feels that too many undergraduate emphases dilute the strength of our program. He feels we should require one year of algebra and analysis of our majors. Bill is discouraged about the public's and administration's view of mathematics as a static topic and believes this adds to the problems of support for changes in the curriculum.

Bill Myers and Bill traded directorship of NSF summer institutes for teachers that lasted from 1961 until 1974. The institutes at UM were designed for relatively well-prepared teachers and offered relatively rigorous instruction. Many students went from high school to two-year college teaching based on the summer offerings. The current *Master of Arts Degree in Teaching* arose as a result of the summer institutes and a few year-long institutes.

Bill has always tried to be a good, consistent teacher who believes that understanding is more important than just facts. He does not really know if he was effective. He was faithful to the ideal of rigorous mathematics courses. He worked on the university curriculum committee promoting a general liberal education for students.

Early in his career at UM, he noted problems in the university that led him to join and promote the Teacher's Union. He also served many terms on the faculty senate. He was Chair of the math department from 1975 to 1978.

Bill has two sons, Tom and Hank, who have jobs in computer software and a daughter, Martha, who is a librarian. At this time, Bill has 3 grandchildren. Bill's hobbies include Hellgramite fishing on Rock Creek and big game hunting with his modified 30-06 army surplus gun. Gloria Hewitt and Rudy Gideon became Rock Creek disciples because of Bill. Bill learned to ski enough to teach his children to be better at it than he was. He used to take long hikes in the mountains with Bill Myers. His wife Lee became involved in the Audubon in the mid 70's. Bill became very active in this organization

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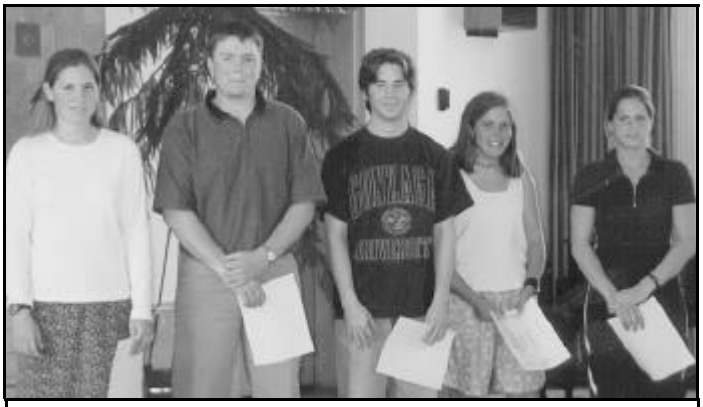
Math Awareness Week Highlights

by David Patterson

Another resounding victory for the faculty over the students in softball culminated the The Department of Mathematical Sciences celebration of Mathematics Awareness Week, April 27 - May 1. Math Awareness Week has become the highlight of math department activities each year, involving undergraduate and graduate students and faculty in a variety of social and academic activities.

The week kicked off with the construction of a mathematical sculpture by the Math Club in front of the Mathematics Building (see the Math Club Corner for more). The sculpture attracted considerable attention all week. On Wednesday, we had our annual awards ceremony in which we recognized winners of various Math Department scholarships and prizes. The number of scholarships we are able to award has increased dramatically with the establishment of the new George and Dorothy Bryan Endowment Fund. It's getting difficult to fit it all in in 45 minutes!



Mac Johnson Family Endowment Scholarship Recipients
(left-right) Samantha Allen, John Keintz, Joe Peterson, Lauren Buckley, Anne Marie Meester
at the Annual Awards Ceremony, April 29, 1998

On Thursday, Curt Vogel, Professor of Mathematics at Montana State University, gave a fascinating talk on "The Atmospheric Image Deblurring Problem." He talked about software-based approaches to correcting distortions in telescopic images caused by atmospheric temperature variations. This is a huge computational problem if one desires to do this "on the fly" since the atmospheric variations are constantly changing.

Finally, on Friday was the annual Math Department Potluck and Faculty-Student Softball Game. The faculty once again trounced the students (13-8), led by Rudy Gideon's two homeruns and a double (which would have been a third homerun if he hadn't decided that he had done enough running for one afternoon!)

1998 Mathematics Scholarship and Award Winners

- Joseph Hashisaki Memorial Scholarships (for two outstanding upper division math majors): Jennifer Berg and Scott Evje
- Mac Johnson Family Endowment Scholarships (for students who have completed at least one semester of calculus and shown exceptional talent in mathematics): Samantha Allen, Lauren Buckley, John Keintz, Anne Marie Meester, and Joseph Peterson
- N.J.Lennes Awards (cash prizes based on performance on a competitive exam): (1st) Luke Powell, (2nd) Scott Jones, Hidekatsu Takezawa, (3rd) Anne Marie Meester
- Undergraduate Teaching Scholars (work with a professor to improve a class): Jennifer Berg (for Dr. Libby Krussel), Daniel Lochridge (for Dr. Greg St. George), and Chad Olson (for Dr. Patricia Hale)
- Undergraduate Tutorial Scholars (assist students in a lower-level course): Samantha Allen, Paul Davis, Scott Evje, Scott Jones, Daniel Lochridge, James McCreight, Joseph Peterson, and Cami Welborn
- Undergraduate Scholar in Technical Communication (works on internet tools for a large statistics class): Elizabeth Hill (for Dr. Don Loftsgaarden)
- John A. Peterson Mathematics Education Award (book award to outstanding senior in mathematics education): Leslie Berg
- Graduate Student Distinguished Teaching Awards (cash awards to two outstanding teaching assistants): Dan Finch and Dave Perkins
- Summer Graduate Research Scholarships: Ron Anderson and Michael Kraemer
- Pi Mu Epsilon New Members: Angela Concepcion-Willmott, Daniel Finch, Patricia Hale, Allen Hild, Kelly Hill, Daniel Lochridge, Anthony Navarro, Joseph Peterson, Sheryl Schopfer, Lisa Smith, and Cami Welborn

University-wide scholarships and awards to math majors:

- Bertha Morton Graduate Scholarship: Jesus Novoa-Ramirez
- President's Senior Recognition Awards: Kendra Eyer (Mathematics), Michele Heyn (Mathematics Education), and Travis Togo (Pi Mu Epsilon)
- Watkins Scholar for 1997-98: Catherine Murray
- Invitation to join Phi Kappa Phi Honor Society: Linda Burrington, Roslyn Denny, and Michele Heyn

πμε/MAA Math Club Corner

The Pi Mu Epsilon / MAA Mathematics Club is well into its semester activities. Once again the year is packed full of great things. Jennifer Berg spoke about her summer REU (Research Experience for Undergraduates) studying basic topology at Tulane University. We have invited other on and off campus speakers to talk with our group about mathematics and science related topics. We plan to feature the "meet your faculty" series, which has been well received in past years. The math club also continues to play an important role in the department's refurbishing of the Undergraduate Study Room (MA 212) and in the acquisition of a collection of mathematical videos.

Last year we saw great success with Mathematics Awareness Week activities. Early in the year we planned to build a sculpture in front of the Mathematics building, and actually came through with it! [See picture.] The sculpture depicted a theorem of Desargues about the collinearity of points of the intersection of extended sides of projective triangles. It was a very popular attraction, so we are motivated to plan another mathematical sculpture this year.

Though we are a small group this year, we are a strong unit. We welcome new faces and invite you to attend our meetings (Tuesdays at 3:10 p.m. in MA211).

πμε / MAA Math Club members include:

Dan Lochridge..... President
Joe Petersen..... Vice President
Cami Welborn ..... Secretary
Angie Concepcion-Willmott..Treasurer

Jen Berg	Amanda Deisher
Cory Fuchs	Kristen Govertsen
Scott Jappinen	Cole Maxwell
James McCreight	Kathleen Ores
Michael Robbins	Travis Togo

Faculty Advisors:

Mary Jean Brod	Keith Yale

Ballard *(Continued from page 6)*

after his retirement and became President of the Missoula Chapter for four years. He is now the State treasurer and participates in the annual bird count.

Bill is a declared Democrat and has been a precinct committee person. He was active in the Missoula Central Labor Council and on the planning committee of United Way. He was on a 40 member committee in 1983 to study City-County government; a plan to establish consolidated government was produced and voted down. He has served on Missoula's open space advisory committee and currently is active on a committee charged with stewardship of Mount Jumbo.

After his retirement in 1987 Bill received a 6-year one-third time contract and so actually worked until 1993. Since that time he has offered various seminars in algebra and number theory each semester for 2 credits for 2-4 students (of course, with no pay). In general Bill likes the strength of the new faculty. The department continues to be much better off because of the years Bill spent here and continues to benefit from his continued support.

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