

# Creative Streak: Williams College Math Department Wins National AMS Award

Allyn Jackson



All photos: Cesar E. Silva.

SMALL at 4th of July Parade, 2012.

It was 1988, and Colin Adams was in his third year on the faculty at Williams College. He donned a gaudy green suit plus cowboy boots, mustered a Texas accent, and gave a lecture in his department. In the lecture, “Real Estate in Hyperbolic Space: Investment Opportunities for the Next Millennium”, he played an unprincipled salesman called Mel Slugbate, who was hawking hyperbolic plots to those chary about investing in traditional real estate. It was the first time Adams had ever put on a costume to give a lecture. He was a little nervous. “I was a junior faculty member,” he recalled. “I thought, ‘This is the end of my career right here’.” As it turned out, his department was very supportive of this unconventional way of introducing ideas about hyperbolic space. Since then, Mel Slugbate has made many appearances in mathematics departments and at meetings, and Adams has developed a thriving sideline in mathematical humor. The now-classic “Great  $\pi$ -e Debate”, which he performs with his Williams colleague Thomas Garrity, is available on DVD.

One big reason Adams’s risky venture worked is the open and creative atmosphere of the

Department of Mathematics and Statistics at Williams College. The department hires extraordinarily talented people and gives them a great deal of freedom in deciding how best to meet their dual responsibilities in teaching and research. This diverse group of dynamic individuals work together on an enormous variety of programs and activities, and they do so in a harmonious way, keeping their focus trained on the big picture: Communicating, doing, and enjoying mathematics. For their wide-ranging accomplishments and for being an inspiration to mathematics departments around the nation, Williams College is receiving the 2014 AMS Award for an Exemplary Program or Achievement in a Mathematics Department.

## Serving All Students Well

Within the mathematical community, the most famous math major from Williams College is no doubt Curtis McMullen, who earned his bachelor’s degree in 1980 and was awarded the Fields Medal in 1998. But outside the mathematical community, the best-known Williams math major might be Bethany McLean, who finished a double-major degree in math and English in 1992. In 1995, she got a job as a fact-checker at *Fortune* and eventually started writing stories for the magazine. On March 5, 2001, *Fortune* published her bombshell story, “Is Enron Overpriced?”, the first report in a major magazine that raised questions about Enron’s accounting. People at Enron tried to dissuade McLean from digging into the details, telling her she didn’t really understand the numbers. “But she had understood very hard mathematics problems, so she believed she could understand the Enron numbers,” said Cesar Silva, who has been at Williams since 1984. As a math major, McLean had also learned tenacity, which helped her to pursue the Enron story at a time when others believed the company to be above reproach. Today McLean is a visiting scholar at New York University, writes for *Vanity Fair* and Reuters, and often appears on television news programs (see sidebar on page 522).

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Around the time McMullen got his degree, Williams had perhaps half a dozen senior majors. By McLean's time, the number had risen to between twenty and thirty. "When we hit forty majors a year, we thought, okay, it's stabilizing," recalled Susan Loepp, who joined the department in 1996. This year, the department has sixty-seven senior majors, about twelve percent of the senior class (nationally, about one percent of seniors are math majors). The department continues to serve well those like McMullen, who are bound for graduate school in mathematics, while also reaching out to students like McLean, who have other aspirations. For both kinds of students, the department tries to spark and stoke a love of mathematics.

The department did not set out to increase the number of math majors. Rather, its goal has been to increase student learning and enjoyment of mathematics. One turning point for the department came about twenty years ago, when it changed its calculus sequence. At the time, the course crammed single- and multi-variable calculus into a single year. Students had "quite a time with it," recalled Frank Morgan, who has been in the department since 1988. Freshmen coming to campus would hear from other students, "Don't take calculus." The department made the course more approachable by rearranging the material to run over three semesters. The course's reputation changed overnight, and now freshmen hear, "You *have* to take calculus."

And they do: Eighty-four percent of Williams students take a course in mathematics or statistics, and about sixty percent complete multivariable calculus. Only a few of these students intend to major in mathematics, but after taking a couple of introductory courses, they are hooked. The department's statistics courses are also highly popular: Sixty percent of the graduating class has taken a statistics course, compared to fifteen percent a decade ago. "We like having a lot of students," Loepp commented. "It adds an energy to the department."

Once the students are hooked on mathematics, the department keeps them hooked by delivering outstanding teaching and offering a wide variety of activities that build a sense of community. Williams has a long tradition of excellent mathematics teaching. These days, in order to be hired at Williams, Morgan said, one's application must have a document containing a statement like, "This is the best teacher I have ever known." Many Williams mathematicians have won teaching awards at the local or national level, and teaching quality as measured in student surveys has risen over the years. When faculty come up for tenure, the quality of their teaching is compared to that of the tenured



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faculty, creating a climate in which continual improvement is the norm.

Using what Adams calls an " $n$ -pronged approach", where  $n$  is a fairly large integer, the department has created a range of student activities. There are weekly problem-solving dinners, monthly dinners for students and faculty, and an ice cream social in which new students get informal course advising from older students, all the while enjoying ice cream sundaes. There is a weekly math puzzle night, and a monthly "Math Conundrum": A mathematics problem with an unusual twist is posted on the departmental webpage, and students can win prizes for solving it. Faculty member Steven Miller runs a "Math Riddles" website that gets 4,000 hits a month. Students have the opportunity to attend conferences, including the Joint Mathematics Meetings and the Hudson River Undergraduate Mathematics Conference, of which the Williams department is one of the founders. The many activities contribute to students' enjoyment of mathematics and make the department a friendly, sociable place to be. Students often comment on the high level of activity in the department.

Another major activity in the department is the series of colloquia given by senior math majors. The colloquium talk is a requirement for the degree. Each math major works intensively with a faculty member to choose and study a topic and to prepare the lecture. Faculty routinely listen to two or more practice runs of the talk before the student is ready. Students often identify the colloquium lecture as one of their most valuable educational experiences. With so many math majors, scheduling all the colloquia is a logistical challenge, and the department has sometimes had to resort to running talks in parallel sessions. The colloquia are well attended, often with friends and family in the audience, and they create a buzz on campus. "Everyone has a friend who gives a math colloquium," Morgan said.



**A group of Williams math majors, mostly seniors, in 2010.**

### **SMALL Program, Large Impact**

One day during his first summer at Williams, Morgan attended a science lunch talk and encountered a hundred undergraduates who were working on research projects. “I thought, What a marvelous thing,” he recalled. “I knew then that mathematics had to be a part of it.” People understood how undergraduates could contribute to research in a lab science—but to mathematics research? This was 1988, and today’s proliferation of Research Experiences for Undergraduates (REU) programs in mathematics had not yet occurred, so there were not many exemplars to follow. But Adams and Silva had done a couple of research projects with mathematics students, and they had a sense of what was possible. That same summer Silva, Morgan, Adams, William Lenhart, and David B. Levine submitted a proposal to the National Science Foundation to start an undergraduate research program named SMALL, an acronym of their last names.

Now more than twenty-five years old, SMALL is one of the best known and most successful REUs. It runs for nine weeks over the summer and brings in about thirty students, some of them from Williams, some from other schools around the nation, and even some from abroad. Each SMALL faculty member assembles a group of undergraduate students, chooses a problem for them to work on, and provides guidance and advice as the students collaborate. Many of the groups have published in standard research journals. The students have done research in a wide variety of topics, including knot theory, minimal surfaces, number theory, symmetry groups, combinatorics, graph theory, computational geometry, dynamics and ergodic theory, neural networks, Bayesian statistics, and commutative algebra.

How do the SMALL faculty come up with appropriate problems for the students? Partly it is a matter of experience, and partly it is a matter of keeping one’s antennae up, Adams noted. For example, when listening to lectures or talking

to people at meetings, “you look for problems where you don’t need a lot of background to make progress, or that can be broken down into cases or boiled down to a simpler situation,” Adams explained. When one is thinking like this, “it just takes off.”

Because SMALL is a well-established program with an excellent reputation, it gets very strong applicants. “It’s so much fun for us to work with these students at an early point in their careers,” Adams said. Today sixty SMALL alumni are in the process of getting their Ph.D.’s in mathematics, and many others have finished their degrees and hold faculty, postdoctoral, and visiting positions in a variety of institutions. Two of the best-known SMALL alumni are Michael Hutchings of the University of California, Berkeley, and Jeff Brock of Brown University. Several SMALL participants have received distinctions such as the Schafer Prize of the Association for Women in Mathematics and the Morgan Prize for Outstanding Research by an Undergraduate, which is sponsored jointly by the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics (Morgan’s mother endowed the latter prize, which is named after her and his late father).

Susan Loepp served as principal investigator on the NSF grant for SMALL from 2009 to 2013 and directed the program for three of those years. For her SMALL groups, she used to choose the students with the strongest records. “Now, I take those I think will work the hardest,” she said. She and the other SMALL faculty have also made a concerted effort in recent years to recruit more students from underrepresented minorities, in particular by forging ties with programs like the Math Alliance and its Field of Dreams conference. Before 2009, SMALL usually had one or two students from underrepresented groups every few years. Today, it is unusual for SMALL to have a year without several such students. About one-third of SMALL participants have been women. “I try to be really supportive of underrepresented students here and elsewhere,” said Loepp. “We need to encourage them and let them know they’re good even if they think they’re not.”

### **Hiring Outstanding People**

Loepp grew up in the Midwest and had never heard of Williams until she was on the job market after getting her Ph.D. Many people recommended she apply to Williams, so she did. “I came out and saw all the fantastic things the department was doing,” she said. The department clearly valued both teaching and research—and excelled in both. “The faculty were writing books, advising undergraduates, teaching innovative classes,” she said. “No one in the department, after getting



tenure, was slacking off. Some did even more. That was the kind of energetic department I wanted to be in.” Not wanting to be a “trailblazer”, as she put it, Loepp was glad that the department already had two women. Today five of the department’s fifteen faculty are women.

One of the main reasons for the success of the Williams department is its approach to hiring. “We say, let’s hire the best person in terms of teaching and research and not worry about area,” Adams explained. “So our pool is maybe eight times as large as at other places. That has served us well.” One exception is statistics, where the department made targeted hires in the belief that statistics is one of the most important needs for the college. In 1992, the department hired Richard De Veaux, who had been at Princeton University. “That was a huge hire,” Adams remarked. “He is someone who organizes things and moves them forward.” The department now has four statisticians, two of them women, and enough faculty to support its new statistics major, established last year.

The department hires serious researchers and expects them to produce. In decisions about hiring and promotion, research and teaching quality are weighted close to equally. The research must consist of published articles in good journals; little credit is given for writing a textbook. (The faculty has nevertheless written a range of textbooks, some of which have been used widely in other institutions and have led to successful teaching innovations.) Faculty in the department are indeed very active in research. Since 2000, they have been awarded a total of twelve National Science Foundation research grants and have published on average a total of nineteen journal articles per year. A weekly department-wide faculty seminar provides a venue to discuss current research, and this seminar has sometimes led to collaborations. The Williams mathematicians and statisticians are in demand as speakers outside the college, delivering each year nearly 200 talks at conferences and other institutions.

Research in the department is closely tied to teaching. “At Williams, we get really strong, smart students,” Adams said. “To be a successful teacher here you have to be involved in research and excited about it. The students expect that.” The department offers a range of advanced courses in areas such as hyperbolic three-manifolds, transcendental number theory, analytic number theory, Riemannian geometry, ergodic theory, algebraic geometry, and Fuchsian groups. These courses are similar in level to graduate courses. “I couldn’t teach such courses without doing research in the area,” Adams said. Math majors have the option of writing a senior thesis, and faculty need to be



**SMALL 20th anniversary conference.**

involved in research in order to be able to identify suitable thesis topics.

A department with so many high-powered personalities could easily become fractured. But the Williams department has not. “Somehow, we have gotten faculty who are very dedicated to the department,” Loepp noted. “There are no political groups. We have opinionated people, but when we vote, we don’t vote according to who we like. We vote on the issue.” Sometimes discussions in department meetings become heated, but afterwards, everyone has lunch together. And they don’t bicker over the small stuff. A department can easily get embroiled in arguments over, for example, whether calculus should be taught by lecturing, by using “reform” methods, by using computers, and so on. But, Morgan noted, if the focus is on whether students are learning, and faculty are free to use whatever teaching methods they personally find effective, “What’s there to argue about?” Whether students are happily learning “is all we care about,” he said. “That’s all we had to agree on. That is the shared vision.”

### **Building an Academic Community**

Olga (Ollie) R. Beaver, a beloved member of the Williams department and recipient of the 1992 Louise Hay Award of the Association for Women in Mathematics, died in 2012. In a memorial tribute to Beaver, posted on the department website, Loepp recounted a story from her first weeks at Williams, when Beaver was department chair. Loepp was heading to a reception for women faculty and stopped by Beaver’s office to ask if she was going to the “chick event”. “I was immediately horrified that I had mistakenly used the possibly offensive word ‘chick’ in the presence of my department chair,” Loepp wrote. “As I stood paralyzed, trying to figure out how to get out of this one, without missing a beat, Ollie leaned over to me and said, ‘Some of us are hens.’”

This anecdote captures Beaver’s inimitable charm. An enormously popular teacher, she co-founded the college’s new Summer Science Program



(SSP) in 1987, serving as director of the program for ten years and teaching in it until her death. SSP identifies Williams freshmen who express an interest in mathematics and science and who are from underrepresented minorities or are the first in their families to attend college (Williams' policy of need-blind admissions and full need for all American students has brought more such students to campus in recent years). SSP is not a remedial program; the SSP participants are talented, high-achieving individuals.

However, some of them come to Williams with the idea that they have to "go it alone". "The main thing SSP does is develop a sense of academic community," Morgan explained. Over the course of the five-week program, the SSP students are encouraged to ask questions of the instructors and to work together with their peers when they get stuck. "This spirit has been transmitted to other, non-SSP students," Morgan wrote in a letter nominating Beaver for the Hay Award. "Now there are successful role models; students help each other. Word gets around that people care here." The majority of SSP participants opt for science-related majors, and a large number enroll in a mathematics course. Some have gone on to complete the mathematics major.

Through the SSP, Beaver touched the lives of around 500 students, conveying a welcoming and encouraging message and transmitting to them her ethic of hard work and perseverance. Silva, who is originally from Peru, has also taught in the SSP since the mid-1990s; other faculty, including Loepp, have taught in it as well. Calling the program "fantastic", Loepp nevertheless acknowledges that progress in bringing underrepresented students into mathematics has been slow. "It's hard," she said. "We are not the best at it. But we are making progress, and I hope we can continue."

### Everyone Loves Math

The faculty of the Williams College Department of Mathematics and Statistics are almost unbelievably energetic. How does the department inspire the faculty to work so hard? "We love what we're doing," Morgan said. "Mathematics is an honor and a thrill to be part of. People come here excited to take their place in what we are doing." With its open, creative atmosphere, the department provides fertile ground for new ideas for pursuing its main goal: communicating and enjoying mathematics. For his part, Silva hopes the department will continue to spread its message: "Everyone loves math, even if they don't know it yet."

### Digging into the Numbers



**Bethany McLean at SMALL 20th anniversary conference.**

*Bethany McLean, whose article in Fortune magazine was the first to report on the Enron fraud, received her bachelor's degree in mathematics from Williams in 1992 (see main article). Asked about how studying mathematics influenced her career, she made the following remarks.*

Math was easy for me until I hit abstract algebra. And then it became impossible. I struggled for Bs and definitely was not going to go on to graduate school. The really great thing about the Williams math department is that they didn't discourage people like me from still majoring in math—in fact, they encouraged it. I think the department has long had the view that they want more students than those who are going to go on to get Ph.D.'s. Math is a relevant degree for so many careers!

I gave a talk at the college a few years ago entitled "Why math made me a better journalist". Part of my argument was that math taught me inescapable logic. I am not naturally a tough, confrontational person. But when A doesn't lead to B, I dig in. I can't get around it any more than I could skip a step in a proof. That's made me ask questions until I get answers.

I also think that it's good to do something in college that isn't easy for you. Math was humbling for me. But I learned what it was like to have to work at something that didn't come easily. That's an incredibly important lesson for any career.