m^3

math majors magazine

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Brought to you by the Undergraduate Math Association

Foreword

It is a pleasure to bring you our first issue of m^3, the Math Majors Magazine. Over twenty years ago, the UMA used to publish a magazine also called m^3, although back then, the initials stood for "math majors monthly". After a couple of issues, it mysteriously disappeared, with the reasons still under investigation. Now, after over twenty years, it has finally come back to life in a different form!

We put together this magazine in an effort to entertain, inform, and connect, for there are so many enjoyable, fulfilling, and educational aspects of life as a math major at MIT, and there are many things we can learn from each other. We have invested a lot of time and effort bringing together this magazine, which has been an arduous task. Nonetheless, we plan on producing more issues in the future with hopefully even more interesting content.

For a magazine dealing with what MIT undergraduates are doing in math, we urge you to check out MURJ, the MIT Undergraduate Research Journal. For a magazine dealing with interesting math research, we urge you to check out the American Mathematical Monthly.

We hope that you find the contents entertaining and useful, because we certainly did. Please do not hesitate to send us feedback or articles that you have written!

Sincerely,

The m^3 Team

Hyun Soo Kim, Editor In Chief

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December 4, 2008

Interview with Professor Stanley

Richard Stanley received a B.S. in mathematics from Caltech in 1966 and a Ph.D. in applied mathematics from MIT in 1971 under the direction of Gian-Carlo Rota. Professor Stanley's research concerns problems in algebraic combinatorics.

Math majors may recognize Professor Stanley from having taken 18.S34, a seminar that prepares students taking the Putnam exam, and 18.S66, a seminar that highlights Professor Stanley's focus on combinatorics.

I had the privilege of sitting down with him and finding out how he picked up his interest in math, how he got involved in combinatorics, why Catalan numbers are special, and his passionate interest in solving chess puzzles.

Where did your interest in math begin?

I would say I developed it in high school.

Was that through competitions or was there a teacher that was influential?

Back then there were hardly any competitions. I moved to Atlanta, Georgia and there was a kid in my class who was doing very sophisticated math by himself and I just felt that I wanted to understand more. That started me off.

At that point, did you know that it was research you were interested in?

At that point, I just wanted to learn more about mathematics. Martin Gardner had a column in Scientific American called "Mathematical Games". There were Mobius strips and flexigons. He had all kinds of neat problems that were very easy to state. I just wanted to learn more. I didn't think of myself doing research.

Did you know you would be majoring in math going to college?

I knew that I would. It was 90% in math, 10% in physics.

Did the college experience encourage you to do math research?

No, I still didn't know. I didn't have a good idea of what math research was. Actually, in high school, I did some research that wasn't really original. But still, I did not see myself as being able to do real research or know what it was like. I just wanted to learn as much as possible.

How about being a professor?

I guess it was a long-term goal. It seemed like something impossible to achieve. I thought I could never be the same as these math professors who were teaching other students, coming up with all these neat ideas just by thinking.

I know what you mean.

Graduate school is very good for helping you learn how to do that.

I read that you worked for JPL for some time. How was that related to your interest in math?

There was a direct correlation. I was in a group there that was responsible for designing the error correcting codes that the spacecrafts were using. It was very mathematical and my undergraduate advisor recommended that I apply for summer jobs there. So that fit right in with my math interests. However, I never saw myself working permanently for the place.

Which people influenced you at the time?

My undergraduate advisor was Marshall Hall. He was a very well-known algebraist and combinatorialist. Although back then I had no interest in going into combinatorics, he was one of the few people who could be considered a combinatorialist. Someone else that had an influence on me was Donald Knuth. He got his Ph.D. at Caltech under Marshall Hall and he stayed there a couple years before moving to Stanford. I took the first course that he taught and the next year I graded it. I talked to him about doing research. He tried to get me interested in CS-type problems to work on.

At that time, your interest in math was not very specific.

In fact, my main interest was algebra. I did not think that combinatorics was a serious subject. I didn't even take the combinatorics course at Caltech. And also, at my work at JPL, it was more of combinatorics than anything else. But even then, I didn't really think of it as a serious research area.

How did you get involved in combinatorics?

I went to graduate school at Harvard. When I arrived, I wanted to work in group theory. There was a famous mathematician there named Richard Brauer doing group theory. But I didn't really like where research in group theory was going. They were just starting to classify finite simple groups and there were hundreds of pages, several hundreds of pages, with many, many cases. But I did have some problems that came out of working at JPL, some combinatorics problems that I was curious about which I never thought of as serious research problems. Someone at Harvard suggested that I go to MIT to see Professor Rota. He encouraged my interest in combinatorics and he became my thesis advisor.

That's how it all started?

That's right. After meeting Professor Rota, I realized that one could do research in combinatorics. It was a Mickey Mouse subject for a lot of people at the time. Some people still think that now, but not so much.

What motivated your long-standing interest in combinatorics?

I think I just naturally liked combinatorics. I think I was more hard-wired to like that kind of mathematics, discrete type mathematics like algebra. I realized it as soon as I found some professor who did some serious work in the area. He had this view that someone should build up general principles to unify combinatorics at the time together with other branches of math. All of that was very appealing. So I'd have to say that it was due to the combination of my natural instincts and finding the right professor.

What do you enjoy most about being a professor?

The freedom is really good.

At the time, did you know what being a professor was about?

It seemed like an extension, being a student then being a professor.

Do you have any memorable moments studying math in college?

When I was in college, I realized how much better I was at algebra than analysis. I took a year's course in quantum mechanics. The first two trimesters [Caltech runs on a trimester system] were based on analysis, Schrodinger equations and all. I found that really difficult. I didn't really have a good intuitive idea of what was going on. The final trimester was an algebraic approach based on linear algebra, matrix theory, and that all seemed so easy to me. I was the first to finish the final exam and I got an A+ in the class so I was really pleased by that. It made me realize that somehow I really was cut out to do algebra. I wonder how much of mathematical talent is hard-wired, how much detail is built into you, like what area of mathematics you're going into. It seems that even that part is wired.

In your opinion, how is the state of combinatorics?

Right now, I think it's a very good, extremely active subject. But I think to do really high-level research now, particularly in algebraic and enumerative combinatorics, which I worked in, you have to know more than you used to. Back when I was a graduate student, you could use the simplest results from other areas like topology. Take the Euler characteristic. You could interpret that combinatorially and come up with all kinds of interesting results. Now, the topological combinatorics gets into some of the deeper more recent aspects of topology. Combinatorial representation theory is a huge subject now, probably one of the main areas of combinatorics. At the beginning, the very simplest representation theory – groups acting on sets – was enough to get all kinds of neat things. Now you have to be into all the latest algebras, like affine Hecke algebras, quivers, and very sophisticated, mainstream stuff that people are working on. You have to know more now than you used to.

In the Enumerative Combinatorics book, you list many exercises that ask different ways to prove the Catalan numbers. Where did that start, and why Catalan numbers?

Catalan numbers just come up so many times. It was well-known before me that they had many different combinatorial interpretations. I think there was a paper in the Monthly that had a dozen or so of these interpretations and it notes that some professor had a hundred combinatorial interpretations that he came up with, unpublished.

When I started teaching enumerative combinatorics, of course I did the Catalan numbers. When I started doing these very basic interpretations – any enumerative course would have some of this – I just liked collecting more and more of them and I decided to be systematic. Before, it was just a typed up list. When I wrote the book, I threw everything I knew in the book. Then I continued from there with a website, adding more and more problems, and people would write to me with more interpretations. Many of them are very similar to each other, which make them really interesting.

How are Catalan numbers special?

They're the most special. I think a lot of it has to do with the binary tree. Breaking structures up into two pieces – there are so many structures that you can do that with, even if it's hidden. There are some other numbers you can do a lot with. $(n+1)^{n-1}$ – that's another great interesting sequence.

As this is a math interview, I have to ask: Do you have a favorite number?

I'd have to say my favorite number sequence is the Catalan numbers.

So any number in the Catalan sequence.

Yes. The Euler numbers and $(n+1)^{n-1}$ would be close seconds.

Which graduate schools would you recommend for going into combinatorics?

I think you should go to the best graduate school that is compatible with your area. You should consider some combination of the whole school and the people in the area. Usually, the two are quite correlated. The best people will be at the best schools. You should definitely discuss with an advisor.

What kind of hobbies do you have?

I like juggling, although I'm not very active now. Bridge is something I enjoy. I like chess problems. I don't really like chess, but I like chess problems. It's a serious area that is very small and extremely well-developed into an art form.

A machine could solve just by going through all possibilities, but that's not what people are interested in. There are some aesthetics to that. It's not just a question of solving the problem. You have to understand the themes of these problems and exactly what these problems are trying to show, what pieces interfere with each other in a certain way. It's like trying to get a maximum amount of interesting play from these pieces. The problems are not always "mate in a certain number of moves". There are "selfmates", "helpmates", and all kinds of new pieces people put in.

Most people do not realize that this area even exists. Not too many people are into it. If you go to my webpage and click miscellaneous and click on chess problems, you will get some links.

Thanks for your time Professor.

Interviewed by Hyun Soo Kim

Introduction blurb taken from MIT's math website