Still Questioning Authority: An Interview with Jean Taylor

Donald J. Albers

Jean E. Taylor is a professor of mathematics at Rutgers University, Vice-President of the American Mathematical Society, and a member of the Board of Directors of the American Association for the Advancement of Science. She finished first in her class at Mount Holyoke College. Taylor retains the questioning manner that distinguished her as a schoolgirl, as evidenced by her fondness for the bumper sticker "QUESTION AUTHORITY!" Over the past quarter century she has studied minimal surfaces, the closed surfaces enclosing the least volume or those with a given space curve as boundary that have minimal surface area.

In the early days of her career as a mathematician Professor Taylor tested her theoretical models of minimal surfaces by dunking loops of wire into her kitchen sink of soapy water. Later she turned to high technology, especially computer graphics software, to model bubbles. Today, she has moved from soap bubbles to crystals, which conform to more complicated rules about minimal surfaces.

Taylor's daughter calls mathematics "the family business." Two of Taylor's three collaborators on a recent research project are in the family. With her husband Frederick J. Almgren of Princeton, her stepson Robert F. Almgren of the University of Chicago, and Andrew R. Roosen of the National Institute of Standards and Technology, Taylor is trying to model the growth of snowflakes and other crystals on a computer. Her daughter Karen Almgren, a senior at Princeton High School, gave a talk at the spring 1996 meeting of the New Jersey Section of the Mathematical Association of America: "Calculating the Capillary Forces Exerted by a Drop Between Two Cylinders." It seems the family business is expanding.

Taylor loves the mountains. An accomplished climber, she was invited to join the Annapurna expedition. Which of her many achievements most pleases her? "The day I climbed both Cathedral Spires and Church Tower."

Taylor was interviewed in her office in the summer of 1994.

"Scrambled Brains"

D.A. Where did you begin life?

J.T. I was born in San Mateo, California, and moved to Sacramento when I was three. I don't have childhood memories of any place but Sacramento.

D.A. What do your parents do?

J.T. My father's a lawyer, and my mother's a gym teacher.

D.A. Did either one have interests or abilities in the quantitative sciences?

J.T. I think I'm totally unique in that area. My sister is in languages, and my brother is also a lawyer. Both sides of my family are involved in education, but not in mathematics or in science.

D.A. Did your parents play with you a lot? Lawyers and teachers can be busy.

J.T. I remember when I was in college, my father somehow latched onto this business that you can prove that you can't trisect an arbitrary angle. It seemed to him very odd that you could prove that you couldn't do something. So he would send me totally nonsensical drawings in his letters, saying "These are my latest researches on how to trisect an angle." It was a running joke between us for a great many years.

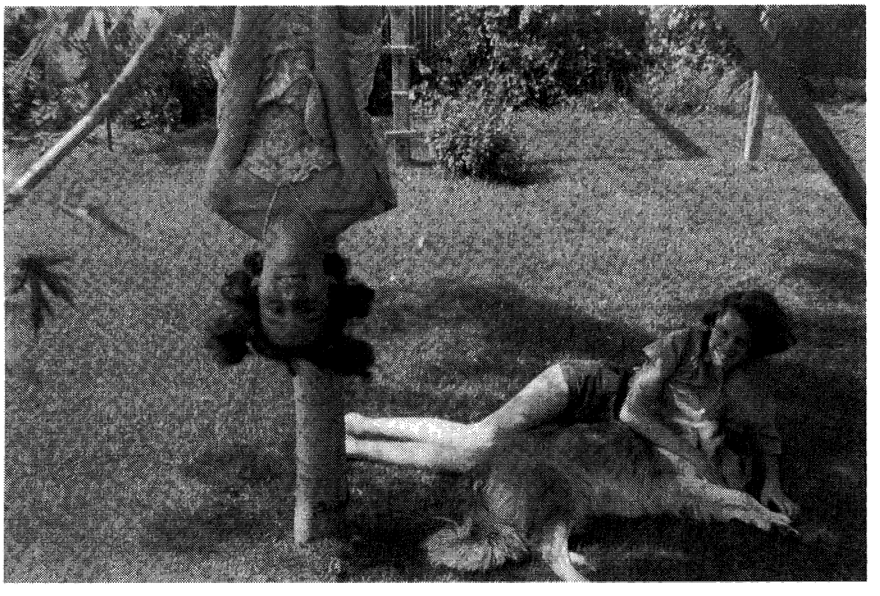
D.A. How about your mother? You probably spent more time with her.

J.T. Oh, yes. One of her great disappointments in life was that she could never teach me how to do a cartwheel. Here was this gym teacher with an uncoordinated kid! She's a very warm person, very good at relating to other people. She became a high school counselor after she stopped teaching.

D.A. What kind of a kid were you?

J.T. I did like to read. I read an enormous amount—science fiction, Daniel Boone and pioneers, that genre. For a long time I felt like I must have been born exactly in the wrong age. In the future I could have been the captain of a spaceship. And in the past, I could have been an adventurer as a pioneer. Sacramento and the early fifties just seemed entirely wrong; I was not in the right place.

D.A. I remember having similar desires at that age.



A young Taylor getting a different perspective on the world.

J.T. A few times I had accidents that knocked me out. When I was a kid I put a rocking chair up on the table on our patio and then turned over backwards and fell on the cement. When I was 11, I was in a bad automobile accident. I had a concussion with fluid coming out of my ears and was in the hospital for a week. My father said that each time my brains got scrambled they turned out a little bit better.

D.A. How about school itself?

J.T. In elementary school I got "C" in handwriting and in self-control.

D.A. Self-control? How about academic subjects?

J.T. One time we had a math problem, multiply 26 times 40, and it had the 40 on top and the 26 on the bottom. So I flipped it over to do the multiplying. The principal gave me a very hard time about that: "You do the problem the way it's given to you. Put the 40 on top, and you must have the 26 on the bottom."

D.A. You wanted to take advantage of the zero.

J.T. Why, of course. It seemed the most obvious way to do it, to me. Another thing I remember very clearly is that I liked to do the puzzles which they had at that time in the newspaper. Like, you have 15 jars total and there are twice as many jars on the second shelf as on the first shelf, and one less on the third.

I remember that algebra was fabulous because here was a means to make these problems really simple. I really appreciate this need—having a pre-established desire to solve that type of problem made me much more motivated to learn how. I think that was part of the issue of what my elementary school called self-control. I was pretty obstreperous in class!

In ninth-grade algebra I kept asking, "Well, why can't you do it this way?" At one point my teacher said, "I tell you what. I'll give you an exam in calculus that I took when I was in the Navy. If you do well, I'll give you an A. If you don't do well, I'll give you an F. You have two choices. You can accept it and take this exam or shut up."

I chickened out and shut up.

A Excellent **C** Fair **F** Failure **B** Good **D** Poor	**SCHOLARSHIP GRADE**	A X
A Excellent **C** Fair **F** Failure **B** Good **D** Poor	**CITIZENSHIP GRADE**	D–
Scholarship and citizenship grades become a part of the permanent record of each student.	**CREDITS EARNED**	5

A+

Taylor's seventh grade teacher checked "Shows little respect for authority" and commented: "Pops firecrackers in my apt. and hangs out with a bad crowd—Probably is the ringleader!"

D.A. I have noticed in some meetings that you certainly question very fundamental assumptions.

J.T. One of my favorite bumper stickers is "Question Authority!"

D.A. How about later? Those high school years can be ferocious.

J.T. Something that made an impact on me in my mid-20s was meeting one of the women who had been really popular in high school. She had been class president, and here she was working as a teller in a bank. I had the feeling that her best years in life were probably over, and that mine were obviously still in front of me.

High school can be so tough! Kids shouldn't worry so much about the popularity thing—it's not that big a deal. Still, you feel it so much when you're in high school. It's a whole lot better to have lots of good years later instead of three good years in high school.

Mountains and Mount Holyoke

D.A. So, in high school obstreperous Jean Taylor was pushing the outer envelope. You clearly did very well throughout your high school years, because you went from there to Mt. Holyoke. How did you choose a women's college?

J.T. The only colleges I knew about in the East that accepted women at that time were the Seven Sisters. You could apply to three for the price of one, which sounded like a good deal. Mt. Holyoke had two lakes and a ski hill, so I put down Mt. Holyoke as my first choice.

The other place where I thought I really wanted to go was Stanford. I got my acceptance to Stanford, and I was all ready to send it in when I got a telegram from Mt. Holyoke saying that they had given me a Seven College Scholarship. I had never received a telegram in my life, and that really impressed me. They asked me to wire back, collect, and to keep it confidential!

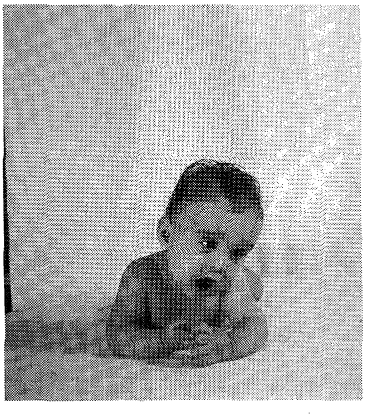
D.A. You were really a hot ticket.

J.T. Yes. Also my father was changing jobs at that point. Up until then, my father had been with a bank, and he decided to go into private practice. The family income plummeted for a year or so. I got scholarship offers that evened out the cost, so even with two trips back and forth across the country to Mt. Holyoke it wasn't going to be any more expensive than going to Stanford or to Berkeley.

D.A. So you really got to choose where you wanted to go.

J.T. Entirely. I had never been east of the Rocky Mountains, so I decided to go to Mt. Holyoke.

One thing that I have been impressed with since then is how well Mt. Holyoke has done in graduating women who go on to get Ph.D.s in science. I had no idea of this when I went there, but it was probably one of the best places I could possibly have gone. Just recently, I was looking at the absolute numbers of women who go on to get Ph.D.s in the physical sciences and mathematics. The top four schools



Mathematician-to-be Jean Taylor, resting on her tummy as an infant and later as a high school student.

were Harvard, M.I.T., Cornell, and Berkeley. Tied for fifth were Rutgers and Mt. Holyoke—a 1600-student women's college!

D.A. Can you recall any special reasons for choosing a women's college?

J.T. For me it was really odd because in high school my friends were almost all boys. There was a group of six boys and me that hung out together a lot. We ate lunch together, we all piled into a car to go off to football games together, etc. I did not have any really close friends who were girls. Most of the girls in high school didn't seem to be interested in the things I was interested in.

D.A. Which was what? Football games?

J.T. We went to all the football games and most of the basketball games. Some of the guys were interested in science things, but none of them were top-notch students.

D.A. So you were definitely interested in science at that point?

J.T. Oh, yes. There were four of us who tended to win most of the academic awards; I was the only girl. So it was very weird at Mt. Holyoke. I was surprised how hard it was not having boys as friends. Everything was set up in those horrible mixers! I remember showing up at Mt. Holyoke and looking at a blotter on my desk, with a schedule of some of the Ivy League football games. I said to myself, "Gee, it would be nice to go," and then as the semester progressed I realized that you had to find a boy and have a date to be able to go to those games.

The thing that rescued me was the Outing Club. I got involved in that at the end of the first semester. Otherwise, I would have been ready to transfer and come back to California.

D.A. I noticed that when you were at Berkeley, you were in hiking clubs.

J.T. Yes. But now my husband, Fred Almgren, doesn't have as strong a passion for mountains as I do. We have a cabin in the Sierras, near Lake Tahoe, that my parents built with another family. It's near Mt. Ralston, which I have climbed many times.

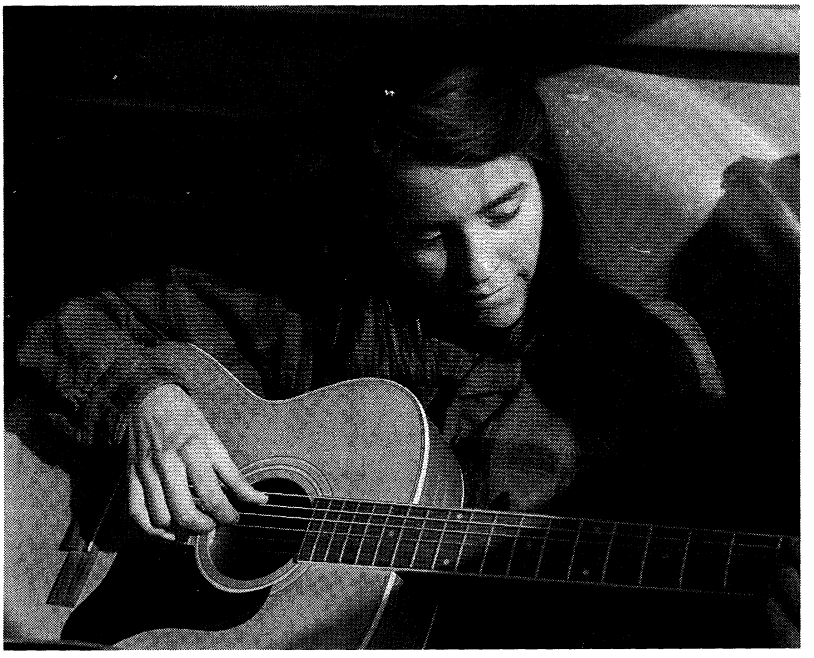
D.A. So you really love mountains.

J.T. Oh yes! I remember at one point in graduate school my boyfriend asked if I could be doing anything, what would I choose? I said I'd like to be hiking in the mountains. And he said, "I would like to be doing exactly what I'm doing now, working on mathematics."

Good Chemistry

D.A. How did you end up as a chemistry major at Holyoke?

J.T. The chemistry department was really exceptional. First of all, when I went there, the chemistry department said: "Based on your mathematics, you should skip the first year of chemistry and study qualitative analysis." And I had only had ordinary chemistry in high school! Although I had completed a semester of calculus in high school, the math department said, "Well, we're not sure your math is good enough for us." So they put me back in math.



College student Taylor in a pensive mood.

The chemistry department treated me more specially, which was good for my ego. And there was this dynamism that was just not there in mathematics. It was challenging and interesting. Anna Jane Harrison, who was the chair of the chemistry department, went on to be president of the American Chemical Society and the American Association for the Advancement of Science. She was a very forceful and intelligent woman. Another chemistry professor, whom I did a couple of honors projects with, was Lucy Pickett. She was really an exceptional person.

So in chemistry I had all those exciting things to do with these really spectacular people. I liked it.

D.A. What did you like best about chemistry?

J.T. My high school chemistry teacher had suggested I think about chemistry as a major, and I said, "I don't like labs." And he said, "Well, in college you'll take enough labs that you'll learn how to do it and you will enjoy it."

So there I was in qualitative analysis, where you have to work with samples. I extracted one thing after another, and while stirring things I managed to put the glass stirrer through the bottom of the test tube and got junk all over the top of the table. All I could do was look at the colors as one substance reacted with another. There was no hope of going back through that whole procedure again.

Next I took organic chemistry. At one point, the professor was coming through, and I started to talk to him. I knocked over a graduated cylinder, lunged for it, and knocked the whole apparatus over. Glass flew all over.

I was not very competent in any of these lab courses, so my chemistry professors eventually told me, "Look, there is this thing called theoretical chemistry, where you can get out of the lab." I thought that was the key.

Finally, in graduate school my advisor told me, "A chemist who can't do experiments is like a man who deliberately cuts off one of his hands." According to him, I needed both the experiment and the theory. So it seemed to me that my time when I could get out of the laboratory was receding into the far future.

D.A. Well, if it's any comfort a few other well-known mathematicians started in chemistry and gave it up for essentially the same reasons: the laboratory was just an absolute disaster area.

J.T. It's too bad, because chemistry is full of fascinating ideas. This whole business about the shapes of molecules and how they react is great stuff.

Berkeley Years

D.A. Despite your laboratory problems at Mt. Holyoke, you were elected to Phi Beta Kappa and graduated summa cum laude. Your chemistry grades must have been good enough to get you into graduate school at Berkeley, one of the best places in the country.

J.T. I didn't know what I wanted to do when I applied to graduate school. I applied to Harvard in biophysics, Berkeley in chemistry, and a bunch of different places, and I got in everywhere. But during my senior honors project on separation of the components of collagen, when I had to obtain the collagen by pulling out the tendons of frozen rats' tails, I decided that biophysics was a bit too messy for me. So I went to Berkeley in physical chemistry.

D.A. Back to the West Coast. Did you miss the West? Do you think that was a big factor in your decision?

J.T. No, I had also applied to Harvard in biophysics. I'd gotten more and more involved in mountain climbing and rock climbing when I was at Mt. Holyoke. I went rock climbing a lot in the Shawangunks, and those mountains could have kept me happy.

D.A. So you went to Cal, where the laboratory scene was not an improvement over Holyoke. Did your mathematical interests begin to emerge then?

J.T. Yes. I guess the best way to explain it is I got involved with the hiking club as soon as I got there, and a lot of the members were mathematics graduate students. I found myself hanging out with them, and they would suggest interesting classes for me. So I began auditing some mathematics classes.

D.A. While hiking you would end up talking about mathematics?

J.T. The math grad students were talking about it, and I listened. Mathematicians everywhere talk about math while roaming.

D.A. But you must have had a fair amount of training to appreciate what they were talking about.

J.T. Graduate students are always interested in passing on what they've learned to other people. I had had two years of calculus, one year of abstract algebra as an undergraduate, and I'd been told by the chemists at Holyoke that group theory would be good for chemistry. At Berkeley I first audited a course in algebraic topology. Then I audited one in differential geometry by Chern and it was fantastic. That did it!

The previous March I had passed my doctoral qualifying exams in chemistry, so I was just doing my thesis work. I found myself coming in every morning and not really wanting to get down to work. I'd read the newspaper for an hour, have coffee—it was obvious avoidance. I just wasn't enjoying chemistry.

Differential geometry, on the other hand, was full of beautiful ideas. So I talked to Chern about the possibility of switching to mathematics, and he encouraged me to do so. He also told me to take the final, even though I was only auditing the course. I did, and on the basis of that final he wrote me a letter of recommendation for being accepted into mathematics at Berkeley.

D.A. Berkeley was a wild place in the 1960s.

J.T. That's for sure! When I went off to college, I think I was still a Republican like my father. During my time at Mt. Holyoke I had been getting progressively liberalized, even radicalized. Then, at Berkeley, friends of mine were in teaching assistant strikes and stuff like that. I was involved a lot with anti-war demonstrations, even though I never worked harder in my life than I did that first semester in mathematics at Berkeley. It was terribly challenging.

D.A. Well, you didn't have a standard mathematics background for grad school.

J.T. I was behind. I read Rudin's book, and went back and reread linear algebra and Herstein's algebra, and tried to fill in the other things. So I did a fair amount of reading and was working hard. But there I was, suddenly in math graduate courses.

I took functional analysis and tried to do a problem on the mid-term—to prove that two norms were equivalent. I got a C, which was dreadful for me. When I talked to the teacher about it, I said, "Well, these are the words you're supposed to use, and I thought I was using those words." He looked at me and asked, "Do you really understand what it means for two norms to be equivalent?" I said, "No, I don't."

That was a real shock, to be in a hard, legitimate mathematics course. It was embarrassing! But somehow I managed to survive that chaotic quarter.

The next quarter, mathematics was more stable, but I was extremely unstable. My boyfriend John was writing me very nice letters from the IMPA [Instituto Matematica Pure e Aplicada] in Brazil. I was getting distraught at the political situation, and John wrote, "Why don't you come and join me in England? Get out of Berkeley and go to the University of Warwick and marry me." It was an appealing, romantic thing to do—so I did it. I dropped everything, and was on an airplane to England within a week. At Berkeley I arranged to take rapid finals in various courses to get credit. I left for England just before the end of the second quarter.

D.A. To Warwick, which was essentially a new university.

J.T. Green and peaceful.

Warwick and Princeton

D.A. So there you were in Warwick continuing to study mathematics.

J.T. Yes—and hiking, naturally. Mount Blanc and other lovely peaks.

D.A. The Alps? Color me envious.

J.T. My mountaineering was pretty much limited to expeditions in August and skiing in the middle of winter. I also did some hiking and climbing in Wales.

Taylor and her husband Fred Almgren on a backpacking trip in her beloved mountains.

John was worried about getting his draft notice while we were there. He figured he needed to be more in touch with things, so he wanted to come back to the United States. So after a year and a half in Warwick, John went to work at the Institute for Advanced Study. I applied to Princeton, the graduate school closest to the Institute.

D.A. Had you met Fred Almgren by that point?

J.T. The first time we met was in 1970 at the International Congress of Mathematicians in Nice, just when John and I were going to Princeton. His talk on geometric measure theory was wonderful! It was just the sort of thing I was interested in.

I spoke to him afterward, and he described a problem: There are three half-circles at 120 degrees and the surface of least area spanning them is three half-disks. Then if you move any one of the curves an arbitrarily small amount, it wasn't even known if the curve down the middle stays a finite length. It was very appealing to me.

D.A. So when you got to Princeton, you had a nice problem to work on.

J.T. Yes. By that time I had already had four years of graduate school: two in chemistry and two-thirds of a year in math at Berkeley, and one year at Warwick. I had passed two different sets of Ph.D. qualifying exams—in chemistry at Berkeley and in math at Warwick. I'd also studied for the one at Berkeley and intended to take it, except I left for England. So I figured I'd been a student long enough!

At Princeton, I put my blinders on and finished my thesis in two years. John had finished his two-year term at the Institute, so then both of us were looking for jobs. At the very beginning, M.I.T. offered John a position and me an instructorship. Stanford was going to split one job between us. And Santa Cruz was offering something like one and a half jobs for the two of us. All the negotiations seemed so complicated.

D.A. This was 1972? The market was really falling to pieces.

J.T. Yes. But we had those two independent job offers from M.I.T. I could appreciate all the efforts to accommodate spouses, but it certainly feels like you're being dealt with in a more straightforward manner when you get an independent offer.

Unfortunately, during that summer weaknesses in our marriage started showing up, and in the fall we split up. Later, we separated for good.

D.A. When you were a graduate student in mathematics, there were considerably fewer women in the field than today.

J.T. There were no women faculty at Princeton, that's for sure. Though among the graduate students that year there were actually a lot of us: Marjorie Stein, Marsha Simon, and two others.

D.A. Were other things not especially supportive of women in a graduate program?

J.T. I felt quite intimidated by the other graduate students. The common room conversation and things like that were not encouraging. But I just didn't pay a lot of attention to it. I'm really good at putting the blinders on. Furthermore, I was there only two years.

Putting the Blinders On

D.A. Tell me about putting the blinders on.

J.T. I can really put them on. For example, I can be reading and be so focused I simply don't hear people around me talking to me.

D.A. Well, those who have looked into the work habits of some famous scientists say that some had profound powers of concentration. Newton apparently could work on a problem single-mindedly, quite oblivious to most basic needs. He'd even forget to eat. It sounds as if you're very fortunate in having that power of concentration. It would be a great advantage in working on a tough problem.

J.T. My family doesn't necessarily think it's fortunate! I find it very distressing if I'm trying to focus on something and somebody wants to come up and talk to me. It takes me a long time to climb back out of what I'm focused on, and then a long time to get back into it. So I absolutely hate to be disturbed when I am really concentrating.

D.A. So how do you work?

J.T. I like to find chunks of time so I can really sink into a problem.

Visual Images

D.A. Do you deal primarily in visual images?

J.T. Oh yes! I have to. To really understand something I need pictures of it.

That's one of the reasons abstract algebra never appealed to me. Polynomials never had any good pictures to go with them. With some of these approaches to crystal growth, like the viscosity solution method, I can "see" it.

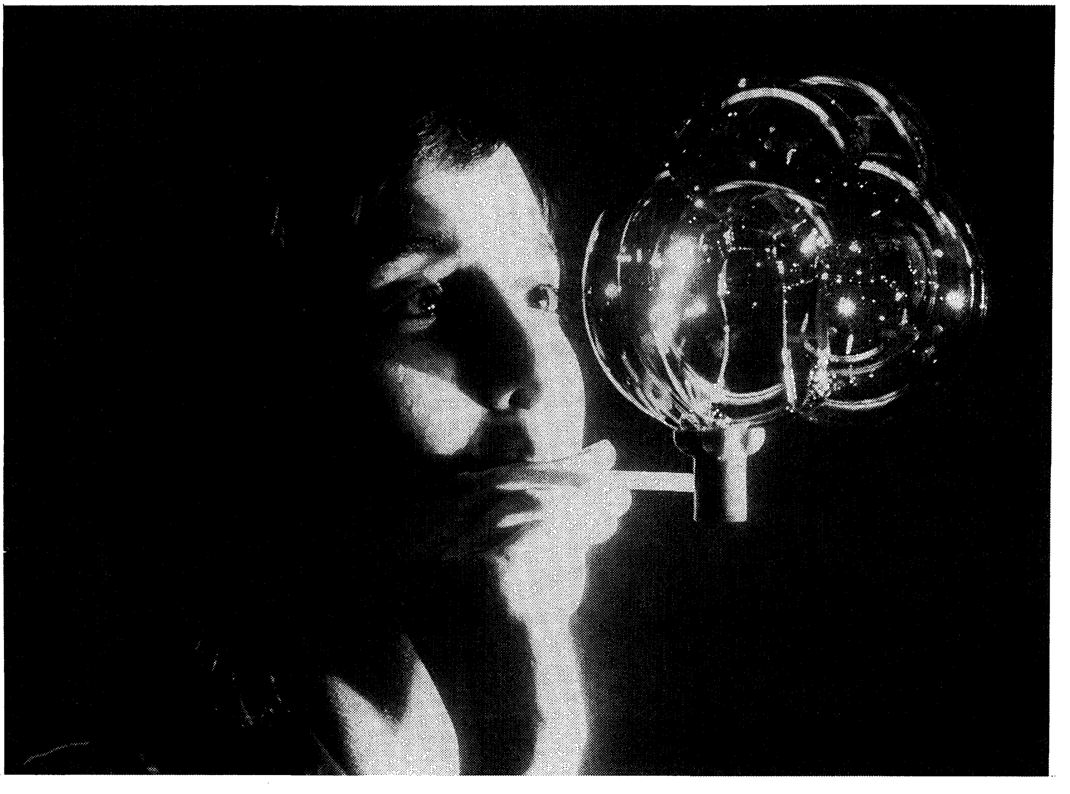
When people just write formulas on the board and prove things by manipulating the symbols, that does not appeal to me. It was very hard for me to get the feeling of what polynomials are all about. Only if I try to understand it in my own way can it move beyond just the symbols to the point where I really understand why it works.

D.A. Understanding in your "own way." When do you feel you really understand something?

J.T. When I know why it works. Not just the logical chain, but what's behind it.

D.A. Your work is tied closely to the physical world, so the "why it works" can take on an extra dimension for you. You can literally see some of this.

J.T. Yes, but there's a physical why and also a logical why. One of the things I really liked in my initial contact with differential geometry was having concepts like torsion which provide a language to describe physical properties of curves. I thought it was wonderful.



Bubble, bubble. Mathematician Jean Taylor loves bubbles, for they provide beautiful examples of minimal surfaces. She has done pathbreaking work in the mathematics of minimal surfaces and has extended her work to crystals.

If you have the language of curves without pictures of curves or mental images of curves, that won't do you any good. But to have the curves without the language is also no good. It's the interaction that makes the difference.

Experimental Math

D.A. In a recent article, "The Death of Proof,"[1] you are referred to as an "experimental mathematician." Did you accept that appellation?

J.T. Yes. I like what Steve Krantz wrote, that David Hoffman and I do experiments, but we also prove things. If you just do experiments without trying to give proofs, then you're missing some of the heart of mathematics. I absolutely agree with that. I do some experiments, maybe drawing little pictures on paper or manipulating images on the computer. I work from examples in order to understand.

All the current ideas about how you should teach certainly resonate with the way that I learned things, which is understanding the example as a motivation for ideas. Good examples can really embody the heart of the theorem. I do experiments, for sure. But I also try to prove that what I see is what you have to get.

D.A. As I look around the mathematical community, I don't see many mathematicians who are able to play with wire frames and soap solutions, or with crystals. There's something really pleasant, I think, about being able to look at a frame in a soap solution and see your theoretical results.

J.T. Yes, it is pleasant. On the other hand, I'm not sure that playing with soap films gave me any of the insights for my thesis or the work I did after that. Still, having seen soap bubbles for so long, maybe it was ingrained. I knew what the surfaces looked like. I didn't have to study them carefully. I don't recall ever having tested something as an aid to conjecturing.

D.A. But it started with bubbles, and you later hooked up with metallurgists. Where are you going to go next?

J.T. Well, there are still a lot of other interesting things out there in terms of the shapes that crystals make when they grow or shrink. About five years ago I was really wondering where to go next, and then I found myself in the middle of all this stuff involving crystal growth. I did not know much of anything about it. At the moment I'm co-authoring a couple of papers, and I'm way behind in doing my share. Right now, it's more a matter of how I'm going to get through doing all the things I'm supposed to do in the next few months!

What I've been looking at recently is surface diffusion on these new materials. I'm doing this with curves, which are much more easy than surfaces.

D.A. It doesn't sound like you're going to run out of problems too soon.

J.T. Not in the next year or two.

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[1] *Scientific American* 269:4 (October 1993) 92–103.

Good Problems

D.A. What's a good problem for you?

J.T. One of the most important things for me in choosing a problem is whether I can make a unique contribution. If it's something somebody else can do, and I'm just trying to race to do it faster, that's never had any particular appeal for me. I want something that's not too likely to get done unless I do it.

But it also has to have some geometric aspect. To do something without any mental pictures, I would find very difficult. I certainly like the connection with physical reality. That's very appealing.

One thing that surprised me that I enjoyed was some historical research. Someone had pointed out that the things I was talking about were like "zonohedra." I looked up Coxeter's definition of this strange term and found that his definition had an extra condition in it that I didn't want to be there. I checked to see where it came from and traced it to the Russian crystallographer Federov. So there I was, reading a German translation of a Russian article, trying to understand it with my somewhat incompetent German. And the extra condition wasn't there!

So I traced back in Coxeter's articles and found where early on he had overlooked something and said that this thing had that as a consequence. Then he started taking the consequence as part of the definition. From that experience I can understand why people enjoy historical research.

When I checked with Marjorie Senechal, she went back and read the original Russian and said "You're absolutely right. That's what Federov said." So the zonohedron originally meant what I wanted it to, but it had acquired this other meaning, and I couldn't have it back again.

Lots of Balls in the Air

D.A. Besides being a woman in mathematics with a very good research record, you have been the Vice-President of the AMS, you serve on a zillion committees and advisory boards, and your involvement is not likely to go down. In fact, the pressures are likely to increase. Why do you do it all? Does it feel good?

J.T. I've never done just one thing. In high school I was involved in a huge number of activities. When I got to college, out of the way of my family, I stopped going to church and I stopped playing the piano, after taking piano lessons for ten years. I just totally stopped all of the things that I had been doing. But I put other things in their places. On most weekends I was off rock climbing or mountain climbing or skiing, and I also was politically active. Ideas about how you can shape politics were very appealing to me.

What kicked in my political interest most solidly was the assassination of Jack Kennedy. That really had a big impact on me.

D.A. Do you remember what you were doing when you heard about Kennedy?

J.T. Of course. I was in the physics lab.

I've been interested in politics a lot for a long time. Between my junior and senior years in college I was invited to be an intern in Senator Cranston's office, although I chose a chemistry summer program at Mt. Holyoke instead. I went to the inauguration of Johnson and Humphrey in 1964, and in the inaugural parade I had a sign from a Humphrey rally I'd organized at Mt. Holyoke. Humphrey saw it and waved at me.

D.A. All of those activities sounds slightly daunting.

J.T. I don't think I've ever been single-minded in doing anything. Plus it's more interesting to have lots of balls in the air. Though sometimes they all seem to come raining down, and it seems a bit much.

D.A. You've got a lot of them in the air now.

J.T. Yes. I've also got two graduate students working with me now, and that's wonderful. One of them just proved her first theorem.

I have said no twice to being a candidate for department chair. And I said no to some other things. I don't want to be an editor of a journal, because I know that is something I would not be good at. If you send me papers, they will pile up in my office. So there are certain things that I do manage to say no to.

D.A. At age 50, you seem to be picking up steam. For a number of mathematicians at the half-century mark, it's often going the other way.

J.T. In some sense, that is a concern—whether my energy is going to stay at a high level. I always thought in high school and college that one reason I did particularly well is that I worked hard. I did try to manage my time reasonably well. It sometimes seems to me now that I get tired more easily. Maybe I'm not getting enough physical exercise. But lying around for a while can sometimes seem awfully nice!

D.A. Well, you seem to be accelerating.

J.T. Maybe. I like being involved in a lot of things. It's part of what keeps me energized. I probably would prove more things if I weren't involved in other activities, but I find my life more interesting if I am. If I were trying to maximize the numbers of papers I publish or the depths of the papers I publish, I would lead a different life than I do. This underscores something very different about Fred and me, because he is much more focused on doing his work than I am. It is not nearly as important to him to have other things to be involved in.

Gender Issues

D.A. What do you think women bring to mathematics that men don't?

J.T. One important thing anyone can bring to mathematics is the "right" to question authority. Just trying to look at things differently is actually where you get your insight. Some of the people who have made the big strides did not just take the received wisdom and accept the same modes of thought. Instead they asked, "What if you look at it this way?" If you come into a situation thinking about things in a way different from anybody else, that can be a plus.

To the extent that women are socialized differently, they can bring a different aspect and identify what questions are important to them. People talk about the male idea of dominating the environment. Women don't think about science that way and don't approach it that way.

Most of the women I know of who are good in mathematics are also good in a whole lot more things. The men who rise up in mathematics are often more focused on one thing, or maybe they can somehow afford to have one interest and be much more into doing mathematics. Take, for example, talks. I listen to lots of professional talks, and women give better talks. Women on the committees I have been on have worked much harder than the men—on the average. Maybe this is an aspect of our mothers making us more rounded than men.

D.A. Or perhaps women feel the pressure to perform well because they're "representing" women in mathematics.

J.T. It does seem to me that the women I know in mathematics have a greater richness than the men I know. I'm not talking about all men or all women, of course.

D.A. Two years ago we did a survey of the entire MAA membership and about 10 percent responded. It was very apparent that on average, by several different criteria, women seemed to focus more on teaching and students than did men.

J.T. I think that's true. It has always seemed to me that there is something exceptional about the general performance that women put forth in mathematics. A lot of weeding out goes on, and perhaps it is only women with relatively strong personalities who manage to stick with mathematics and research, and they can handle lots of things. If you haven't got high energy levels, you are much less likely to make it. And therefore you're interested in education, in many things.

D.A. Do you think male faculty members, when considering a woman candidate, still engage in some of the old rationales? Saying, "Well, we know that she's just going to go off and have babies and not really be an active mathematician." Is gender still a big factor?

J.T. I think it is. On the other hand, this is a blinders issue. I don't think it does any good for younger people to stay focused on that. It just takes up energy that is better spent elsewhere.

D.A. For a time consciousness was high, but there's a danger that it will fall back.

J.T. Well, have you seen Beth Ruskai's statistics on participation of women at AMS sessions? Notice the number of sessions with zero women—even one that was organized by women had zero women. Thirteen organized by men had zero women. I posted the statistics on my office door and somebody came along and wrote "Good job!" Somebody else had written up in the corner, "I'd rather be shopping."

Role Modeling

D.A. Your name is all over the place these days and, like it or not, you have become a role model for a lot of younger women who may be aspiring to careers in the mathematical sciences. You may not have done that by design, but it's a fact.

J.T. When I think of some of my women professors in college, intentionally or not they had effects on me and served as models.

D.A. I know that you are brought into contact with women students who are thinking about careers. What do you tell them? What's your advice to women who are thinking about serious work in the mathematical sciences?

J.T. The key is finding out what really turns them on. You listen and try to see what makes their eyes light up. And then you encourage them to do what they want to do.

Sometimes I advise them that having blinders is not a bad idea, but simultaneously I try to convince them that you don't have to have blinders.

I strongly emphasize that they should do what they want to do. Today, students also are concerned about finding jobs. My hope is that they also become aware of how mathematics ties to other subjects and that the current talk about interdisciplinary work will not be all just talk.

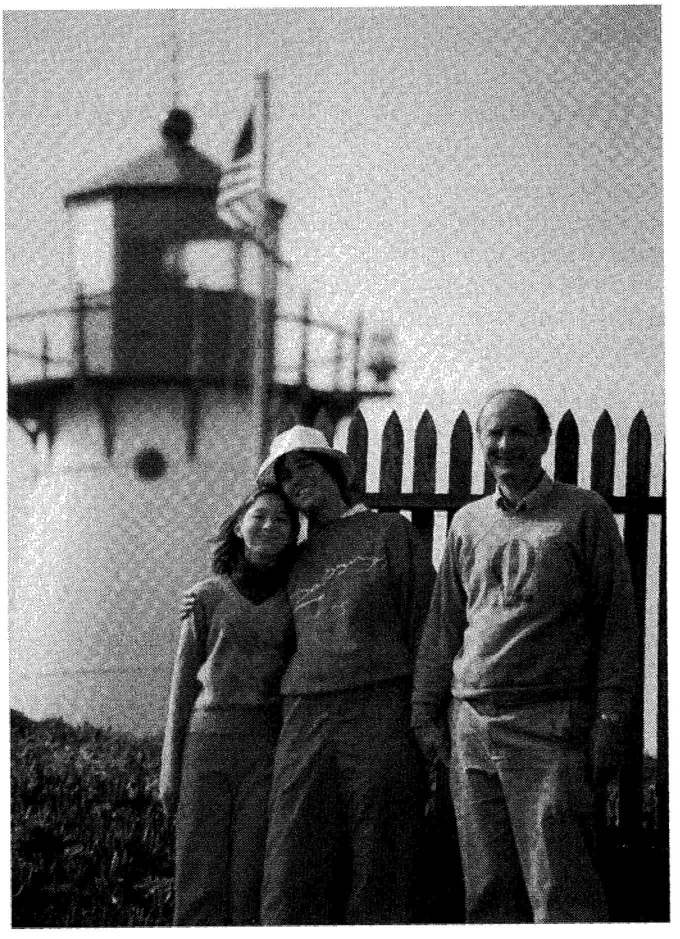
D.A. I have the impression that you are not too bullish on mathematics education these days.

J.T. I'm enthusiastic about trying to teach. I wish the students were as enthusiastic in return! There are some students in almost every class for whom I seem to make a major difference. And that makes a big difference to me. I have students from ten years ago who still write back on occasion.

D.A. So you really like teaching.

J.T. Yes. But I could strangle those students who refuse to learn.

D.A. What is your explanation for that kind of behavior?



Taylor in 1987 with her husband Fred Almgren and daughter Karen, who calls mathematics "the family business."

J.T. I really don't know. For some students there is just nothing that I do that makes a difference.

D.A. We haven't talked much about your children, yet.

J.T. The importance of my kids, including my stepchildren, to my life has been huge. A big part of the pleasure in my life is having children. Maybe women are not supposed to talk about that, but it's a real good thing for me.

I'm very proud of all my children. My stepdaughter Ann and I hiked the John Muir trail together, and she is an utterly delightful hiking companion. It can be quite an experience to spend three weeks with one person.

D.A. I understand that your teenage daughter took complex analysis at Princeton last semester, while still in high school.

J.T. Karen is a smart kid! Absolute straight A's in high school. At age 16, she was taking abstract algebra at Princeton. I can hardly believe that my own daughter likes abstract algebra! She jokes about mathematics being the family business. I'm absolutely astonished at this child Fred and I produced.

Unexpected Results

D.A. You've done many things, and not just in the mathematical sciences. What do you feel best about?

J.T. Well, I remember one spectacular rock-climbing day in Yosemite with Greg Schaefer. In one day we climbed Church Tower and both Cathedral Spires—the three big climbs. That was a definite high point!

Then there have been various times of getting wise, figuring out some mathematical things. Sometimes they were not entirely positive experiences; what I expected did not turn out to be the case.

D.A. You mean you got a particular result and it was different from what you had guessed? Is that a little discomforting?

J.T. Well, it shows that my assessment of the situation was missing something. It says: *"Look, kid, you were wrong."* On the other hand, it's also very exciting!