Eleven

Fern Hunt

Claudia Henrion

If you ask mathematicians why they went into mathematics, you will often hear something like "It was fun; I was good at it; it seemed like a natural thing to do." But for a black woman born in 1948, there was nothing natural about going into mathematics; indeed, not a single black American woman received a PhD in mathematics until 1958. So for Fern Hunt, who later became a professor at Howard University and who is now a senior researcher at the National Institute of Standards and Technology, pursuing mathematics meant beginning a journey through unmapped territory. It was hard work, for as Hunt said, "I was no one's fair-haired boy."

For the most part, Hunt did not receive encouragement from the usual sources: early teachers (with one notable exception), peers, or role models. How, then, did she decide to pursue mathematics, and what enabled her to achieve a successful life as a mathematician?

For Hunt, commitments to research and teaching have been intimately intertwined. Teaching gave her the opportunity to convey to her students that life is much more than "what you own, the car you drive, and where you live." She tried to share the deep excitement of an intellectual life. At the same time, even with a demanding teaching load at Howard University, it was important to her to continue her research in mathematical biology and applied mathematics. In 1993 Hunt accepted a full-time position at the Applied Computation and Mathematics Division of the National Institute of Standards and Technology. There she works on mathematical problems that arise in research on the physics and chemistry of materials important to U.S. industry. She continues to have contact with undergraduate students by lecturing at colleges and universities and working with summer students.

Fern Hunt's experiences in first predominantly white or mixed schools and then later at a predominantly black university shed light on the advantages and disadvantages of each of these environments.

Growing Up

Fern grew up in a housing project in the middle of Manhattan, not far from Lincoln Center. It was not long after World War II,

and there was a great deal of idealism about these housing projects. They were well cared for at the time; trees and shrubs were planted throughout the project, creating a haven in the middle of the city. Her father was a postal employee, and her mother went back to work when Fern was seven, as a transcribing typist for the Welfare Department. Being in a predominantly black environment created a kind of buffer from discrimination.

From the start, Fern was very independent. She was essentially an only child for seven years, until her younger sister was born. She describes herself as "a difficult kid who resented being told what to do. I was a little spoiled, probably ... and I was not

Figure 11.1 Six-year old Fern after a piano lesson.

a terrifically outgoing person." At first she didn't care much for school and was more absorbed with emotional and personal issues than with doing well in her classes. But at the age of seven, she changed her attitude when she realized that she was in a "slow" reading group. That, she decided, was unacceptable. At the time there was a tracking system in the public schools of New York City, which began as early as second grade.

> It seemed to me that I could do better than this ["slow" reading-group placement]. I was comparing myself with people in the group and already knew more than they did. It just seemed to me that they were going very slowly. So at that point I started making some extra effort. Bit by bit [I worked my way up], jumping two or three groups. I started slightly below normal in reading, and ended up reading a grade or two above by the end of the year.

From this early age, she was well aware of the inequities in the public school system. Although the schools she attended were integrated, the lower-level tracks were predominantly black, and the upper tracks were predominantly white. It was the upper-level classes that had the best teachers and offered the best education. Seeing this, Hunt became motivated to do well both in her classes and on standardized exams in order to ensure that she received the highest-quality education available.

But even getting into these top classes did not erase the different treatment she received because of her skin color. Most of her teachers were white. "This often meant that some of the smaller-minded ones tended not to pay very much attention to you. You didn't get very much encouragement at all." So she made a point of doing so well academically that it was difficult to ignore her. Not until junior high school did she have a teacher whom she liked, a woman mathematics teacher, Freida Denamark, of whom she says, "She treated me with respect. I think she liked me. And that was definitely different." Building up a student's self-esteem was not a focus of most teachers at that time, "and even if they did, people tended to build up the self-esteem of people of the same color." Although Hunt was a bright student, most teachers did not try to encourage or really connect with her.

At this early stage of her life, Hunt was much more interested in subjects she learned on her own than those she learned in school. What first excited her about science was the books she read and a Gilbert chemistry set that her mother gave her when she was recovering from an appendix operation. She was nine years old. "This was a fantastic thing for me because I would just play around and do these experiments. It's kind of strange because if you look at the cover of the chemistry set—I had the junior level—it showed two boys working. I realized that it might be a difficult career [for me], but I thought I'd worry about that later."

A mathematical spark was not lit until much later, when she started learning algebra rather than arithmetic. In elementary school, "mathematics was a subject that I hated. Arithmetic was not very interesting. I always had difficulty with bodies of knowledge made up of arbitrary rules, and that is what math seemed like." But later, when she was thirteen

or fourteen and began to develop an aesthetic sense for art and music, she also began to appreciate mathematics.

Algebra—"Things Fit Together"

> I began to get more of an aesthetic sense of mathematics when I started doing algebra. I think I did so well because it was a body of knowledge where things fit together. There was some structure, and that fit with my sense and appreciation of structures. It wasn't arbitrary pieces of facts, higgledy-piggledy, but some kind of inherent relationships between facts. That began to change my attitude toward mathematics. But I still didn't see myself as a mathematician because the people around me who were good at math were boys—and white.

Throughout Hunt's early life, the images and messages that surrounded her consistently implied that she would not fit in as a mathematician or a scientist—both because she was female and because she was black. How then, did Hunt come to believe that she *could* be a mathematician?

In ninth grade, Hunt finally had a black teacher, Charles Wilson. That changed her life. He was a science teacher with a master's degree in chemistry from Columbia University.

Hunt: It was really a lucky thing—a chemist with an excellent education and a first-rate mind. He was the existence proof that a career in science for a black person was possible. I badly needed that at that age. He had a wonderful laboratory stocked with all kinds of things, from fetal pigs to electrical motors to Bunsen burners and chromatography tubes. He knew chemistry, physics, and biology, including biochemistry, and would help me and other students with setting up our science fair projects. Mr. Wilson used the Socratic method in his teaching, which was difficult for us at times, but in the end it taught me how to think like a scientist. He was the right person at the right time, and so he had a very profound effect on my life.

MP: *Would he talk to you, also, about going on in science?*

Hunt: Oh, yes. I told him my interests and ambitions. He did two very important things. The first was to tell me about the Saturday program which was available through Columbia University for kids interested in studying science. In fact, this program led to my decision to become a mathematician. The second was that he encouraged me to apply to Bronx High School of Science. If you could point to a single person who had a major influence on me, it would be Charles Wilson.

Bronx High School of Science

Hunt was indeed accepted to the very selective Bronx High School of Science. But to her disappointment, it was not the intellectually stimulating environment she had hoped for. Bronx Science was a large school with three thousand students and a male-to-female ratio

of two to one. Most of the students in Hunt's classes were a year or two younger than she was. As she remembers it, the atmosphere was immature and repressive—there was a lock on everything, and monitors were everywhere. Competition was the norm. Alhough the students were quite bright, most were primarily focused on getting into Ivy League colleges and high-paying professions. Few, she felt, were "genuinely interested in ideas." And the few teachers who made an impression on her were not in mathematics or science but rather in French and history. "The key thing is not so much subject area as much as the kind of teaching approach you take with students who are going to deal with ideas in their adult careers. A teacher should foster curiosity and intellectual energy. That's a rare commodity, and young people who have it need to see examples of adults who have not lost this quality but have used it to lead a satisfying life."

Although she found high school, in general, socially and politically isolating, Hunt was able to piece together a community of her own. She made friends with students in the book club, and outside of school her friends came from the Saturday Science Program and her church.

The Saturday Science Program at Columbia University that her teacher Charles Wilson had told her about provided the stimulation and scientific training that would influence the rest of her life. She began by taking two science courses, including one in astronomy. It was only when she ran out of science courses that she reluctantly agreed to take mathematics. "It didn't sound very interesting, but I did it anyway. That is definitely when I changed my basic interest from chemistry to mathematics." She discovered that she loved abstract mathematics as she learned about groups and fields—a passion that she kept alive by reading mathematics books on her own throughout high school. These included the New Mathematical Library series that the Mathematical Association of America put out for high school and early college-level audiences—books such as *Continued Fractions, Numbers: Rational and Irrational,* and *Geometric Inequalities.*

During this period, Hunt read not only about mathematics but also about biology. She was excited by Mendel's genetics work on peas, and these ideas planted the seeds that later came to fruition in her research in mathematical biology. But at that point in her life, Hunt had no idea that she would end up as a mathematician; she simply could not envision herself in that role. "At that point I never really thought about what being a mathematician would be like—it was not something that I thought would be at all viable. Part of the reason was that somehow I got the idea that it was a rarefied kind of profession—that you had to be either wealthy or very, very smart, smarter than I was. . . . I really didn't see it as something that I could be doing on a day-to-day basis."

Although she could not yet imagine herself as a mathematician, Hunt *was* able to imagine being an electronics engineer. She persuaded her mother to buy electrical kits so that she could do some experiments at home, most of which ended up short-circuiting the house.

What, then, did finally enable Hunt to envision herself as a mathematician, to imagine that she could participate in this "rarefied

kind of profession"? She remembers exactly what changed her mind. It was a booklet put out by the National Council of Teachers of Mathematics that had pictures and short biographies of several mathematicians, one of whom was Cathleen Morawetz, a mathematician at the Courant Institute, whom Hunt later met when she began graduate school at NYU. It was seeing a woman that made Hunt think that maybe it was possible to be a mathematician after all. Admittedly, she still had never seen or heard of any *black* mathematicians, but she was going to school during a period of great social change; in those days anything seemed possible.

College—Bryn Mawr

There was never a question in Hunt or her family's minds that she would go to college, but Hunt was not sure where to apply. So she sought advice from the Negro College Fund, which provided both career and college counseling. Hunt was given a list of possibilities, including many Ivy League schools, but she was most interested in the Seven Sisters colleges. She wanted to go to an all-women's college, but not one that was more like a finishing school than an academic institution. "I knew that I would have to go to the most academically demanding place because that is where I would get the best education." She chose Bryn Mawr because she was told that it was the most rigorous of the women's colleges.

Bryn Mawr was a total contrast to her high school. Where Bryn Mawr had fifteen hundred students (undergraduate *and* graduate students), Bronx Science had one thousand in her senior class alone. Bryn Mawr was all women, whereas Bronx Science not only was coed but was about two-thirds men. The graceful collegiate architecture and spacious campus of Bryn Mawr were strikingly different from the newly built modern architecture of her high school. She welcomed the new environment and was excited about starting college.

But her undergraduate years proved to be a mixed experience.

Hunt: There were things that were very positive about the college. There were a lot of very smart people; I learned a great deal from the other students. I learned about anthropology, psychology, things that normally I wouldn't have learned about at all had I gone to a large university. I probably wouldn't have known enough to have taken those courses, and I wouldn't have met the people who would take them. Going to a large university would have been like my high school experience; I would have continued in a certain groove. But as it was, in the setting of a small college, I encountered people who had very different interests and who were coming from a different social class and background. So that was very positive. I did a great deal of reading when I was in college—general reading. I wasn't that good a student.

MP: *They didn't reform you until graduate school.*

Hunt: That's right! I did work at my math courses, especially in the second half of my college career. I was very serious about that.

But about my other subjects, I have to admit I was not as good as I should have been.

Although the diversity of experiences was new and exciting, Hunt also experienced a sense of social isolation through much of her college years. It is hard for her to disentangle how much of that came from being black in a predominantly white institution and how much came from being less affluent than many of her classmates. But there was another big issue as well.

> I think the biggest source of my unhappiness was the basic philosophy of the faculty at that time—their attitude was that if you had a question you wanted to investigate, you should find out what everybody else who had investigated that question said. Although I agreed, I thought it was important to start out fresh and see what *you* think first and then consult other people's work. I felt out of sync with the faculty.

Creativity

This independent streak and the tendency to run counter to the prevalent attitudes in her formal education are recurring themes in Hunt's life. She was influenced early on by a little book about creativity and science by A. D. Moore, whose thesis was that "creativity is one of the most important attributes that a scientist can have, and that sometimes education can really work at cross-purposes to developing a kind of freshness and independence of mind." As Hunt goes on to say, "I felt that the faculty were promoting something that was quite the opposite. So I was rebelling against them."

How did this rebellion manifest itself in mathematics? "I tried to be a little bit unusual and inventive in terms of solutions to problems and things like that. I was always trying to look for the unexpected. I think most of the time I was simply wrong." The professors acknowledged, however, that while her approach was often not the most efficient one, it did display creativity.

Hunt learned quickly that a creative spirit necessarily entailed a willingness to be wrong. This has always been, and continues to be, an enormous challenge for her. "Willingness to look bad, to be wrong, is very difficult. . . . Things would have happened a lot faster had I been more confident about that. It took a very, very long time, and I'm definitely better than I was, but I still have reticence. You can't really make good things happen unless you make a certain number of mistakes. And you might as well go through them right away."

Hunt goes on to say that it can be particularly difficult for black people in the intellectual sphere because "if you make a mistake, then some people are likely to say, 'Well, that just goes to prove how stupid "they" are.' That's unendurable. Nobody wants to add to the stereotype."

What allowed Hunt to break through that barrier of fear of failure?

> I think that my desire to become a mathematician—well, my desire to do research, something worthwhile in some sense—overcame (eventually) whatever reluctance I had. I never knew at any

point before the end that I would indeed get a PhD. There never was a time when I thought, This is it! It's all downhill! Until the very, very end. But I knew that if I did not risk trying, it would be certain that I would not get a PhD or become a mathematician. So it was always balancing on the one hand the certainty of failure if I did not risk, against the uncertainty of success if I did risk. So I took the uncertainty.

Thinking about a Career in Mathematics

During her undergraduate years, Hunt read a book by Richard Bellman about the impact of computers on mathematics in biology. It had a formative influence on her later choices.

> The advent of computing made it possible to look at models of biological systems and analyze them. This was a new field, and he made clear it was a good field for people going into research because there were lots of problems, some unsolved for hundreds of years. There was room for people of all abilities to make contributions, so I took this to heart. I don't think I did anything about it immediately as an undergraduate, but it must have started me thinking. Eventually I did work on mathematical biology.

Throughout college, Hunt wanted to pursue a career in mathematics, but she had "grave doubts" about whether she was "really good enough to do that." So she wrote a letter to one of her professors in the mathematics department, Marguerite Lehr, an algebraic geometer and someone who Hunt felt was "an outstanding mathematician." In the letter Hunt wrote about her interest in mathematics and some ideas she had for research. She also wrote about her doubts in her own ability. The woman responded with a warm letter saying that Hunt *should* continue and that she was encouraged by the specific ideas for research that Hunt had mentioned. The professor said, "It's often the curiosity that one has about mathematics that is a sign that you have what it takes."

This was the encouragement and inspiration that Hunt needed to pursue a career in mathematics. She could have simply applied to graduate programs and assumed that if she got in, she was qualified to pursue mathematics. But what she needed was the personal encouragement of someone she admired and respected to bolster her confidence. This pattern of doubt and encouragement does not occur just once in a mathematician's life—it is a cycle that continues throughout one's career: during college, graduate school, thesis work, finding a job, getting tenure, and so on. Encouragement and support are needed at all of these stages for both men and women. But for women, and especially black women, these do not come easily.

Graduate School

Hunt's choice of graduate school was influenced very much by one of her professors at Bryn Mawr, Martin Avery Snyder, who had just graduated from New York University. He said it was a good place and that she

Figure 11.2 Hunt as a graduate student on vacation.

could get a scholarship to go there. Although she thought about other graduate schools, including Yale, she did not know anyone who had been there, and she worried about her chances of getting in. The Courant Institute of New York University, therefore, seemed like a natural choice.

Her experiences at Courant were again mixed; there were some wonderful aspects of the program, but her path was neither easy nor fluid. Although she received her master's degree, she also received a B instead of the required A on the qualifying exam and as a result lost her fellowship and her office. At the end of her second year, she left the university. She worked for a while until she was ready to return, at which point she received a fellowship from NYU, which enabled her to finish her course work and begin her dissertation. She received an office again, and she began working as a lecturer at NYU.

Graduate school was the first time Hunt really began to feel a sense of camaraderie with her fellow students. The faculty were focused primarily on their own research and did not spend a lot of time interacting with students. As a result, the graduate students banded together and formed a culture of their own. Hunt describes it as a "very jolly and supportive" atmosphere. Students regularly worked together, particularly in preparing for exams. They would take practice exams with each other, pretending to be the committee of examiners. Even after many of Hunt's peers had graduated, they would come back to be together. Although most of the graduate students were men, there was a critical mass of women that was sufficiently large to contribute to the positive atmosphere for women. A number of her peers became lifelong friends, mentors, and future collaborators.

One important source of support for Hunt during her graduate years was an organization of black graduate students called the New York Mathematics Society, later renamed the Baobab Society. It was formed to create a sense of community among budding black mathematicians who were spread out all over New York City. They met regularly for many years, holding seminars in which they would talk to each other about their research or bringing in other black mathematicians to talk to the group. An important function of the group was to support each other, "to be a sounding board for students, talk about mutual difficulties, and advise each other, especially those who were doing their theses. There were many friendships born then which have more or less sustained themselves."

A Support Network

Graduate school is a critical period in the development of a mathematician. This is

where one forms a community that will be crucial throughout one's professional life, and this community plays a powerful role in shaping one's sense of self as a mathematician. Having this kind of community is an important source of support and camaraderie and yet is often so taken for granted that it becomes invisible. But for women, particularly women of color, such a sense of camaraderie and community is not as easily formed. When Hunt found it both among her fellow graduate students and in the New York Mathematics Society for black mathematicians, she had a support network that could help her through the obstacles and difficulties one inevitably faces as a graduate student. And although there were excellent teachers at NYU, it was really the student community that she learned the most from and that defined her experience there.

Having such a community made it much easier for Hunt to imagine herself as a mathematician. She was no longer alone: as a woman, as an African American, as a young struggling mathematician. The connections she formed through these graduate student communities helped her to find a thesis advisor and a job when she graduated and helped to establish her research affiliation with the National Institutes of Health.

One of Hunt's fellow students heard her talk about her interest in mathematical biology, and it was he who put her in touch with the man who became her advisor, Frank Hoppensteadt. Hunt describes her advisor as an unusual person because he is a mathematician and at the same time is very interested in science. Both his style and his interests dovetailed well with Hunt's needs.

> He had confidence in me. And he was a strong and good enough person to say so. He didn't say it often, but he said it. It's what I probably needed to hear. I came to him with a lot of skills. I think I was twenty-seven years old when I started working with him, so I was a little older with a lot of math under my belt, so I wasn't green in that sense. Even so, he somehow seemed to be able to pace me. He knew how much to give me and how much I could do, but he did not baby me. He didn't give me any breaks when it comes right down to it. He gave me a chance, and he expected me to perform, and he said I was capable of doing it and capable of pursuing a career in mathematics. He treated me like a professional, a fellow professional.

She had found an advisor, but the process of writing a dissertation was quite challenging. She was working on difficult problems, and there were very few people working in the field of mathematical biology to turn to for help. Fortunately her advisor had a good sense of how to keep her going. If she got stuck on a problem for too long, for example, he would redirect her toward a new problem, so that she would stay mathematically active. But in her last year of graduate school, a different kind of obstacle arose. Her advisor left NYU and went to the University of Utah—not a place many black people would have chosen to attend. Nonetheless, she did follow him out there for a year to complete her thesis, taking a position in the mathematics department. To her surprise, it was a comfortable and pleasant place to be. Piecing together her

solutions to problems her advisor had given her, she finished her thesis midway through the year, and came back to NYU to defend it over Christmas—a major hurdle conquered.

Howard University

While Hunt was at NYU a man named Jim Donaldson came as a postdoctoral visitor. He was the chair of the mathematics department at Howard University, and he invited her to come visit Howard, which she did. It was a good visit, and he said she should look them up when she was ready for a job. That is exactly what she did, and they hired her immediately.

Hunt did not learn until much later that other universities were interested in her as well. Later, these schools said they did not understand why she had not applied, but she was given no indication that there was any reason to apply to them. Hunt believes that in order for affirmative action to work, schools must take a more active role in seeking out women and minorities and encouraging them to apply for jobs, just as Jim Donaldson did to lure her to Howard. At the time, there was nothing obvious or natural about applying to a host of unknown schools.

As it turned out, being at Howard was good for Hunt in many ways, especially because of the tremendous support from Donaldson.

> After I finished my dissertation, I had some surgery, which should have been fairly routine, but the upshot of it was that I was allergic to the anesthetic, and I got toxic hepatitis. The stress of finishing the dissertation and the illness was like fighting and squeezing my way out of a very narrow, tight opening. It left me tired and a little uncertain about the future and whether I would be able to do any research. I did start working again, but it was Jim who always had a high opinion of me, and I appreciated that. He would say, "Don't worry; you'll find a problem and you'll do it!" He just took that for granted.

And indeed, Hunt has managed to continue to be productive in her research even with a fairly heavy teaching load at Howard. She had leaves to pursue research at the National Institutes of Health and later at the

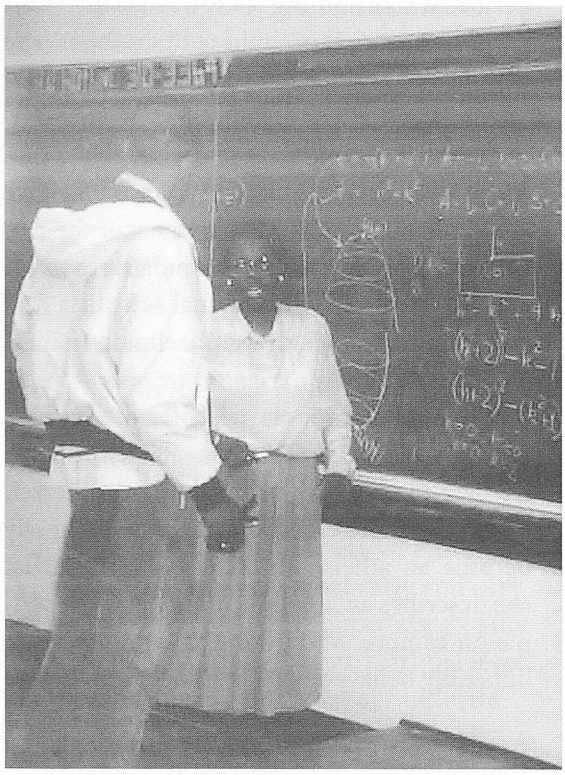

Figure 11.3 Hunt with a student after teaching a class at Howard University.

National Institute of Standards and Technology. She attributes her productivity both to the fact that she has very few family demands and to the fact that she has had so much encouragement in her research from people such as Jim Donaldson, Adeniran Adeboye, Tepper Gill, Gerald Chachere, and many others on the faculty at Howard University.

The Role of Religion

Like every mathematician, Hunt has her good periods and her discouraging periods. Mathematics can be hard, time-consuming, and frustrating. "Sometimes I go through long periods where nothing really works out." What keeps her going during these times is her love of mathematics and her religious faith.

Many scientists who have a spiritual dimension to their lives are reluctant to talk about it publicly because modern-day science is usually pitted against religion as if the two were contradictory. This is a relatively modern view, and many individual scientists find the blending of science and religion natural and important.

Although Hunt was raised as a Christian and actively participated in church, during her late high school years she found herself becoming more disillusioned, and she finally became an atheist. In college she met what she describes as "a couple of the very few people on campus who not only went to church but really believed."

> They didn't proselytize, and in fact you had to know them well before you figured out they did go to church. They were full of jokes and puns—they were quite irreverent and at times mischievous. They gracefully blended these qualities with courage and integrity. I thought this was so odd; I knew very few people like this. Since I found the whole subject of religion to be embarrassing and beneath notice, I tried at first to overlook this weakness in them. But they were good friends to me and I really liked them, so after a while I started thinking.

Then the summer of her sophomore year, Hunt had an experience that fundamentally changed her life. With the help of the dean of the college, she was offered a summer job as an engineering assistant in New London, Connecticut. The dean tried to set up housing for Hunt, but it fell through. So when she arrived in New London, she tried to find housing on her own. But no one would rent her a place to live because of her skin color. It was the first time she had encountered such overt and direct discrimination. She was eighteen years old.

Hunt: It was not subtle and it sort of sent me reeling. I got pretty close to the edge then. I was by myself. My folks were in New York. There wasn't anybody I could go to. Somehow I needed help to survive this. It was shattering. For the first time, I understood that religious faith can sustain you. It is the real ground on which we stand—not our family and not our friends, however much they love us. I wish there were less painful ways of finding this out. As it was, I am grateful that I was "brought up short" on this issue early in life. After many years, I can say that the most important gift that religious

faith has given me is gratitude for being created the way I was. Perhaps I wouldn't have been happier, and I almost certainly wouldn't have been a better person, had I been born with qualities that some view as more "acceptable."

MP: *Did you know that discrimination existed when you were growing up in New York City?*

Hunt: Oh, yes, I knew that discrimination was around, and I saw it, but I never understood the extent of it. At home, I could always go back and tell my family about it. I had this matrix of support. During high school you saw discrimination, but also, at that time in New York City, there were still lots of people of good will who were committed to integration of some kind, and the social fabric had not yet pulled apart, and the economic conditions had not worsened to the point where there was really overt racism. In some parts of New York City, things were bad, but you just avoided those places. In a completely new environment, though, I had no guideposts—college, after all, had been rather tolerant. Now there was nobody I could go to, and I couldn't find a place to live.

MP: *Total isolation.*

Hunt: Yes, totally isolated. I was living in a place where no one would speak to me. I was it. My choices were to turn around and go back on the train or to survive. And I couldn't go home. Maybe that was sort of foolish, but I felt I couldn't go back to New York. I needed the money and this job.

MP: *So you stayed?*

Hunt: Yes. And I eventually got acceptable housing. I think I called the NAACP, and they referred me to somebody. I think that's eventually how it worked itself out. But even at work the people weren't terribly forward. I have a fairly thick skin; that, plus being at home, always provided this cushion, but suddenly it was just stripped.

MP: *When you later experienced discrimination, was it less difficult because you had already been through that?*

Hunt: I learned to take a long view. A couple of decades down the road, these things are going to seem trivial. You have to think about the end of your life. If you sum up your life, what do you want to say? When the curtain comes down, what do you want the review to be? So several things helped me: I took a longer view, I had inspirational resources, and I also have a very stubborn personality that says, Well, I'll show them!

For Hunt, dealing with doubt and uncertainty was an integral part of her life. It brought together questions of who she was as a person and as a mathematician.

> The crisis of youth is the crisis of self-definition. Even in a society where an individual's role is defined early and very clearly, there is still the uncertainty of not knowing at a fundamental, spiritual level why we are here and what our ultimate purpose in life is. In a society as fluid as ours—where small differences in our choices can have large consequences—the

question of definition is that much sharper. Problems of race and gender discrimination posed challenges to who I was at a fundamental level. I was forced to search for answers at that level. I think this happens to anyone who has experienced suffering over a long period of time.

Given how important religious faith is in Hunt's life, how does she blend her mathematics and religion? How does she reconcile what some see as contradictory enterprises? For Hunt, the belief in realities beyond our concrete physical world is what unites the mathematical and spiritual components of her life.

> As a mathematician you are dealing with abstract structures, and the kinds of things that impressed me most were not really visible. So as a mathematician it is easier to believe that the kinds of concrete things that we deal with every day do not constitute all of reality; there are realities that are not immediately perceptible by us. That's the basic difference between someone who is some kind of a theist and somebody who is not: the belief that reality is just far wider than simple physical laws, economic and political laws, or relationships that we see.

Lessons Learned from Teaching

Hunt was motivated to teach by a desire to convey to the next generation life lessons and inspiration. "I have learned some things. I've read a lot. I have insights. I would like for the next generation to know about them. As a human being, there really isn't any better purpose for anything you do than to try to give other people the benefit of what you've learned, so that it's a little bit easier for them to advance. Teaching gives me an opportunity to do that."

In giving talks at a variety of schools around the country. Hunt always finds ways to describe how interesting mathematics can be. Often the students ask questions like "What is it like to be a scientist?" Hunt responds: "I tell them that it brings me a great deal of personal satisfaction. Many people feel a lack of direction that comes from not having a strong vocation or a sense of calling to do something. Income, position, being able to support a family at a high level can be motivation for a career." But for Hunt, there is a very deep level of satisfaction in a life of the mind. For this reason she tries to convey that mathematics is about "how to deal with ideas and put together ideas that have some structure and to have an appreciation for them. The world is bigger than what job you have, your income, what car you're driving, or where you live—that's something you try to hold out to people of all ages, but especially younger people."

Three Life Lessons

There are three life lessons in particular that she hopes to convey. The first is about gaining confidence. "I would like to convey to students a little more confidence in themselves

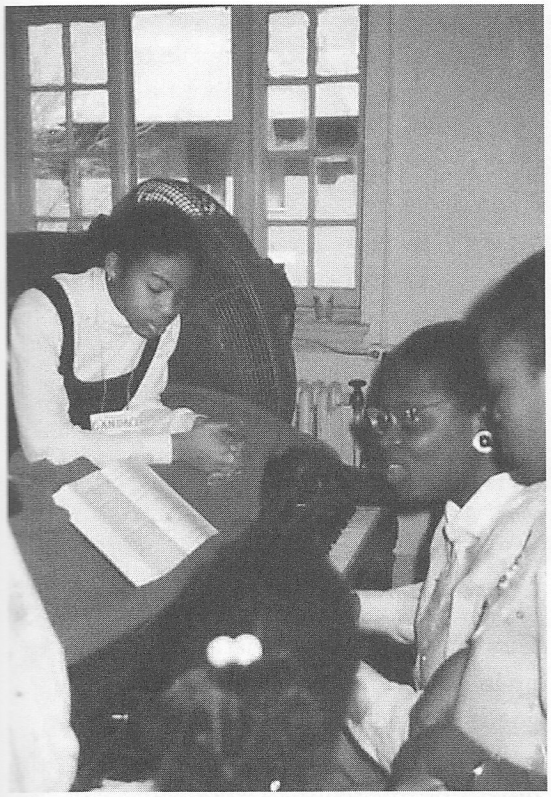

Figure 11.4 Hunt working with students.

and their ability to be able to deal with difficult problems, to know that, at least to some extent, some sense of self-mastery is to be gained by studying."

Second, she hopes to communicate the pleasure of intellectual activity. It's really quite a great life that way. It involves "coming up with the unexpected, enjoying challenges, and having a feeling and appreciation for structure." She goes on to say, "It shouldn't just be left to artists. It's something that other people should have, in particular mathematicians."

The third lesson she tries to impart is that blacks can and should do mathematics. But in order for a teacher to convey that to students, the teacher has to believe in them. She cites the Helen Keller story to illustrate that "in order to be able to teach a person, you have to take them seriously. You can't have contempt for them."

In general, she says, "I hope to convey a certain amount of independence of mind. That is the single most important thing, that when I'm not there, they will be able to approach a problem and be able to think about it. It's a habit of mind, to be able to think about a problem, come up with a hypothesis, and be able to move toward a solution." She tries to communicate how mathematics is not in some distant world, but rather "pops up right in front of you." But the problems are disguised, so you have to recognize them in order to work on them. Otherwise "you're helpless in that situation."

Encouraging More Women and Minorities in Mathematics

Hunt believes strongly in making the field more inclusive—that one's sex, race, or class should not prevent one from studying or pursuing mathematics. She uses an analogy to basketball to emphasize that there are many levels of talent.

> Math is a lot like sports. There is a lot of talent and many kinds of talent. Take basketball as an analogy. We all appreciate players like Larry Bird, Bill Russell, Bill Walton, as well as Nate (Tiny) Archibald or Isiah Thomas. They have

(had) very different abilities and styles of play. Yet they were all marvelous players. So the pool of talent is broad. And when you consider Patrick Ewing, Magic Johnson, Julius (Dr. J) Erving, and finally Michael Jordan, you also see an almost infinite depth of talent. There is probably a broad consensus that Jordan is the greatest player the game has produced, but does anyone think that diminishes the contributions of Julius Erving? Would Jordan have achieved as much without the help of the less talented Scottie Pippen? Mathematics is like that. No matter how good you actually are, there is definitely somebody who can run rings around you. If you encounter these people, it can be intimidating. This, with the fact that mathematics is a field that a lot of people have trouble with, causes a great deal of anxiety both within and outside the profession. I think we should minimize it by trying to be a little more inclusive, by trying to look for the talent people *have*, rather than dismissing them for the talent they lack.

Encouragement is crucial in developing mathematical talent. Hunt gives an example of a student in one of her courses who was doing nothing; the highest grade he got on an exam was a 70. But she noticed that he was going in regularly to see one of her colleagues. Her colleague said, "Yeah, he's a lazy guy, but he is bright" and therefore was giving him some hard problems to work on on his own. The student was in fact doing very well on them, so Hunt decided to follow suit and had the student do an independent project. Not only did this engage him in that work, it improved his participation and performance in class as well.

Hunt: It's important especially when you're trying to increase the pool of so-called underachievers [to find ways to encourage them]. There are a lot of reasons for poor performance. There are more reasons for poor performance than there are for good performance. It makes things much, much more complex.

MP: *Like they might just be unwilling to speak up in class or . . .*

Hunt: Yes, or they feel that they can't speak up in class. It may be that they don't have good study habits or that they don't know how to work with other students or that other students refuse to work with them. There could be other reasons, subtle and difficult ones having to do with personal issues like lack of maturity or family conflicts.

Even in her own undergraduate institution, Hunt was disturbed by the attitude of the mathematics department, which focused only on those few students who were going on to become research mathematicians and ignored the rest. She sees the same phenomenon in graduate programs that turn away talented graduates of small liberal-arts schools because their background is not as comprehensive as that of students coming from large, prestigious universities.

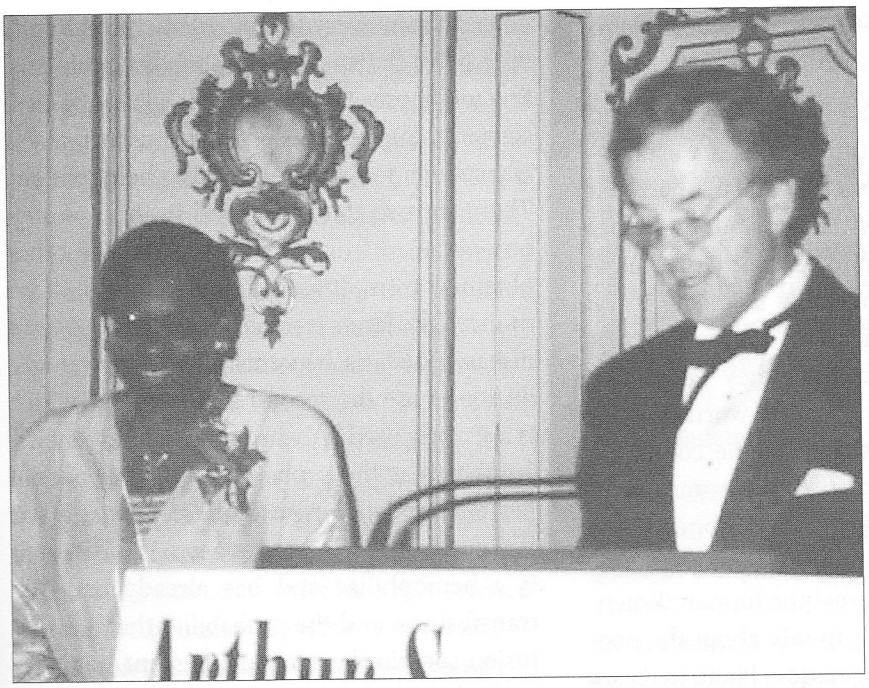

Figure 11.5 Hunt receiving the Arthur S. Fleming Award for Outstanding Achievement in Science in 2000.

This is especially disturbing because some of the small liberal-arts schools have produced a disproportionately large number of female scientists. If top graduate programs close their doors to these students, they are turning away a significant pool of potential women and minority scientists.

Ultimately, Hunt believes that the most important quality for success in mathematics is intellectual curiosity. Clearly a small school cannot offer the range of courses a university offers, but Hunt believes that "if a major can graduate with a solid understanding of advanced calculus and abstract algebra, I think you've got a very good product there, and I think that is somebody you can definitely work with." She argues that various mechanisms or programs could be developed to ease the transition of students from four-year colleges to graduate programs.

In summary, Hunt says, "Our methods don't pick up every possible aspect of the kinds of talents that could potentially be useful. And it's for that reason that we should be more inclusive. Our tools for discerning talent are blunt and imperfect."

Recommendations

Hunt has many ideas for ways to make mathematics more enticing for women and minorities. The following is a list of general ideas that can be incorporated into a classroom, followed by a list of more specific techniques for encouraging women and minorities.

Present Mathematics as a Human Endeavor

Hunt argues that "mathematics history is not taught at all, and I think that's a mistake—math history was something that I had read in high school, and without a doubt it helped me make the decision to become a mathematician." She talks about how inspiring it was to read about the lives of mathematicians: "It makes the kinds of work they were doing exciting—something really worth aspiring to. By being presented in the context of its history, the subject matter becomes more human, thereby making it more appealing to a wider range of students."

A second way to reveal the human dimension of mathematics is to talk about the people behind the mathematics. Hunt makes a point of talking about David Blackwell, who developed some of the material they covered in her classes, when he also was chairman of the mathematics department at Howard for ten years. Since he is black, she thinks it is especially important for the students to hear more about him than his name.

A third way to present mathematics as a human activity is to try to convey the interconnections between a society and mathematics. This is a topic that Hunt finds fascinating and continues to learn about. When we spoke, for example, she had recently been reading about the French Revolution and how important it was in the development of mathematics and technology in France.

Use Real-Life Examples

Because Hunt often teaches probability and statistics, she tries to find examples that could emerge from everyday life. Medicine abounds with basic statistics and probability problems. She might present, for example, a hypothetical scenario. Suppose a doctor decides to give a transfusion to a patient who is a hemophiliac. There are two pools of blood in this country, one obtained from volunteers, and the other obtained from those who donate blood for money. The latter is much more likely to have diseases such as hepatitis. The doctor might decide to use the second blood supply, which is normally used only in extreme emergencies, arguing that the probability that the patient has already been exposed to hepatitis is 100 percent for the following reason: If the patient is a hemophiliac and has already had 100 transfusions, and the probability that a transfusion contains hepatitis is 1 percent, he might multiply 100×0.01 and get a probability of 1, that is, a 100 percent likelihood that the patient has already been exposed to hepatitis. But this would be a drastic miscalculation. The real probability is 1 – [0.99 to the 100th power] = 63 percent. This kind of mathematical understanding is critical to medicine as well as many other types of professions, including law and business. Whenever possible, therefore, Hunt talks about her own work, why it is important, and how it relates to the real world.

Ultimately Hunt sees mathematics as a deeply human activity that gives us a broader vision of ourselves and helps us find meaning in our lives. At the same time, she sees it as a luxury that must be appreciated and passed along, or it could be lost. As she so eloquently states,

> The point is that as soon as there was enough to eat and the environment was

relatively stable, humans were involved in mathematical activity. But this kind of broad vision of mathematics is important in order to secure its future. There is nothing that says that mathematics ought to continue as a cultural activity. Indeed, there are many arts and crafts that have been lost as the civilizations that invented them declined. The first six books of Euclid's *Elements* were lost in the fire at the Alexandria library—a significant blow to the development of mathematics. It would be terrible to think of something like that happening now, but it could. It is better to invest in as many people as possible—to convey the idea that science and mathematics elevate the mind and the spirit and that they are something that people will always need. Somehow that's not being transmitted. Somehow we're letting our machines, our greed, and our own spiritual emptiness devour everything. So the enterprises of teaching and research in mathematics—whether in academia or out—spreading the knowledge we gain to as many as possible are not only noble activities, they are also the conservative thing to do.

The specific techniques Hunt uses to create an atmosphere of inclusivity in the classroom include the following:

Extensive Use of Questions

Most of Hunt's classes involve a kind of call-and-response pattern. She makes a point of always starting with simple questions to get the students initially engaged. Once they feel comfortable thinking and talking out loud, they are more willing to try ideas they are less sure of and are more willing to be wrong in class. If the answer is even remotely right, she tries to work with it.

Since the males in her classes tend to speak more and have more confidence, she makes an extra effort to involve women and hear what they have to say. She finds that this little bit of extra attention is quite effective in drawing women out.

Encouragement

Hunt believes that the most important thing of all is to encourage students. Everything else pales in comparison. This is especially important with any student who expresses interest in mathematics; and since some may express it in very quiet ways, it involves paying careful attention. For example, a student might attend math club meetings but never speak up, or may be very attentive in class but shy about answering questions. So how does one encourage such students? According to Hunt, "I think the most important thing would be to gradually, without pouncing, try to gain their confidence."

> People love to be flattered. Don't become unrealistic. But flatter them. Compliment them. Because I can assure you that if you're a white male faculty member, you probably are not really aware of the extent to which black students are not complimented. Complimenting encourages. Don't be extravagant to the point that it's ridiculous, but be encouraging. If you can, gain that student's confidence. Try to take a genuine interest; people will see that, and they will open up a little

bit. This may seem intrusive, but will be appreciated.

Role Models

It was not unusual for Hunt's students to tell her how much they appreciated having a female black instructor. At the time of the interview, she was the only African American woman in the department—despite the fact that Howard University is a predominantly black institution! Hunt was written up in a brochure that was used in an exhibit in a Chicago museum. From this she has gotten

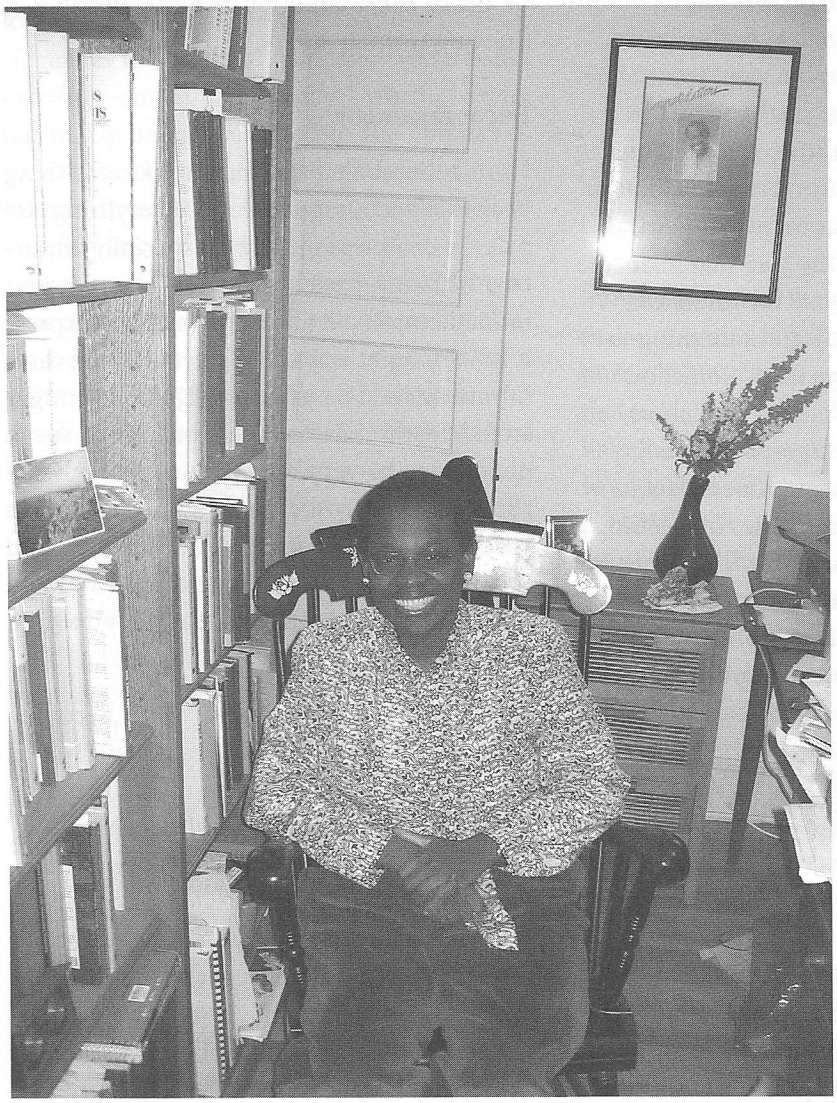

Figure 11.6 Hunt in her home office.

numerous letters from students who were interested in mathematics and had never seen or heard of a black woman in mathematics; they were hungry for a role model.

Some people object to the idea of a role model because they think that each person is unique, and no one can be a role model for anyone else. But a role model, more than anything else, simply opens doors of possibility. As we see in Fern Hunt's case, for women or minority students who have never seen a mathematician of their gender, race, or ethnic background, it can be crucial to find such a model of possibility.

Education in Black and White

Race has obviously been an important factor in Hunt's education and development. How has this influenced her thoughts about the advantages and disadvantages of predominantly black schools versus predominantly white institutions?

MP: *If you had children, would you advise them to go to a predominantly black college?*

Hunt: Not necessarily. A lot would depend on the personality of the student. There was a point, when I was teaching at Howard, when I would say that they should definitely try to get into Dartmouth College, for example. At that time there wasn't the racial exclusion that there had been in previous years. The majority of colleges were integrated. They were admitting students of all colors and actively seeking black students. I advised students at that time to try to go to majority colleges, especially with their previous experience of being in predominantly black schools. You need to meet other kinds of people; I felt that was very good and very healthy. We need to do that as a society, we need to get out of our collective ghettos. However, in recent years there has been a growing intolerance, and I have met some of the students who have transferred from majority colleges to Howard. There is a terrific economic anxiety among white students right now, and some of them seem to be taking it out on black students on these campuses.

I also find that sometimes black students are forming little cliques on the majority campuses. So the situation is very complex. I no longer hold the unequivocal position that yes, you should definitely go to the majority, or yes, you should definitely go to a black college; there are pluses and minuses with both choices. It would depend very much on the individual.

In the end, Hunt says, there is no clear answer to this difficult question. It depends entirely on the particular student, his or her interest and personality, and the particular institutions in question.

Clearly Fern Hunt is just one person, with one set of experiences. But her story illustrates some of the ways that being a woman and being black influence one's mathematical development. Being black affected Hunt's experience at Bryn Mawr, which, while all female, was a predominantly white institution; it influenced the positions that opened to her when she completed her PhD; and it

influenced her experiences with her students at Howard, a predominantly black institution.

At the same time, certain lessons emerge that are universal—most notably that support and community are critical factors in achieving success. This is a lesson that has influenced Hunt's style in teaching. It also suggests one direction for improvement in making mathematics a more inclusive endeavor.

Postscript: On page 211, in the reference to the "loss" of the first six books of Euclid, many details in the complicated tale are left out. Readers interested in a fuller account of the history of versions of Euclid available at various times in history may wish to consult Florion Cajori's *History of Mathematics, Fifth Revised Edition*.