AMS Congressional Briefing: Mathematical Transcriptions of the Real World

Capitol Hill may seem an unlikely setting for a lecture on mathematics, but on March 5 an AMS briefing entitled "Mathematical Transcriptions of the Real World" attracted an audience of about seventy-five people, a good-sized crowd for such an event. In attendance were mostly Congressional staffers, scientific society representatives, and program directors from federal funding agencies. Most notable was the appearance of two Congressional representatives, James Sensenbrenner (R-Wisconsin), and Vernon Ehlers, (R-Michigan). Sensenbrenner is chair and Ehlers is a member of the House Committee on Science.

This was the first time ever that a briefing focused exclusively on mathematics was presented to Congress, which typically has dozens of these events going on every week. Often the briefings are attended only by Congressional staff, not the members of Congress themselves, so it was quite a coup that the AMS managed to bring in two. Sensenbrenner left after making a few remarks, but Ehlers, the only member of Congress ever to hold a Ph.D. in physics, stayed for most of the hour-and-a-half affair.

The featured speaker at the event was Ronald Coifman of Yale University, who discussed the use of mathematics in data transmission, analysis, and interpretation. His talk followed brief remarks by Andrew Wiles of Princeton University, who was proclaimed by the event's emcee, AMS president Arthur Jaffe, as the "most famous mathematician in the world." Jaffe was clearly thrilled at the success of the event as well as by the prominent role the AMS played in a press conference on science funding, held the day before (see accompanying article on page 588 of this issue of the *Notices*). "Mathematics is having a greater influence in the political arena than ever before," he said.

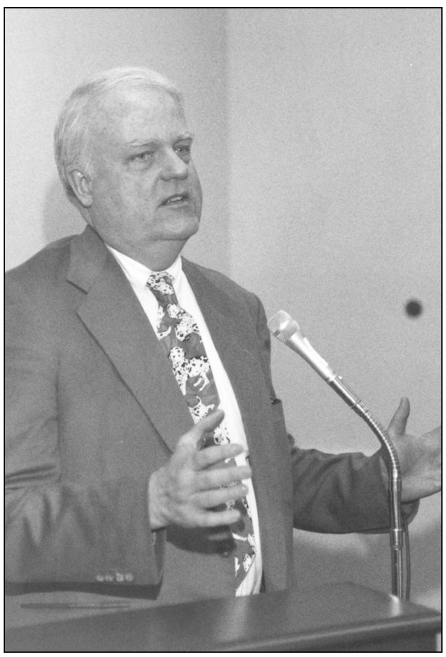
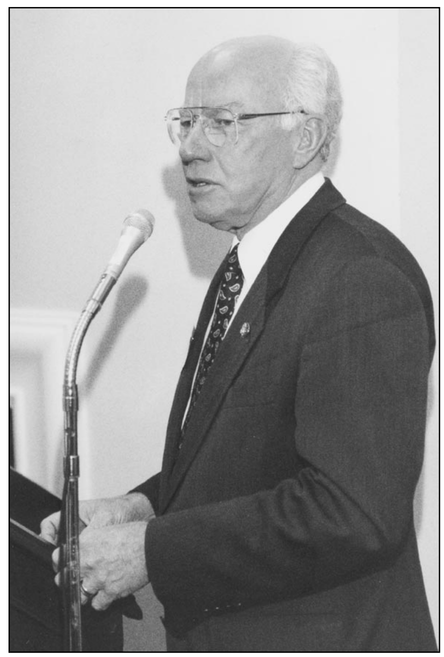
In contrast to the press conference, which was explicitly intended to influence government policies, the briefing was purely educational, an attempt on the part of the AMS to convey something of the utility and importance of mathematical research. Afterward there was talk that some Congressional staffers had grumbled that they did not have time to sit through a lecture that had no clear connection to specific policy issues they were working on. But James Turner, who is on the staff of the House Committee on Science (and who, he confessed, was a mathematics major), did not see the need for such an explicit connection. In fact, he had encouraged the AMS to focus on mathematics, rather than try to pursue a policy agenda. "Most people here don't realize how mathematical research affects their lives," he pointed out, "so this was an excellent lecture to have." He also noted that many Congressional staffers did not realize that the developments Coifman discussed "relate to government funding that their bosses voted on."

From Brahms to Oil Exploration

One of the most striking stories from Coifman's talk was an application to music. Brahms, who died in 1897, made a wax cylinder recording of himself playing the piano. The recording was later transferred to 78 rpm disks, but unfortunately the sound was so garbled that it was impossible to tell even which piece was being played. Coifman took the sound from the 78s, digitized it, and worked with musicians to tease the music out of the signal. The musicians were then able to identify the piece and even get an understanding of how had Brahms played it.

This example captured the main theme of Coifman's talk: How do you extract from a mass of data the features that are important? The talk was replete with examples from an impressive variety of areas. Oil companies suffered from data overload in offshore oil explorations. The acoustic data they gathered was so extensive that it could not be processed right away; it had to be loaded onto magnetic tapes, put on a helicopter, and flown back to the mainland for processing. And even then the processing would take a few months. Now mathematical techniques allow them to scoop out of the river of data just the features they need, as little as 1 percent of the data. The amount of data is so much less that not only can it be transmitted by satellite to a processing facility, it can also be processed immediately to guide the ships then and there to where they need to go.



Speaking at AMS Congressional briefing: clockwise from top left, Andrew Wiles, Ronald Coifman, Vernon Ehlers, and James Sensenbrenner.

To give the audience a flavor of how wavelets work, Coifman described the difference between how a piece of music is encoded on a CD and how it is encoded on a score. On a CD every second of music is divided into 40,000 segments, and a sample is taken for every segment. "That's a complete disgrace, in the sense that it means that you are putting together 40K numbers for a piece of music that takes 1 second," Coifman noted. If musicians operated in that fashion, "they would never be able to describe anything." In contrast, a musical score provides a score for each instrument, with information about which notes are played when, at what pitch, for how long, etc. Wavelets provide an analogous way of representing data, be it audio, visual, or electromagnetic.

If we are in a digital age, Coifman said, it is a very "naive" digital age. He compared today's methods of data representation to ancient methods of representing numbers. Those methods were inefficient and did not allow for computations that people needed to do, such as division and taking square roots. It was only when decimal notation was developed that it was possible to automatize such computations. "In some sense we are exactly at that age now," he said. "We have enormous amounts of data, we have very powerful computers—or so we think—and they just don't do what we expect them to do, because we are a little bit naive about how we present and manipulate the data." With examples from music to mammograms, Coifman demonstrated how mathematics works behind the scenes in many aspects of daily life.

Ronald Coifman (left) and Andrew Wiles.

Left to right, Samuel M. Rankin, Andrew Wiles, Arthur Jaffe.

Planning for the briefing began back in October of last year in conversations between Jaffe, Turner, and Samuel M. Rankin of the AMS Washington Office. In addition to the AMS, a number of other scientific societies sponsored the briefing, including the American Chemical Society, the American Physical Society, the Society for Industrial and Applied Mathematics, and the Mathematical Association of America. According to Jaffe, the plan is for a regular series of briefings on a variety of scientific and engineering topics, organized by the other societies, with another one on mathematics in perhaps a year.

Certainly the strains on federal spending on science are part of the motivation behind these efforts. It is not clear how deeply mathematicians will wade into the intensely political waters surrounding questions of federal spending. But briefings like this one, in which mathematicians speak with passion and grace about the subject they love, seems a perfectly natural venue.

—Allyn Jackson

Remarks by Andrew Wiles

What follows is an excerpt from comments made by Andrew Wiles during the briefing.

"From the earliest times, mathematics has been pursued in two ways. It's been pursued because of its use, because that was how you plotted the course of the stars so that you could navigate, that was how you measured angles so that you could build, that was how you weighed and measured so that commerce could be undertaken. But at the same time, at least as far as recorded history goes, there have been people who pursued mathematics for its own sake, for the sake of mathematics. And I confess I started out that way and I've stayed that way, from the age of about ten, when I first came across the Fermat problem in a book in a public library. I've been hooked on mathematical problems as intellectual challenges. However, we don't have to worry that it won't be used. Mathematics—even the most pure-seeming mathematics, the most abstruse mathematics that we thought would never be used—is now used every time you use your credit card, every time you use your computer. It's used to preserve secrecy, to transmit data, and as you'll see later, to recover data that you thought you'd lost.

"Perhaps another thing to say about mathematics in this respect is that it's a bit like discovering oil. The people who discovered oil were not the people who were actually designing the motor cars to use it. But mathematics has one great advantage over oil, in that no one has yet—and physicists will show you they never will—found a way that you can keep on using the same oil forever. However, mathematics is never lost, it is always used. And it will always be used, the same mathematics; once it's discovered and understood, it will be used forever. It's a tremendous resource in that respect, and it's not one that we should neglect to develop."