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Perfect Violin: Does Artistry Or Physics Hold Secret?

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CAMBRIDGE, Mass.— RENOWNED acoustic physicists, master violin makers and the Tokyo String Quartet gathered here last week, ostensibly to seek agreement on how to go about making a great fiddle. To no one's surprise they failed utterly, but in so doing they produced magnificent music and some modest but intriguing scientific insights.

The eclectic science of acoustics investigates the atmospheres of stars, the mysteries of hearing, the technology of detecting secret nuclear tests, the extent of global climate change, the architecture of boiler factories and concert halls, the quantum-mechanical behavior of ultracold liquids and countless other weighty subjects. But whatever its focus, acoustic science is about sound. Perhaps for that reason, its practitioners

tend to be music lovers, many of them amateur musicians. Meetings of the Acoustical Society of America generally offer some great music to leaven the avalanche of technical and scientific papers that sometimes threatens to bury participants.

True to form, this year's concert, at the Massachusetts Institute of Technology's Kresge Auditorium, blended serious music with some experiments.

The first half of the concert consisted of a preference test, in which the audience was asked to compare fragments of the same compositions as played by different sets of instruments. At the beginning of the intermission, the startled audience was asked to remain seated without talking or coughing. Acoustical engineers set up microphones, clapped their hands and blasted the auditorium with an ear-splitting noise generator to measure how effectively several thousand human bodies could absorb sound from a

reverberating concert hall, a question that has long puzzled acousticians. Thanks partly to a cooperative audience, that question may now have a detailed answer.

In a more agreeable experiment at the opening of the concert, the Tokyo String Quartet, with Peter Oundjian, first violin; Kikuei Ikeda, second violin; Kazuhide Isomura, viola, and Sadao Harada, cello, played snatches of chamber works by Beethoven and Puccini on four sets of instruments, three of them made by modern

American luthiers and the fourth by old Italian masters (including a 1590 viola made by Luigi Mariani). The audience members were asked if they could distinguish the old instruments from the new ones by their sounds, and most listeners correctly identified the performance played by the priceless Italian instruments. Many, however, liked the sounds of the modern violins, violas and cellos, several of which seemed tonally richer, better acoustically balanced and distinctly louder than their Renaissance counterparts.

In fact, members of the Tokyo Quartet told Dr. Herman Medwin, the ocean acoustics specialist who organized the concert meeting, that they had a few misgivings about the modern instruments. The musicians said they lacked confidence in the ability of the modern stringed instruments to sustain superb sound quality when played pianissimo.

Whatever the case, the Tokyo Quartet devoted the second half of the concert to a memorable performance of Debussy's Quartet in G minor using the old instruments. The abrupt tempo transitions and rapid shifts in the

tonal coloration of the piece require perfectly coordinated interpretation, and the Tokyo Quartet played with virtuoso precision. Pianissimo passages in the work brought out the superb quality of even the softest tones produced by the Italian violins, viola and cello.

"Every instrument has its own complex overtones, and a player must learn to compensate and control them," said Dr. Medwin, who is an amateur violinist. "A group of musicians like this quartet must constantly make tiny adjustments in bowing and fingering to blend overtones harmoniously and avoid almost imperceptible but artistically significant clashes between overtones. "Understanding what goes on in the string quartet musician's brain during a performance is one of the greatest challenges to researchers in psychoacoustics," Dr. Medwin added.

The program included a discussion among the Tokyo players, the American makers of the modern instruments that were demonstrated and the audience. Contrasting philosophies of violin making were discussed.

Robert and Deena Spear, a husband and wife whose instruments were among those played at the concert, are both well-known makers of concert violins, but each has a different approach. "I take what I call a homeopathic approach, concentrating on tiny changes in a violin that have big effects," Mrs. Spear said. "Bob concentrates on the larger issues, such as overall violin design and loudness." Vital to Mrs. Spear's work is a careful analysis of the vibration modes of each violin, not only the instrument's wooden sound box but also the air inside it. "I match the modal frequency of the wood with that of the air inside it to get the best results," she said. Mystery of Violin-Making

Mr. Spear said that some of the instruments he and his wife make consist partly of wood from the sugar maple tree, which was once considered unsuitable for stringed instruments. (The traditional violin woods are spruce and curly maple.)

"The trouble is," he said, "most of the wood used by traditional European violin makers came from forests that are rapidly dying out because of pollution. Substitutes are needed. And at the same time, concert violinists increasingly want more volume, more sound. We've found that we can get what they want from sugar maple."

The Spears acknowledged a debt to Carleen Maley Hutchins, the 82-year-old doyenne of American violin makers, who taught Mrs. Spear violin acoustics. Mrs. Hutchins attended the concert, lent the performers a quartet of her own instruments and commented on the science of violin-making.

Mrs. Hutchins began studying acoustics when she was a school teacher, eventually becoming a leading expert in the acoustics of stringed instruments by testing her mathematical and physical ideas on her own creations. Her articles on the physics of violins have appeared in Scientific American over the years.

Mrs. Hutchins has tried to deflate the mystery and mythology of violin making, which she believes to be mere flim-flam helping to drive up the prices of fiddles made by Stradivari, Giuseppe Guarneri and other 18th-century giants of the craft whose workshops were concentrated in the Italian town of Cremona. She has little patience for theories like the one that maintains that Stradivari's secret formula for violin varnish can never be duplicated. (It was recently suggested by an expert that Stradivari added powdered pumice from Mount Vesuvius to stiffen his varnish.)

Mrs. Hutchins believes that with scientific analysis and attention to the principles of physics, modern luthiers will make even better fiddles than those of the Italian masters, which are slowly wearing out and being consigned to museums. Science Versus Artistic Intuition

Her research, which uses accelerometers and other scientific equipment to test resonances, vibration modes and various acoustic factors, has resulted in discoveries that some experts regard as milestones in the evolution of the violin.

Some other master violin makers argue that science is a poor substitute for the fingers, ears and eyes of a master luthier, who must have the intuition of a true artist. The argument between adherents of the two camps is never-ending.

One of Mrs. Hutchins's discoveries is that there is an ideal relationship between the first mode of vibration of the top plate of a violin and the second mode of vibration of the air inside the violin. If the frequencies of these two modes differ by 100 hertz (cycles per second), the violin will have a harsh sound. A difference of 50 to 60 hertz, however, produces a sound suitable for a concert hall. A difference of 10 to 20 hertz is better for chamber music recitals, where subtle tonality is more important than volume.

Modes of vibration, also called harmonics, are defined by the number of wiggles a vibrating object undergoes. A string fastened to posts at both ends is said to vibrate in the first mode when the entire free portion of the string moves back and forth in a single motion. If half the string swings in one direction and the other half in the opposite direction, the vibration is of the second mode. Each additional hump in a vibrating string or plate represents another mode. The sounds made by each of the modes of a vibrating object differ from one another by one octave, a profound discovery made by the ancient Greek mathematician Pythagoras.

The vibrational modes of a violin are so complex and numerous that complete analysis will always be out of the question, scientists agree. But luthiers apply rules of thumb, when carving the wooden parts of a violin,

that usually work fairly well. The modal characteristics of the front and back of a violin (the front plate and the back plate), vitally important to the instrument's sound, can be roughly checked by placing the wooden plate

face down on some resilient material, bombarding it with sounds of various frequencies produced by a loudspeaker and sprinkling sand on the back of the plate.

As the plate begins to vibrate in resonance with one or another of the sound frequencies emitted by the speaker, the sand jiggles into lines corresponding to the regions of the plate where the vibration is smallest.
The patterns formed by these lines of sand reveal the modal properties of the plate. If the lines don't look right, the luthier chips away more wood in appropriate places. What Makes a Great Violin?

But how can anyone define what makes one violin great and another one mediocre?

The answer, all participants in the acoustical society's concert agreed, is in the performer, not in any formal set of criteria. If a violinist finds it easy to draw exactly the sound he wants from an instrument, the violin is a good one -- for him, at least.

Dr. Gabriel Weinreich, a physicist at the University of Michigan in Ann Arbor who acted as chairman of the

concert, recalled that an admirer had once told Jascha Heifetz that his violin produced unbelievably beautiful music. Heifetz held the violin to his ear and replied: "Strange. I don't hear anything."

Dr. Weinreich added: "No violin is great in itself. It takes a great artist to make it sing."

Photo: Carleen Maley Hutchins, leader in American violin-making and expert on acoustics of stringed instruments, at home in Montclair, N.J. (Chris Maynard for The New York Times) (pg. C6) Diagram: "The Art And Science Of Channeling Good Vibrations" Above, the designs for the top and back plates of a mezzo violin (larger and flatter than a traditional violin) before assembly, showing the approximate thickness of the wood in each region. At right, photos of acoustical tests of these plates. Each pair shows the patterns of tiny flakes of black-colored aluminum, not unlike glitter, that collect at the nodal lines, the regions where there is no movement when the plates are bombarded with sound at specific frequencies. The patterns for the first,

second and fifth modes of vibration are shown. The frequency and shape of these patterns can be adjusted by carving away wood in various places.
The New York Times/Illustration by John Papasian from a drawing by Carleen Maley Hutchins; Photos by Chris Maynard) (pg. C1)