THE NEW YORK TIMES, TUESDAY, NOVEMBER 28, 2006

Others, like Mr. Martin's, are one-off prototypes. (He has sold only three.)

In almost every case, a central goal, particularly in the resonating top or soundboard most responsible for an instrument's voice, is a mix of stiffness and lightness.

This combination increases an instrument's ability to turn the energy in a vibrated string into waves of appealing sound.

That is where unconventional materials come into play. Layered graphite fibers and carved balsa are very stiff but far less dense than the traditional choice of spruce.

"Wood reached the limits of its potential in the first half of the 18th century," Martin Schleske, a leading violin maker from Munich, asserted in a recent lecture in Germany. "I have no doubt that if Stradivari were alive today with the same force of innovation, he would have already discovered the fascinating acoustic properties of graphite fibers and would have ushered us into a new golden age of violin making."

This month, Ingolf Turban, a touring concert violinist, compared Mr. Schleske's latest violin, which has a top made of a mix of spruce and graphite, with a 1721 Stradivarius by recording passages from Mozart's Violin Concerto in D Major with each. He told Mr. Schleske he preferred the new one.

"I have never been playing any violin with such a singing E string," Mr. Turban said in a testimonial. "It is no longer like playing violin but like singing."

Some instrument makers and researchers are using science to deconstruct the dozens of kinds of vibrations and waves that interplay in a violin or guitar to create their distinctive sounds.

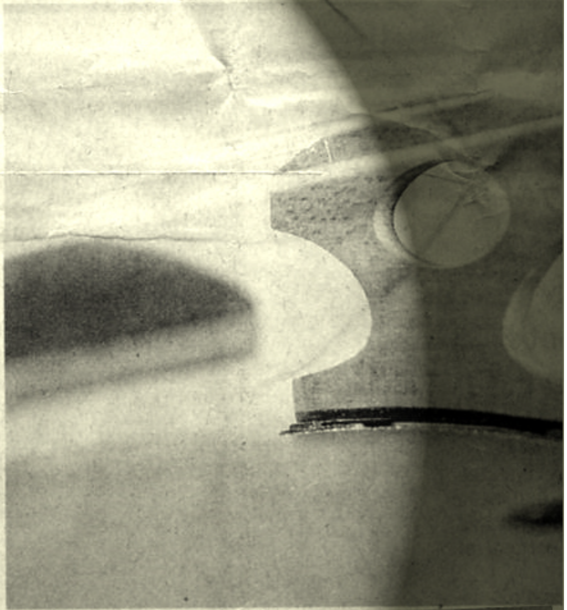
Working with Mr. Curtin and several other violin makers, George Bissinger, a physicist at East Carolina University in Greenville, N.C., is using medical-imaging gear, laser scanners, arrays of microphones and computers to measure and model how the parts of a violin react once energy is introduced by a bow, fingertip, pick or, in the laboratory, the repeated taps of a tiny hammer.

Depending on many interrelated variables, from the force exerted on the strings by the player to the stiffness, density and shape of an instrument's parts, a layered field of sound emanates, sometimes containing dozens of distinctive overtones and harmonics.

Some sounds disperse in the air evenly in all directions, while others — especially high notes on a violin — push outward in a particular direction, funneled by the shape of the instrument.

Particularly important, Dr. Bissinger said, is determining which factors translate the side-to-side sawing of a bow on a string into vertical motions of the violin top. "Up and down is what matters," he said.

Other vibrations travel in the body — at different speeds reflecting the orientation of wood grain — setting up all manner of ripples and bouncing waves and more ripples.



VARIATIONS Top left, Douglas Martin at home in Maine. Top right, a design by Nathaniel Rowen, who says his ideas were "inspired by a dream." Above left, Martin Schleske, a leading violin maker from Munich. Above right, an unorthodox bridge designed by Joseph Curtin. Below, a Schleske design, left, was preferred to a 1721 Stradivarius when played by Ingolf Turban, a concert violinist.

Top left (violin maker), Herb Swanson for The New York Times; top right and center left, Bill Crandall for The New York Times

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