# String Theory Meets Practice as Violinmakers Rethink Their Craft

**Incorporating innovative designs and novel materials, bright and responsive "ultralight" instruments may be the sound wave of the future**

**KING OF PRUSSIA, PENNSYLVANIA**—A little thin down low, the sound of the violin blossoms as Bach's unaccompanied sonata in C major wends into the upper registers. Close your eyes, and you can almost see the instrument making the bright, crystalline sound, its classic form curving as gracefully as the music, its amber finish enriched with nicks and scrapes accumulated over the centuries, its compact body resonating with the very emotion of the soloist. It may be best to keep your eyes closed, however.

In fact, the instrument looks less like a violin than a model airplane gone horribly wrong, and it's hard to reconcile the beauty of the sound with the device's homely appearance. A latticework of spars covers its asymmetrical balsawood body. Crude vents perforate its top where a traditional violin's elegant "f-holes" would lie. Yet the thing sings to the violinist's touch. "The sound is just enormous under the ear," says Annalee Patipatanakoon of the Gryphon Trio, a chamber group based in Toronto, Canada. "Wow!"

**Innovator.** Joseph Curtin is one of a small group of violinmakers experimenting with new designs and materials.

The odd contraption exemplifies the innovative approach some violinmakers are taking to the hallowed instrument. For decades, scientists have tried to explain the violin's captivating sound and the supposed superiority of instruments made 300 years ago by Italian masters such as Antonio Stradivari and Giuseppe Guarneri. Now, a handful of top makers are embracing scientific methods and striving to move beyond copying the "old Italians." Several have gathered here to report their progress to the Violin Society of America (VSA)* and encourage others to follow their controversial lead.

"I've been trying to step outside and say, 'Hey, is [the traditional design] perfect?' " says Joseph Curtin, a violinmaker from Ann Arbor, Michigan. "In some ways it may be, but the more I look into the design, the more it looks rife with things that could be improved." Such efforts have begun to attract attention outside le métier. In September, the Chicago, Illinois–based John D. and Catherine T. MacArthur Foundation awarded Curtin a $500,000 "genius grant" for his use of acoustic science, innovative designs, and novel materials such as balsa wood and carbon-fiber composites.

Some aficionados say the traditional wooden violin could use a rethink. "We are at the beginning of a revolution," says Fan-Chia Tao, an acoustical engineer with string manufacturer J. D'Addario & Co. in Farmingdale, New York. "Within a generation, the wooden violin will be as obsolete as the wooden tennis racket or the wooden golf club." But others hesitate to fiddle with the fiddle. "I think that many who engage in [the scientific approach] feel that they'll be able to make Stradivariuses like you make Ford Explorers," says Hans Tausig, former president of VSA, from his home in Forest Hills, New York. "And that's where they go wrong."

### Sonic lighthouse

A work of art, a historic artifact, a million-dollar investment: A fine old violin is many things. But when it comes to making music, a violin is a tool for producing sound. A violinist sets a string vibrating by bowing it and fixes the frequency, or pitch, of the vibration by pinning the string against the fingerboard. The string pushes the bridge, a wooden stanchion that suspends the strings above the top of the instrument, and the jiggling bridge forces the body of the violin to vibrate, too. The moving body pushes the air to create sound.

That seems simple enough, but the character of a violin emerges from the subtle details. The vibrating body can contort in many distinct patterns of motion, or "modes," depending on the frequency. For example, at frequencies around 285 cycles per second, the top and bottom of the body move in opposite directions, as air flows in and out through the f-holes in the top. Thanks to the myriad overlapping modes, a violin cranks out certain frequencies more efficiently than others, and the differences give the instrument its distinctive voice.

The violin also acts like a sonic lighthouse, beaming its sound in specific directions, explains Gabriel Weinreich, a physicist retired from the University of Michigan, Ann Arbor. The directions change rapidly as the frequency changes, so that even the slightest wiggle of the player's hand—such as the shaking "vibrato" violinists use to embellish notes—causes the direction of the sound to vary dramatically. Known as directional tone color, that phenomenon may explain why a good violin sounds "alive," Weinreich says.

And all agree that the best old Italians possess a buttery, lively sound that has set the standard for violins for centuries. Through innovations of their own, the Italian masters of the late 17th and early 18th centuries developed a design that violinmakers have copied religiously ever since, sometimes down to the blemishes in the finish. But a few makers are trying to push past the bounds of tradition.

For ages, people have tinkered with the violin. In the 1970s, aeronautical engineer Leonard John, currently with Bombardier Aerospace in Downsview, Canada, developed a carbon-fiber violin. And the grand dame of violin research, Carleen Hutchins of Wolfeboro, New Hampshire, produced a variety of novel instruments and inspired Curtin and others. But now, makers with sterling reputations for producing top-quality traditional instruments are embracing the insights of science, says Jeffery Holmes, a violin restorer and dealer in Ann Arbor. "They're interested in how the violin works and how science applies to it," Holmes says.

CREDIT: A. CHO/*SCIENCE*

* 33rd Annual Convention, 10–13 November 2005.



*Published by AAAS*

**Light and lively.** Balsa-wood violins crank out the sound.

### Mapping modes, sculpting sound

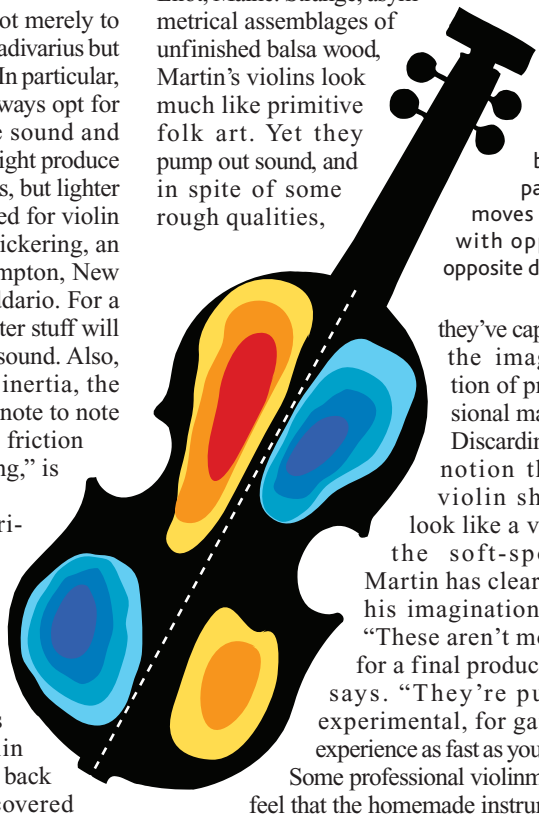
At the least, a scientific approach should help produce instruments that sound more like the old Italians. Martin Schleske, a maker in Munich, Germany, has mapped the modes of classic instruments and analyzed the sound they radiate when tapped on the bridge, measuring the relative strengths of the constituent frequencies. He uses the data to make "tonal copies" that mimic the voice of the originals. "A lot of musicians say it's great," Schleske says in a phone interview, "because there is now a way of getting an objective measure of an instrument."

Taking a different, rather irreverent tack, Samuel Zygmuntowicz, a maker from Brooklyn, New York, is experimenting with tailoring the sound of an inexpensive violin by simply gluing small strips of wood to it. The spars stiffen the instrument and alter its modes. "I started as a sculptor," Zygmuntowicz says, "and to me what's exciting about this is I can shape sound the way I used to shape clay." Such experimenting could help pinpoint the origins of a fine violin's superior tone.

But innovators are striving not merely to produce a better knockoff of a Stradivarius but rather to achieve something new. In particular, they argue that violinists will always opt for instruments that project more sound and respond more quickly. Makers might produce them by using materials as stiff as, but lighter than, the spruce traditionally used for violin tops and backs, says Norman Pickering, an acoustical engineer in East Hampton, New York, and a consultant to D'Addario. For a given amount of energy, the lighter stuff will move more and create a louder sound. Also, because the material has less inertia, the instrument should switch from note to note more readily, provided that the friction within the material, or "damping," is about right.

So violinmakers are experimenting with light, stiff materials such as carbon fiber and balsa wood. "When you get a lot lighter than traditional [materials], you get an immediacy of response that's almost shocking," Curtin says. He has brought to the meeting a violin whose vacuum-molded top and back consist of two plies of balsa covered with a thin laminate of spruce. Stripped of the corners and curlicues that adorn a traditional violin, the instrument looks at once old and modern, its economical lines hearkening back to the architectural designs of Frank Lloyd Wright. It sings sweetly when the Gryphon Trio's Patipatanakoon plays it in a demonstration of the innovative instruments.

Curtin's violin looks positively conventional next to the creations of Doug Martin, a boat builder and amateur violinmaker from Eliot, Maine. Strange, asymmetrical assemblages of unfinished balsa wood, Martin's violins look much like primitive folk art. Yet they pump out sound, and in spite of some rough qualities, they've captured the imagination of professional makers. Discarding the notion that a violin should look like a violin, the soft-spoken Martin has clearly let his imagination run. "These aren't models for a final product," he says. "They're purely experimental, for gaining experience as fast as you can." Some professional violinmakers feel that the homemade instruments can teach them something, too.



**Visualize the vibe.** A violin's body oscillates in a variety of patterns, or modes. Here, the top moves in a butterfly-shaped pattern, with opposite quadrants moving in opposite directions.

### Top down or bottom up?

To be sure, some makers bristle at the idea of innovation. William Fulton of Idyllwild, California, questions whether a carbon-fiber or balsa-wood instrument counts as a violin. "It represents a new instrument that looks like a violin and it plays like a violin," he says, "but it ain't a violin."

Others worry that the use of carbon-fiber composites will inevitably lead to mass production of instruments. But cheap wooden violins are already mass-produced in China and elsewhere, and factories are cranking out ever better instruments, says Gregg Alf, a violinmaker in Ann Arbor. "Innovation is our defense against mass production," Alf says. "It allows us to offer something more than a factory that's 5 years behind."

Ultimately, musicians will decide whether innovative violins succeed. But no one knows what it will take to persuade a soloist to play Carnegie Hall with an ultralight violin. Some say it's simply a matter of getting superior instruments into the hands of leading violinists. "I suspect there's an underground lake of anger at having to pay so much money and having so many problems with [old] instruments," Curtin says, "so that if there's something better, [musicians] will change fairly quickly."

Others predict that change will begin at the bottom, with instruments for students. Student instruments are often so poorly made that it's nearly impossible to wring a decent sound from them, says D'Addario's Tao. Lightweight carbon-fiber instruments would be easier to play, he says, and if students grow up with innovative instruments, they may be more receptive to them as adults.

At least a few players are already willing to consider novel instruments. "I don't think anyone is willing to discount anything anymore," says violinist Patipatanakoon. In the end, what matters is how an instrument plays, she says, and she praises one of Martin's rough-and-ready balsa violins. "It's so comfortable," she says. "You can just sink into it."

Still, when asked which of the several instruments suits her the best, Patipatanakoon chooses one made of traditional materials by Andrew Ryan of Providence, Rhode Island—the most conventional one of the lot. A revolution in violinmaking may have begun, but it seems there's a tune in the old fiddle yet.

–ADRIAN CHO

CREDITS (TOP TO BOTTOM): A. CHO/*SCIENCE*; ADAPTED FROM MARTIN SCHLESKE



*Published by AAAS*