AMERICAN HERITAGE OF Invention & Technology MAGAZINE

SPRING 2000 • VOLUME 15/NUMBER 4

Beyond Stradivari

by Steven L. Shepherd

Violin makers today can learn more, faster, than anybody in history. The result is a new Golden Age in lutherie.

Jascha Heifetz was the most celebrated violinist of the twentieth century. Luminaries from throughout the violin world attended his 1972 Los Angeles farewell concert—as did at least one former student. Now a Hollywood studio musician, Ron Folsom recalls that when his old teacher played the slow movement of the Strauss violin sonata, "there wasn't a dry eye in the house."

Heifetz died in 1987, and a year later Britain's venerable violin magazine *The Strad* published a full-color poster of the violin he had used in this last concert. Named after the nineteenth century virtuoso Ferdinand David, Heifetz' violin was made in 1742 by Giuseppe Guarneri del Gesù. Guarneri's instruments today are rarer and in many cases more valuable than those of Stradivari. Heifetz acquired his in 1922, paying the then-lofty price of $30,000, and over time, says Folsom, it became for him "like religion.… It was his life." He is even said to have rejected a 1969 offer for the "David" that included $3 million *and* his continued lifetime use and possession of the instrument.

So close was Heifetz to his violin that when Folsom once had the brief chance to play it he felt as if the very spirit of the great musician had instilled itself in the wood. Indeed, the "David-Heifetz," as it has since come to be known, is now on display in the Fine Arts Museums of San Francisco, and just below one of the *f*-holes you can see in the varnish a distinct light-colored smudge. It is, says Folsom, Heifetz' thumbprint.

When *The Strad*'s poster was published, Ron Folsom looked at it a long time. He had it framed. He hung it in his study. And then he decided he wanted a copy of the instrument for his own use. A very good copy.

The history of violin copying is nearly as old as the history of violin making itself. Stringed instruments in endless variety are of ancient origin and have been developed and refined in cultures from Asia to Africa. But it wasn't until the development of the violin that musicians had access to a tool with a palette of sound to match that of the human voice. Although the circumstances of its origins are murky, the first known image of a violin is contained in a fresco painted in 1508 in the northern Italian town of Ferrara; the first written reference to a violin is a 1523 accounting record from Vercelli, in the upper Po River valley. Where or by whom these violins were made is unknown, but what *is* known is the name of the instrument's first great maker.

Midway between Vercelli and Ferrara, on the banks of the Po, lies Cremona. There, in 1526, the census lists the name of Andrea Amati (c.1505–1577), apprentice in the house of a "luthier." Such a luthier would in those days most likely have made a wide variety of stringed instruments, from lutes to mandolins to guitars; whether he made violins and taught his apprentice to do likewise is unknown. But however he learned, by 1565 Amati was sufficiently regarded that the King of France ordered from him a set of 24 instruments. One of these violins survives and can be seen today in Cremona's town hall; unlike the rather odd-looking instrument in the Ferrara fresco, it is virtually indistinguishable from a modern violin.

In addition to establishing the shape, size, and reputation of the violin, Andrea Amati set other precedents that came to characterize the tradition of violin making in Cremona. He was long of life, rich of offspring, and master of a prosperous family workshop. He was also grandfather to the next great maker in the history of the violin.

Niccoló Amati (1596–1684), became an apprentice at the age of 10. He had already become master of the shop and mainstay of the Amati business when, in 1629, plague struck the Po valley. The disease reached Cremona a year later and within two months Niccoló's father, mother, two sisters, and a brother-in-law were dead; soon, so too were all his competitors.

Much of his clientele also died, but eventually the business began to recover and it was then that Niccoló—who went unmarried until he was almost 50—first found it necessary to take on apprentices from outside the family. The first of these was Andrea Guarneri (1626–1698); another—although the evidence is disputed—is likely to have been Antonio Stradivari.

The instruments of Niccoló Amati remain highly prized, but he left his greatest legacy in the students he taught. After his apprenticeship, Andrea Guarneri opened his own shop just down the street from Amati (Stradivari later opened *his* shop next door to the "casa Guarneri"); he then fathered two sons who became makers and of these one fathered two more sons who became makers—of whom the youngest was Giuseppe, maker of the "David."

Stradivari (1644–1737), of course, went on to become the most famous violin maker ever—supplying royal courts throughout Europe and continuing the traditions of longevity and fecundity: he lived to 93 and fathered eleven children, of whom one son (Paolo, 1708–1775) became a violin dealer and two became makers. When these latter two died in 1742 and 1743, respectively, followed a year later by Guarneri, the "Golden Age" of Cremonese violin making began drawing to a close.

Violin making did spread elsewhere of course, and so too did another tradition with close ties to Cremona—copying, or, in its related forms, forgery and mislabeling. Reflecting his fame and stature, one of the earliest victims of the practice was Niccoló Amati. In 1685, a year after his death, an instrument with an Amati label was sold in the nearby town of Modena. The buyer had paid twelve pistoles but, he wrote, underneath the Amati label he had found the label of "a maker of much less repute, whose violins at the utmost do not realize more than three pistoles." That maker was from Cremona.

Because the profits from misattributing a violin's origins rise in direct proportion to the prices fetched by the work of the purported maker, it is no surprise that the most abused of all names in this respect is that of Stradivari. It is a little surprising, however, that among the first to have engaged in the practice was Antonio's son Paolo, the dealer. After the deaths of his father and violin-making brothers, Paolo inherited the contents of the family's shop, including a number of finished instruments and a supply of undated labels. Suspicion seems to have arisen that Paolo was making rather liberal use of these labels, for late in his life he was forced to sign a statement that the Stradivaris he was selling had been made only by his father and brothers.

But it is hardly necessary to have had access to Stradivari's workshop and labels to forge or copy his instruments. By the late nineteenth and early twentieth centuries, factories in Europe were turning out as many as 40,000 violins a year fitted with the labels of Stradivari and other famous makers. Many were exported to the United States and sold by mail order, and many can be found today in attics and secondhand shops. These were the crudest of copies, but more sophisticated efforts have occasionally been so successful as to take on a life of their own. Such was the case of the "Balfour" Strad.

The "Balfour" was made in London around 1900 by William Voller, one of three brothers who made high-quality copies of old violins marked with their own Vollers' label. Under uncertain circumstances, however, William's instrument was purchased for £45 by an upstart violin dealer named Balfour & Company—with a Stradivari label inside. In 1901 Balfour's then advertised its "1692 Strad" for £1,000—a bargain, but one without takers. Undaunted, Balfour's raised the price, and finally sold the violin for £2,500. A mysterious letter then appeared in *The Strad* questioning the instrument's authenticity; so prompted, the buyer returned the violin and Balfour's granted a refund. Balfour's, the company, then went out of business. But Balfour, the “Strad,” was just getting started. In the years following it was bought and sold repeatedly and at one point even acquired a scavenged set of real Stradivari ribs. Not until 1964 did a prominent London dealer buy the violin and remove it from the market.

Plainly, profit and deceit have long been motives for the copying of violins. But there are legitimate reasons as well for wanting and making copies. For a maker, the close copying of an “Old Italian” instrument can offer a rigorous training exercise. For a player, use of a copy is an excellent way to reduce wear and tear on a valuable old original; for a player without such an original, a copy can help sidestep the tendency of audiences to confuse a violin’s price with its owner’s talent. For others, copies offer a way to feel closer to history.

Once Ron Folsom decided he wanted a copy of the “David-Heifetz,” he had to find a maker. He recalled having seen a violin made for a friend by a pair of luthiers in Ann Arbor and of thinking at the time that the work was “awful nice.” So he called, talked to one of the makers, and knew from the outset that “He was the guy. His heart was in it.”

Gregg Alf is a soft-spoken, contemplative man who, along with his friend and former partner Joseph Curtin, has developed a reputation as among the foremost luthiers in the world today. During the 12 years they worked together, the pair made violins for such renowned virtuosi as Elmar Oliveira, Ruggiero Ricci, and the late Yehudi Menuhin. Members of orchestras around the world play their instruments. And in 1990 the two collaborated on a Stradivari copy that was later sold at the highest auction price ever paid for a violin by a living maker.

In 1997 Gregg Alf and Joe Curtin divided their business so each could more freely pursue his own interests. But even as partners they had often worked on their own projects, and so it was that it was Alf alone who undertook to copy the “David-Heifetz,” and Alf who flew to San Francisco in June 1989 to examine the violin. Unlike a guitar, whose front and back are flat, the plates of a violin bulge outward. The size and shape of these bulges has an enormous influence on an instrument’s sound, as does the nature and varying thickness of the wood, and all these quantities and qualities needed to be measured and recorded.

Back in Ann Arbor, Alf set to work. His first task was to select from the shop’s inventory of aged tonewood those pieces that most closely resembled the wood of the original Guarneri. As with most violins, the “David-Heifetz” has a two-piece top of spruce, joined down the middle, and a two-piece back of flamed maple. Acoustically, the spruce is more important than the maple, but the maple, with its distinctive “flames,” is more important aesthetically; to make a convincing copy, the flame of the original must be matched as closely as possible and in some cases it can take years to find the right pieces.

Once he had chosen the wood, Alf began cutting and assembling the parts. Luthiers differ widely in their opinions on the use of power tools. One view is that handmade violins should be exactly that: handmade—just as they were in the days of the old Cremonese. But others note that Stradivari, for one, was both an innovator and a businessman whose methods were state-of-the-art for the times—and that modern makers owe themselves no less. Greg Alf falls squarely in this latter group, and when cutting the parts for the “David-Heifetz” copy he was aided by a basement full of modern power tools.

The front and back plates, however, he did carve largely by hand, with ever-finer tools, including thimble-sized finger planes and thin metal scrapers; in a copy, the plates’ outer curvature recalls the shape of the original instrument, but the inner is governed by acoustics, as suggested by the changing sound of finger-elicited “tap tones” as the wood is thinned gradually from the inside. To assemble the parts he used hot, rabbit hide glue, as have luthiers from times immemorial—not from sentiment, but because the glue can be easily separated for repairs. The varnish he made from pine resin and linseed oil laced with such pigments as Rose Madder and Quinacridone Orange; applying it, says Alf, requires an eye for texture and color and the skills of an oil painter. To give the appearance of a quarter-millennium’s worth of accumulated grime, he rubbed a slurry of dry pigments —“fake dirt”—into the surface with emery cloth.

Then, in the spring of 1990, a year after he started, Alf sent Folsom the finished violin. When it came, says Folsom, “I was afraid to open it. I was afraid to look at it. I thought I’d be disappointed.”

So his son opened the package instead. “Wow!” he said. “Dad, it looks *great*!”

Then Folsom gathered his courage and went to look at the new violin. And there he saw, the instrument still in its case, that Alf had reproduced the great old violin’s every nick, ding, and repair. Where the varnish of the “David-Heifetz” was worn and discolored, so too the varnish of the copy. Where the corners and edges had rounded with age, so too the copy. Alf had misaligned the *f*-holes, as had Guarneri. And where Heifetz had left his thumbprint, there too was a smudge on the copy. “Wow!” thought Folsom. “It *does* look great.”

But, he thought, “How does it sound?”

The sound of a violin is a physical phenomenon of almost impossible difficulty to characterize. Vibrating strings alone have been the subject of scientific scrutiny as far back as the sixth century BC, when Pythagoras found that two strings of equal tension and thickness will produce notes an octave apart if one is half the length of the other.

Two thousand years later, Galileo found that length itself wasn't the critical variable. Rather, it was the speed at which the string vibrated: changing length changed the vibrating frequency, and *that* is what produced the change in pitch. About this same time it was recognized that strings vibrate in more than one manner at a time: the whole of the string vibrates as a single unit at the frequency of the string's fundamental pitch; simultaneously, each half of the string vibrates as would a string half the length of the whole (producing an overtone, or harmonic, one octave higher than the fundamental), as does each third of the string, each fourth, fifth, and so on. In theory, the number of harmonics so produced is infinite.

By the late nineteenth century it was further known that the behavior of strings set in motion by a bow was even more complicated than that of plucked or hammered strings, both because of frictional forces between string and bow and because the transfer of energy to the string was sustained rather than instantaneous. By the early twentieth century the behavior of bowed strings was recognized as sufficiently complex that their study drew the attention of such scientific notables as the Indian physicist C.V. Raman, who developed a theoretical model to describe the patterns of string movement he found in experiments using a mechanical bow and who later (for other work) won a Nobel Prize.

Once a collection of bowed strings is coupled to a resonance box of irregular shape, made of natural (and therefore infinitely variable) materials, played by a human, to express emotion, using a medium that is more than the sum of its parts, to an audience with its own likes and dislikes, in settings that are each acoustically unique, then the problem of understanding the violin as a mechanical radiator of sound is understood as one of formidable challenge. It is simply not easy to say why two violins are alike or different—or to apply that knowledge to the making of a third.

The first physicist to study the violin in its own right was the Parisian Felix Savart (1791–1841). Among other experiments, Savart performed a series of investigations examining the vibrational characteristics of unattached violin plates, which he accomplished by sprinkling the plates with sand, then observing the resultant patterns as the plates were vibrated by running a bow across their edge—a technique used today in modified form by some violin makers to "tune" their plates during carving.

In addition to occasionally building his own instruments for experiments, Savart also collaborated with the most famous violin maker of his day: Jean Baptiste Vuillaume (1798–1875). In one such case, the two created the biggest member of the violin family ever made: a 12-foot, 3-string behemoth called the octobasse that was so big it had to be tuned with the help of an assistant who stood upstairs after the scroll was stuck through a hole in the ceiling. (Vuillaume, incidentally, was also a superb copyist, and there are some experts who suspect he is the true maker of the world's most famous "Stradivari"—a virtually new-looking violin called the “Messiah” that was never seen publicly until the day it appeared in Vuillaume’s shop in 1855.)

The first American scientist to study the violin was Frederick A. Saunders (1875–1963), who was not only an amateur violinist but also chair of the physics department at Harvard University from 1926 to 1940. Saunders, whose principal research interest was atomic spectroscopy, began work on the violin in the mid-1930s and continued his inquires for nearly three decades, coauthoring his last paper at the age of 85, just three years before he died.

From the beginning, Saunders’ goal was “to discover the characteristics of the best instruments and the reasons why poor ones fail.” Toward this end he tested hundreds of violins, from Strads and Guarneris (including the “David,” which Heifetz played for him), to Strad and Guarneri copies, to a $5 instrument he called his “standard of badness” and that others simply called “wretched.” To facilitate his work he developed a pair of data measurement and display techniques he referred to as “response” and “loudness curves.” These consisted of graphs plotting in decibels the volume of the overtones detected by a custom-made “harmonic analyzer” during the sustained, even playing of a single note. The response curve showed the volume for each individual harmonic (of which there might be 30 or more per note); the loudness curve showed the total volume for all the harmonics combined. For each instrument, Saunders recorded the playing of 46 notes and generated over 1,500 data points.

One of his first findings was that every violin tested—old or new, “good” or “bad”—showed pronounced variation in the total volume it could produce from note to note. Moreover, one instrument’s pattern of peaks and valleys showed little consistency with that of another—even when the two violins were by the same maker. This was both striking and embarrassing, wrote Saunders, because it meant [his emphasis] “there is *no one quality which is characteristic of any violin*.” The result of this variability, he later added, was that any tonal characteristics one sought in an Old Italian instrument—Stradivari or otherwise—could be matched in a well-selected instrument of newer construction or by a maker of lesser renown.

Saunders demonstrated this point several times in listening tests with audiences. In 1940, for instance, he asked a Philadelphia audience of some two hundred musicians, nonmusicians, and “experts” to identify the Stradivari from among violins A, B, and C when played by a concert violinist behind a screen. The proportion of listeners that correctly chose the Stradivari was the same as that predicted by chance alone, and over half the audience thought a modern Strad copy sounded more Stradlike than the Strad. The musicians and experts, noted Saunders, chose no better than anyone else.

Nonetheless, Saunders never lost sight of a phenomenon that complicates the interpretation of such tests. Almost by definition, a good violinist can make almost any violin sound good—even the "Wretch," wrote Saunders, "sounded well when Mr. Heifetz played it." But even while making the task look effortless, the player is never in doubt as to the ease or difficulty of eliciting the desired result from the instrument. And there lies the problem. A fine violin, wrote Saunders, has "an undefined something…which is immediately felt by the player, even if it is not recognized by the listener."

One of Frederick Saunders' most prominent scientific heirs is University of Michigan physicist Gabriel Weinreich, who became interested in musical acoustics after a long career in more conventional areas of physics. Weinreich's first acoustical studies involved the piano. But he soon turned his attention to the more complex problem of the violin, which he calls "the instrument that has been most studied and about which least is known."

Weinreich has now devoted parts of the past twenty years to the investigation of myriad aspects of violin physics, including a phenomenon called "directional tone color," which refers to the fact that different notes radiate from different parts of the violin's body at differing loudnesses. His goal throughout has been the same as that of Frederick Saunders: to discover those physical properties that distinguish the best violins. But Weinreich has remained as stymied as his predecessor. That "undefined something" is as undefined today as ever. Some objective quality is clearly involved, says Weinreich, for "if we hand any experienced player a violin and ask that it be classified into one of three categories: (a) 'student instrument'; (b) 'decent professional instrument'; or (c) 'fine solo instrument,' the judgement would not take more than about 30 seconds and the opinions of different violinists would coincide absolutely." Yet the criterion a player uses to make this discrimination is still a mystery, and there remains no physical test or specification that enables a scientist to describe what a player so immediately feels when putting bow to string and pronouncing one violin good and another bad.

It is, he admits, "extremely frustrating."

Of course, it may be that physicists have been looking in the wrong place. This possibility is raised in a respected textbook when, after a long discourse on violin physics, the authors point out that players are responsive to psychological factors as well as physical. "If a violin appears to have been made by a master craftsman," they write, "it will probably be played accordingly. This is especially true if the player knows of the maker and his reputation."

Looks count, in other words.

And so it was only after he had gazed at his new violin for the longest time that Ron Folsom finally put it to his shoulder. Violins take time to break in, and despite the instrument's beauty he was still worried. “Is this going to work?” he thought. “Or do I have to play it for a year before I can even take it to the recording studio?”

But at last he touched bow to string. “And by golly,” he says, “it sounded right away. It sounded very well.”

It would only get better—the violin would, as Folsom says, “ripen”—but even then he was so emboldened that he took it the next day to a session at Warner Brothers, and he remembers now that his colleagues were quite impressed. “Everybody loved playing it—it sounded wonderful.” And at that moment it became his primary recording instrument.

Despite the quickness with which his doubts were dispelled, Ron Folsom’s initial wariness was by no means unusual. For reasons unknown, violins do indeed “sweeten” with age and playing (Frederick Saunders thought a possible mechanism might be the development of microscopic cracks in critical glue joints, thereby allowing freer vibration of the plates). But musicians have long overlain the phenomenon with their own prejudice. As far back as 1676—when both Niccoló Amati and Stradivari were working—the author of one musical text advised his readers that although there were then “excellent good workmen …, yet we chiefly value old instruments before new; for by experience, they are found to be by far the best.” And today there are conductors of major American orchestras who prohibit their string players from using new instruments.

All the same, more and more modern players are joining Ron Folsom in their willingness to consider new violins. Part of the reason is scarcity. There are more players today than ever, yet every year there are fewer available old instruments. According to Gregg Alf, there are about 70 historic old masters—Italian and otherwise—whose work comprises the bulk of the fine instruments sold and resold by auctioneers and dealers around the world. The average lifetime output of these makers was about 200 instruments, meaning the world’s total original inventory was about 14,000. But each year the inventory shrinks. Some instruments, like the “David-Heifetz,” are acquired by museums and removed from the market; others simply wear out.

The result of this imbalance between supply and demand has been an astronomic pricing structure for old violins. There are players who will impoverish themselves for life to make such a purchase, but an increasing number are deciding that it simply makes more sense to buy a new instrument.

Certainly economics favor such a decision—a musician can purchase a violin by one of America’s best contemporary makers for $25,000 or less. But increasingly, so does quality. In 1996, *Strings* magazine conducted a market survey of U.S. businesses involved in the violin trade. Of the nonmakers who responded—those whose business was buying, selling, or repairing—58 percent said today's finest new instruments are "equal in sound to the best ever made"; 22 percent said they were "superior.", There were similar findings for workmanship, which means that, overall, four-fifths of those queried believe today's best violins are equal to or better than those made in the "Golden Age" of Cremona.

Which is one way of saying we are now in a new Golden Age. And among the best new makers are Americans.

Perhaps the first violin built in America was made in Massachusetts in 1767 by a German immigrant named Gottfried Leutz. Writing in 1922, the Boston luthier John A. Gould (1860-1944) described Leutz' creation as a "crude old fiddle" with a "puny tone"; the shape was unorthodox and it was Gould's belief that Leutz built the thing entirely from memory.

Gould made these observations in what is probably the first written history of early American violin making. Colonial America was no Renaissance Italy, but even so, said Gould, "It is scarcely possible to imagine a spot less favorable to the encouragement of the violin maker." The Pilgrims considered instrumental music of all kinds sacrilegious, but the violin especially was vilified. In one community a violin was put on trial, convicted as the favored instrument of Satan, and buried. "Why it was not burned," wrote Gould wryly, "is unexplainable."

Not until the mid-nineteenth century did the number of violin makers in the U.S. rise above a handful. Even then, most were tradesmen—cabinetmakers and the like—who made violins primarily as a hobby or for supplemental income; few had access to fine instruments to serve as examples, and in a typical critique of their lutherie, Gould wrote of one that he was a "capable farmer." A few did ply their craft fulltime and could in that sense be considered professionals, but even these were mostly self-taught and Gould's comments on their work were backhanded at best: he wrote of one that he had "neat workmanship" but "knew nothing of acoustics"; another may or may not have had some training, but "it is certain that his first source of information…was incorrect."

Gould himself learned violin making as an apprentice in his native England. In the late 1880s he moved to Boston and there established a shop that remained in business for nearly a century and in which he made fine violins—including one tested by Frederick Saunders in 1938 and deemed a "lovely instrument."

John Gould was by no means the only skilled American luthier of the late nineteenth and early twentieth centuries. But neither he nor his peers ever enjoyed the reputation that might otherwise have accrued to a maker of such qualification. Rather, the members of America's first generations of luthiers were uniformly saddled with a reputation based on the homespun products of its violin-making carpenters, mechanics, and "capable farmers." So poor was that reputation that well into the middle of the twentieth century an American violin (no matter its quality) could be purchased for a small fraction of the price of its European equivalent. Compounding the problem, the best instruments were often relabeled by middlemen and sold as Italian.

But no longer. And though the turnabout began slowly, recent decades have seen an exponential growth in both the quality and reputation of American lutherie. Indeed, where once there were American instruments falsely proclaimed as from elsewhere, Greg Alf recently discovered a Chinese cello sporting the label of a prominent modern American maker.

Many factors have contributed to this changed state of affairs, but one of the earliest was the growing number of important artists who began calling the United States home. Great artists demand great instruments (Heifetz, a Russian immigrant, owned two Strads in addition to his Guarneri), and as these began to circulate, American makers had increasing opportunities to see high quality examples on which to base their work. For it was lack of information more than anything else that so hampered America's early makers.

Information control was what kept so many of the Old Italians' "secrets" secret—skills and techniques were kept within the family and the shops were run under strict guild-like conditions. But in America, says Thomas Wilde, author of the classic reference book, *The Violin Makers of the United States*, violin making has been characterized from the outset by the free and willing exchange of information; once a bit of knowledge became available, it was quickly spread.

One vehicle for this was the formation of groups and societies devoted to violin making. Among the first was the Violin Makers of Maine, organized in 1916; the group lasted only 10 years, but its legacy survives today in the form of such large and vibrant organizations as the Southern California Association of Violin Makers and the Violin Society of America, whose combined memberships number nearly two thousand people. An organization at once similar and unique is the Catgut Acoustical Society, founded in 1963 to help promote original research. The work of the Society's founder, Carleen Hutchins (a New Jersey violin maker who collaborated for years with Frederick Saunders), has twice been featured on the cover of *Scientific American*, and today the Society's membership includes luthiers, musicians, and scientists from around the world.

All these groups and organizations hold conventions, workshops, and conferences. All publish newsletters and journals. All serve to spread and maintain information. And none are alone in this. Libraries and museums are indispensable. Telephones have long been used. Faxes help. And the Internet is fast becoming a critical tool: Recently, Gregg Alf was building a cello when he began to consider using fabric panels to strengthen the ribs—a technique used by Stradivari but now relatively uncommon. He posted a question to a newsgroup and within days had replies from colleagues around the world. Modern air travel also facilitates information flow—a maker in Michigan can as easily go see the "Messiah" in Oxford as the "David-Heifetz" in San Francisco. And the grand result, says Chicago-based violin collector and historian David Bromberg, is that luthiers today can "learn more, faster, than anybody in history."

Which is not to say that physical technologies haven't played their part. When Gregg Alf measured the "David-Heifetz" he was limited by circumstances to the use of centuries-old technology: ruler and caliper. But a few years later, when the Los Angeles-based violinist Endre Balogh commissioned Joe Curtin and Gregg Alf to copy his 1728 Stradivari, the "Artôt-Alard," the two makers used a method decidedly more modern.

Plaster casts have long been used in lutherie. But in 1990, with the help of an employee who had learned her skills in the model shops at General Motors, Curtin and Alf began developing casting techniques new to the world of violins. They learned how to create flexible rubber molds from materials that cure at room temperature, absorb no moisture, and stick to nothing—materials that could be poured directly onto the unprotected surfaces of Balogh's Stradivari. Into the molds an epoxy resin is then poured, which, upon hardening, produces an exact dimensional copy of the original and in such detail that the grain of the wood can clearly be seen.

Such casts provide permanent references from which a violin maker can take measurements without risking damage to the original. There are shelves upon shelves of these castings, from a dozen or more instruments, in the current studios of both Joe Curtin and Gregg Alf, and a visitor can pick up—or drop—an exact plastic model of the scroll, top, or back of the "Artôt-Alard."

Of course, technologies today are superseded nearly as fast as they are developed, and both Curtin and Alf envision a day when the 3D laser scanners now used widely in industry are applied to violins and an instrument's dimensions are taken without anything having touched it but a beam of light. The resulting computerized data could then be stored and shared or, with the aid of a CAD/CAM program, manipulated by a luthier seeking to produce his or her own variation of a classic model by Stradivari or Guarneri.

But more than just working with new ways of measuring and copying old instruments, lutherie today is alive with experimentation and innovation. Carleen Hutchins helped pave the way in the early 1960s when she capitalized on her work with Frederick Saunders to build a theoretically derived Violin Octet. Designed to fill gaps in the acoustic spectrum left by the traditional string family of violin, viola, cello, and double bass, the Octet's eight members range from a tiny treble violin to a huge "large bass."

Another such collaboration now continues in Ann Arbor, where Joe Curtin and Gregg Alf are well acquainted with the inside of Gabriel Weinreich's acoustics lab and where both have incorporated concepts from physics into their approach to violin making. Curtin in particular has found the insights gained from his work with Weinreich so powerful that he has put them in service of a long simmering goal.

In 1997, after he and Alf separated their studios, Curtin decided to quit making copies and to use the time "to try some other things." Since then he has experimented with what he calls alternative architectures: a violin with a single crescent-shaped opening in place of the *f*-holes; a viola with sloping shoulders. He has experimented with materials: crafting composite plates that let him vary thickness without adding weight—layered sandwiches of wood veneer, carbon fiber, and aeronautic foam. And he has experimented with procedures: forsaking the traditional planes and scrapers and shaping the plates instead with vacuum pumps that draw the materials into conformity with epoxy resin molds.

His purpose in all this has been to better understand and to "get to the heart of violin sound"—so he can then build instruments that create that sound. But it is more than a sound he seeks. "It is," he says, "a tactile as well as an aural thing." What a few great makers of the past seem largely to have achieved through intuition (or chance or the good graces of time), he now seeks to achieve by design, using the best of science and art, technology and craft. What he seeks is to put into his instruments that very thing that makes playing a great instrument so exciting, so inspiring for a violinist—that "undefined something."■

NOTE: Published by *AHI&T* as "The Mysterious Technology of the Violin" — a title that undermined the whole point of the article — the preceding is the original submitted text (and title) before its editorial erosion. You can read *AHI&T*'s full-color, but slow-to-load version here.