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Carleen Maley Hutchins: Reconsidering the Legacy of a Luthier and Acoustician

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In her compelling biography of Carleen Maley Hutchins (1911–2009; fig. 1), Quincy Whitney detailed the life of a brilliant and complicated woman who "went head to head with a closed and ancient guild [of lutherie] . . . [and] collaborated on more than 100 experiments in violin acoustics."[1] After making her first viola as a relief to the boredom brought on by societal restrictions on pregnant women in the 1940s, Hutchins gradually became a central figure in violin acoustics research. Her notoriety rests primarily on her work with tap tones and the development of the New Violin Family, an octet of acoustically balanced violins spanning the range from C^1 to E^6 (C, to e'''), as well as forming the Catgut Acoustical Society (CAS), devoted to acoustical research related to bowed string instruments. Her strong personality and obsession with the octet polarized opinions about Hutchins as a person and about her contributions to science and lutherie. Whitney finds an appropriately balanced point of view in her biographical portrayal of Hutchins, but both published and internet information about Hutchins's work tends to swing widely from effusive praise to dismissive condemnation, without much ground in the middle.

A more reasonable stance is that Hutchins' scientific methodology was often faulty, and her instruments were only mediocre—but her passion for the work was singular, and in light of that, she played an undeniable role in several regards. First, she defied the patriarchal worlds of early twentieth-century science, lutherie, and society as a whole. Second, she was a catalyst toward lutherie as a collaborative enterprise and in preparing the way for meaningful presence of women in lutherie. Above all, however, Hutchins served as a bridge between the worlds of science and violins, advancing scientific inquiry in music and its application in violin making.

1. Quincy Whitney, *American Luthier: Carleen Hutchins–The Art & Science of the Violin* (Lebanon, NH: ForeEdge, 2016). Readers should consult Whitney's work for anything more than the minimal biographical details offered here.

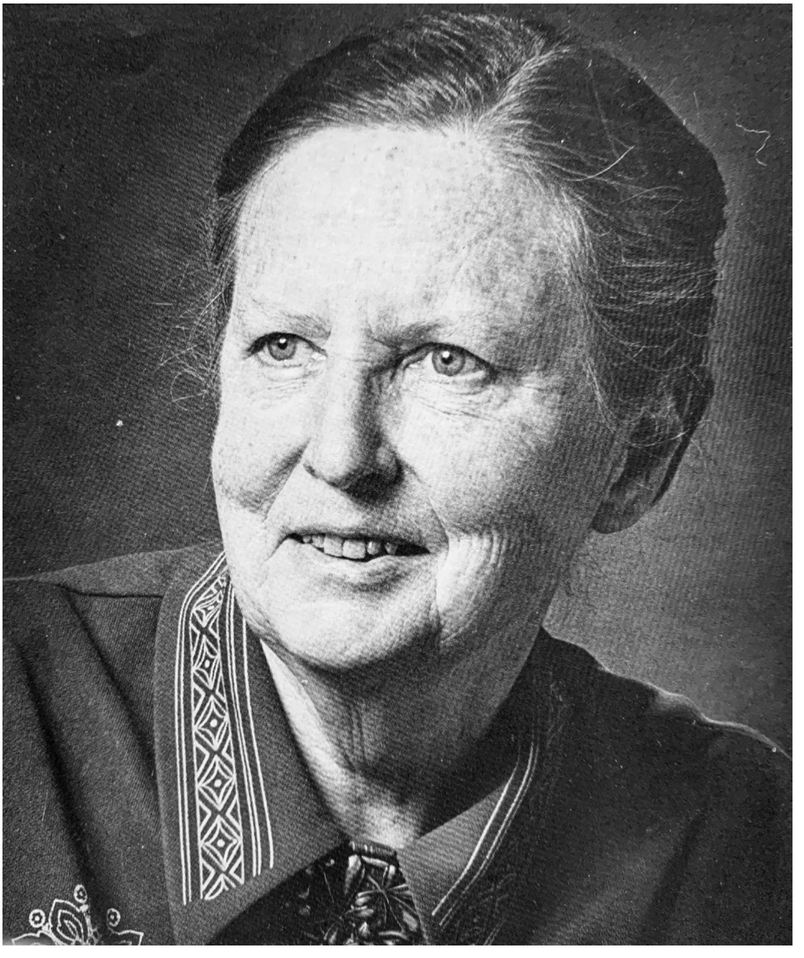

FIGURE 1. Carleen Maley Hutchins (1911–2009). Portrait c.1990. Copy in Carleen Hutchins Papers, Stanford University Department of Special Collections and University Archives.

The Early Years

The era in which Hutchins came of age was not an era of equality for women. Twentieth-century America was a giant pendulum of expectations for women, exemplifying journalist Gail Collins's notion that the history of women in the United States is primarily a "struggle to straighten out the perpetually mixed message about women's role that was accepted by almost everybody of both genders."[2] It may be that Hutchins' forceful personality and her inclination to reject many traditional expectations for women was because she was not raised in a home that insisted on conformation. She told Paul Laird, "I didn't do things intentionally to be different, but I went my own way . . . I've just done what I was interested in doing and . . . it didn't fit with what was going on with . . . a lot of people most of the time."[3]

She graduated from Cornell University in 1933 with a degree in biology education and found teaching jobs, most notably at the Brearley School, a private girls' school on the Upper East Side of Manhattan. A decade later than was typical then, at age 32 she married the Harvard-educated chemist Morton A. Hutchins and realized how radically her world would have to adjust to her husband's: "I realized his way of thinking and mine were utterly different . . . we just got married, and I had to fix my schedule so we could do it."[4] Likely, she was able to retain her teaching job at the Brearley School only because she had been single when hired there in 1938. In the early 1940s when she married, marriage bars were still in effect, but if a woman had been hired while single, she was not forced out of the job when she married.[5] Atypically, Hutchins continued teaching even after the birth of her first child, William, in 1947, but three years later, with Carleen again pregnant and finally giving up her position at Brearley, the couple moved to Montclair, New Jersey. There, they joined Carleen's parents in the Maley family home. Caroline was born there in 1950, and although Carleen was then a "stay at home mom," little about the Hutchins family fit the image and expectation of the new suburbia. The house was strewn with viola parts and woodworking tools, and much of Carleen's work in those years was done at her kitchen ta-

2. Gail Collins, *America's Women: 400 Years of Dolls, Drudges, Helpmates, and Heroines* (New York: HarperCollins, 2003), xiv.

3. Paul Laird, "The Life and Work of Carleen Maley Hutchins," *Ars Musica Denver* 6/1 (Fall 1993). Reprinted on the Catgut Acoustical Society website, accessed November 23, 2019. http://www.catgutacoustical.org/people/cmh/index.htm.

4. Whitney, *American Luthier*, 40.

5. Cf. Claudia Goldin, "Marriage Bars: Discrimination Against Married Women Workers, 1920s to 1950s," Working Paper No. 2747 (October 1988), National Bureau of Economic Research. DOI: 10.3386/w2747. Marriage Bars were common in education and clerical work, mandating that married women should not be hired. Rationales for such bars in the years after the world wars included that the jobs should be reserved for returning servicemen or for single women who needed the employment since they were not supported by a husband.

ble, with tools arranged in the grooves of the circular condenser on the refrigerator.[6] In a 1953 newspaper article, Hutchins is quoted as saying, "I poach two eggs each morning for the children, using a three-hole egg poacher. In the third hole I put my glue pot to warm."[7] While modern sensibilities cringe at the reporter's further claim that "Mrs. Hutchins . . . does not let her hobby interfere with her household duties," it was some time before Hutchins herself considered her viola making anything other than a hobby. Only after she had become involved with acoustical research did her perspective on her role in lutherie appear to begin shifting.

Hutchins seemed incapable of separating herself from the fiddles or of integrating them with other aspects of life. For her, there were only fiddles, and anyone who came within her orbit was sucked into the vortex of her obsession. Her friends and acquaintances were central to her achievements, and she did not hesitate to use any and all connections. When Helen Rice was hired as head of the music department at Brearley, Hutchins' was introduced to an influential new network of people. Rice, a young lady from American aristocracy who moved in refined circles, had the connections—and the willingness to use them on her friend's behalf—that allowed Hutchins entrance into that society. Hutchins mentioned to Rice that she thought she could build a better viola than the $75 Hornsteiner she was playing. Rice laughed uproariously and responded that if Carleen built a viola, she would eat her hat. Indeed, she finally did that very thing, wearing and then cheerfully eating a cake hat on the occasion of Hutchins' first rehearsal with the viola she had made, the viola that changed the direction of her life. It had taken her almost two years, primarily following Edward Heron-Allen's book.[8]

This viola and all those to follow are labeled with a "SUS" number, a numbering system for which Rice is indirectly responsible. Rice's family farm in Stockbridge had a sow that had given birth to piglets. Rice knew that as a biology teacher, Hutchins collected all manner of critters for her classroom and thought she would surely like to have a class pig. The first time the two women met, Rice bribed Hutchins with a piglet. She prom-

6. Audrey Brown, "Home is the Workshop," *Montclair Times* (February 7, 1952), cited in Whitney, *American Luthier*, 53.

7. Frank Eakin Jr., "Violas the Product of this Montclair Woman's Hobby," *Newark Sunday News* (November 8, 1953). Also cited in Whitney, *American Luthier*, 53.

8. Edward Herron-Allen, *Violin-Making: As It Was and Is: Being a Historical, Theoretical, and Practical Treatise on the Science and Art of Violin-Making for the Use of Violin Makers and Players, Amateur and Professional* (London, 1884).

ised her a piglet, *if* Hutchins would play viola in her students' ensembles. Hutchins agreed immediately. They named the pig Susie Snowwhite—as a play on the Latin word for pig, *Sus*. Although it came as a surprise to Rice, who said she did not see the connection between Susie Snowwhite and Hutchins' instruments, in apparent homage to the friendship that got her started, Hutchins' instruments have SUS numbers, rather than opus numbers.[9] In the end, they ranged from SUS 1 to somewhere around SUS 485 or so. This numbering system presents several challenges. First, she regularly rebuilt an instrument and then gave the rebuilt instrument a new number. Unfortunately, the record keeping is inconsistent, and for most instruments, it is impossible to tell which instrument was reworked and renumbered. Occasionally, the transfer can be traced, as is the case with SUS 176, which was reconfigured as SUS 204 (a cello). There does not seem to be an opus list of the instruments at all, perhaps because so many hands were involved that it becomes difficult to assign authorship to any one person. Hutchins welcomed scores of young violin makers into her home to learn about lutherie, and when she ultimately turned her attention to science and the idea of a violin family, she was working on these issues with entire teams of violin makers. Some work sheets and study sheets indicate who performed what work on an instrument and when, but such records are relatively scarce and entirely inconsistent, appearing only in the later years. For example, SUS 192 (1983), a tenor, has work charts indicating the ribs were made by L. W. Dunham, joined by L. Carlson, routed by Hutchins, hand-finished and assembled by H. K. Jackson, final varnish and adjustments by Hutchins.[10] Occasionally, the

9. Helen Rice, dictated to Gaby Biden (1980), as relayed in Rustin McIntosh, Helen Rice: *The Great Lady of Chamber Music* (Burlington, VT: George Little Press, 1983), 134. Rice described Susie Snowwhite, immaculately white, tearing up and down the halls at Brearley, skidding and pirouetting like a lamb. The girls got to take Susie home on weekends, but they were required to produce a written invitation from their mothers to do so.

10. A chart notation indicates the instrument was sent to Mark Wilkeus in Palo Alto, California May 26, 1992 on approval for a $8,000.00 purchase price. No further information is given, and the current location of the instrument is unknown. While purchase approval loans have always been common in violin sales, Hutchins was extraordinarily generous about loaning her instruments, sometimes to her detriment. One such loan, of cello SUS 200 (1979) to Frederick Goldstein, was stolen from Goldstein's car in New York City. Insurance paid $9,000.00 for the instrument, but the cello was never recovered (at least, recovery is not noted in the archival records). SUS 250 (1983), a 16 ¼" Gasparo model viola, was purchased by John Rosenberg in 1988 but stolen from his car in California the following year. SUS 247 (1983), a 16 ¾" Gasparo model viola, was on loan to Jheng Wang of Shanghai when he dropped it, cracking the upper left top. It was returned to Hutchins and repaired.

instrument's label will indicate this information.

Acoustics Research

Rice also introduced Hutchins to Frederick Saunders, a retired Harvard physics professor. As Hutchins talked with Saunders, she realized the acoustical research he was doing in his retirement was seriously hampered by his lack of access to instruments on which he could experiment. Saunders's career had been spent in optical spectrometry, but as an amateur musician with retirement time on his hands, he wanted to see what he could learn in acoustics. He discovered, of course, no one wanted to let him experiment on Stradivari or Guarneri violins. It struck Hutchins that this was a way she could help: by building instruments on which Saunders could conduct these experiments. Therefore, most of the instruments Hutchins made in the 1950s and early 1960s were instruments specifically for Saunders to use in his acoustical experiments, in which she became increasingly involved. Saunders and Hutchins, when she joined the project, used an acoustic analyzer for harmonic analysis of notes produced on the violins, compared intensity curves, and electromagnetically analyzed vibrations using an oscilloscope. The original idea was to use scientific methodology to determine what made a violin "great" and, upon identifying those elements, to be able to replicate such instruments in a scientifically intentional way, rather than continuing to rely on the mystical transmission of the ways of lutherie in a time-honored tradition of father to son, master to apprentice. While the latter aspect of this idea is laudable, the "great" instrument aspect of the premise was problematic—even if a consensus could be reached about how to define "great." In the early stages, even Saunders was working from an "old is better" premise. "Old" vs. "new" is a false dichotomy, though, when so precious few of the "old" violins are *entirely* old and purely the fabric of their original maker.

The desire to use scientific methodology to isolate qualities that create the purported magic of the classical Italian violins has a flip side: a persistent aspiration to *improve* on the classical Italian model. Even as players, dealers, and collectors venerated late-seventeenth- and eighteenth-century, northern-Italian instruments as the gold standard, experimentation throughout the nineteenth and into the twentieth centuries was relentless in pursuit of a violin that was more audible, more responsive, more eventoned—or whatever the superlative-du-jour happened to be. Scientifically based violin experimentation in the nineteenth century by makers like François Chanot, Jean-Baptiste Vuillaume, Félix Savart, Johann Georg Stauffer, Thomas Howell, Nicolas Sulot, and Alfred Stelzner sometimes led to instruments that departed from classical models. Saunders rekindled interest in this scientific spirit of investigation, but trained his vision on consistent reproduction of the classical Italian masterpieces.[11] Return to the experimental bent would wait almost another thirty years for Hutchins to arrive on the scene, and yet a return it was. Hutchins was certainly not the first to take up the mantle of scientifically based violin research, but she did step into work that had been set aside for a number of decades. Most importantly, she passed on her passion for the work to succeeding generations so that research continues rather than languishes once again.

Most of the collaborative research between Saunders and Hutchins was conducted via mail. Instruments were shipped back and forth, and reams of mailed correspondence discussed the processes and results. Research papers exploring and reporting on their findings exist in dozens of drafts, each bleeding with comments and suggestions from the others. In the thirty-some years Hutchins participated in this research, numerous outstanding scientists were drawn into the work, scientists such as Saunders, Alvin S. Hopping, John Schelleng, Karl Stetson, Robert Fryxell, and Oliver E. Rogers. Some of the scientists were retired, and nearly all of them were highly respected in other scientific fields, rather than in acoustics. Often they were amateur musicians themselves, and found themselves completely powerless against the magnetism of Hutchins' personality and passion. They could see she was on to something and were delighted to become involved in the studies in their spare time. Robert Fryxell, for example, was a chemist involved in high-temperature research for General Electric, a part of nuclear submarine and aircraft development. He was also a cellist, and he participated enthusiastically in re-

11. Nineteenth-century violin experimentation has been the subject of several excellent research studies in the last decade by scholars such as Christina Linsenmeyer, beginning with her dissertation: *Competing with Cremona: Violin Making Innovation and Tradition in Paris (1802–1851)* (PhD diss., Washington University, 2011). https://doi.org/10.7936/K74T6GFN. See also Sarah Gilbert, *Intersections of Music and Science in Experimental Violins of the Nineteenth Century* (MM thesis, Florida State University, 2013). https://pdfs.semanticscholar.org/ca37/dafa1c5c9a4f57dea422dddcc277b2cb46a6.pdf?_ga=2.54111979.2101405931.1586546724-1025988631.1586546724.

search and experimentation with Hutchins, editing the Catgut Acoustical Society (CAS) newsletter until his death in 1988. Erik V. Jansson, a Swedish physicist now retired from the KTH Royal Institute of Technology, who carried out substantial and important violin acoustics research throughout his career, became a CAS member in 1972. He worked with Hutchins on several editing projects, but although they shared data, contacts, and findings over the years, they never collaborated in published writings. In fact, while they remained professionally cordial, Jansson and Hutchins did not always see eye to eye when it came to violin acoustics and Jansson at times raised questions about her methodology and focus.[12] When Hutchins started publishing more often as a sole author on a study, she continued to have scientists read her drafts prior to publication. The older she got, however, the less likely she was to incorporate the suggestions of those reviewers into the final form of a paper of which she was

12. A February 1997 letter from Jansson to Hutchins reminisces: "I was young when I very early in 1968 found my way the first time to 112 Essex Avenue . . . . 'Much water has passed under the bridges of Paris since then' as we say in Swedish. We have had our nice meetings both with agreements and some disagreements. All this has ment [sic] a lot to me." Erik V. Jansson, letter to Carleen Hutchins, February 24, 1997. Stanford Digital Repository, Stanford University Special Collections. https://purl.stanford.edu/yg961hd4399.

A letter from Hutchins to Jansson several years prior to this displays some alarm (not to mention condescension) when Hutchins felt her work questioned. She writes, "Dear Eric: [sic] The comment in your letter that you would check the A1 and B1 peaks in redoing my work has me worried. If you will read the enclosed reprint carefully, you will learn that I am measuring the A1 peak from the inside air to air test in the lower bout and comparing its frequency spacing with the dip caused by the B1 mode absorbing energy from the air to air test. I do not use the apparent B1 peak frequency on the input admittance curve. I am sure you know that the peaks on the input admittances curve do not always represent modes of vibration or their correct frequencies. The A1-peak-to-B1-dip spacing was worked out with Art Benade several years ago theoretically using 'Math-Cad.' Also, I haven't said much about it but with the help of Skudrzyk, I know the two mechanisms which control the playing qualities of a violin as the A1-B1 delta frequencies change. . . . It will be interesting for you to try to check my measurements, but I see no need for you to do a full-scale research program on this work and write papers on it since I have it well in hand here and will be publishing more soon. Perhaps you can investigate some of air-wood mode couplings in the 1,500 to 2,500 Hz range." Hutchins, letter to Jansson, June 13, 1991. Stanford Digital Repository, Stanford University Special Collections. https://purl.stanford.edu/yg961hd4399.

In a typically gentle manner, Jansson responded shortly thereafter: "I admire you and your work very much and I do want to see you continue it the way you feel is right. Still I need to follow my own ideas in my way. It seems that differences in way of working (you are working with real violins while I am working with simplified models and rather crude manipulations) at some instances have caused 'friction.' If you find so please tell me and I shall do my very best too [sic] straighten things out—my main interest is that we both shall be able to follow our roads as we find the best. In this way I believe the most is gained." Jansson to Hutchins, June 16, 1991. Stanford Digital Repository, Stanford University Special Collections. https://purl.stanford.edu/yg961hd4399.

the sole author listed. All this aside, the scientists thought Hutchins would be useful as a bridge between the worlds of science and music. Arthur H. Benade (1925–1987), a low-energy atomic and nuclear physicist at Case Institute of Technology in Cleveland, wrote a letter to Earle L. Kent (1910–1994), Director of Research, Development, and Design for the C. G. Conn Company in Elkhart, Indiana, as they were planning the 1964 convention of the Acoustical Society of America (ASA). Benade urged Kent to allow a good deal of time in the program to Hutchins because "to the extent that she can convince [music] people that science has a contribution even to something as sacred as violins, to that same extent we will have succeeded in our purpose."[13]

In the end, Hutchins contributed a large body of work to the field of violin acoustics. Including her Catgut Acoustical Society newsletter and journal publications, conference presentations, local and regional meetings and gatherings, she produced in the vicinity of 130 discreet studies (a selective bibliography appears in the appendix to this article). That is notably prolific and was significant in propelling the discipline forward. In 1981, Hutchins received the inaugural Silver Medal in Musical Acoustics of the Acoustical Society of America, becoming the first—and as yet only—woman to receive this honor. The medal is given on an irregular basis "for contributions to the advancement of science, engineering, or human welfare through the application of acoustic principles, or through research accomplishments in acoustics." Seven years later, the ASA bestowed an Honorary Fellowship on Hutchins, again the first and only woman among luminary recipients such as Thomas Edison. The honor is given to an individual who has "attained eminence in acoustics or who has rendered outstanding service to acoustics." Even when scientists felt unable to lend whole-hearted support to her acoustical theories, they were cognizant of her tremendous role in garnering attention for scientifically based violin research.

Hutchins' most compelling scientific contribution was her theories of tap tones, the sounds a violin maker hears by tapping and flexing the free plate (i.e., front or back, not yet attached to the ribs) after the plate

13. Arthur H. Benade, letter to Earle L. Kent, n.d. [1964]. Carleen Hutchins Archives, National Music Museum, Vermillion, SD. Benade's second reason for suggesting a good amount of time allotted to Hutchins was even less complimentary: by this point in the schedule, the audience would have been strained after the presentation of much complicated material, and hearing a little music would be a "pleasant relief."

is graduated to nearly the desired thickness (2–4 mm for the top and 2–6 mm for the back), still unvarnished, including purfling but excluding f-holes. Plate thickness has long been a hot button for luthiers, because the line between too thin and just right is razor fine indeed. Dealers, collectors, and makers are renowned for their wariness if they discover an instrument's thickness is going to be measured and recorded.[14] Hutchins wanted to take the mystery out of tap tones and use science (specifically eigenmodes) to guide plate graduations. She believed that a scientific methodology would be far more likely to permit consistent replication for amateur violin makers, and even for master luthiers attempting to teach apprentices what they are listening for with their tapping and flexing.

Her method involved an application of a technique developed by Ernst Chladni (1756–1827), in which the motion of vibrating plates could be studied by sprinkling a metal plate with sand and observing the patterns formed when the plate was excited. Chladni discovered that characteristic patterns could be related to the physical dimensions of the plate. Hutchins mounted the violin plate on foam pads and sprinkled the plate with sawdust or aluminum flake. An audiogenerator generated a sine-wave sweep, which was transmitted through a 10 W amplifier and a 15 cm loudspeaker. As the sine wave swept through a chosen frequency range (~50–500 Hz), the plate modes of vibration could be observed as the flakes bounced out of the active antinodal areas and gathered along the nodal lines whenever the frequency of the input signal matched the frequency of a plate mode. Eigenmodes are the bending modes that cause the flakes to bounce out of the actively moving areas. They occur at the frequencies that form the plate resonances. Hutchins' goal was to make the top and back plates for each violin in the sized octet (described below) show the same mode sequence. As the respective plates varied in length, however, each size would have its own unique frequency value for each mode in the sequence. She determined that Modes 5 and 2 were most helpful in measuring and judging the resonant characteristics of the free plates.[15]

14. Cf. James N. McKean, "The Thickness of an Instrument's Top & Back is Measured in Tenths of Millimeters, but There is No Perfect Formula," *Strings*, "Instruments, Bows, and Gear" blog (February 20, 2018). https://stringsmagazine.com/the-thickness-of-an-instruments-top-back-is-measured-in-tenths-of-millimeters-but-there-is-no-perfect-formula/. McKean relates the tale of examining a Stradivari at Jacques Francais's shop in New York and having Francais tear up a measurement chart when he realized McKean and his friend were recording graduations.

15. Carleen Hutchins, "Tuning of Violin Plates," "Bowed Instruments and Music

Her theories were not entirely correct, and tap tones are not the magic formula she may have hoped. A maker cannot simply isolate one modal response in a free plate and expect to work the same way in an assembled instrument. Hutchins knew that, but she had neither the years of life nor the sophisticated equipment necessary to follow it through. While the completion of this work remains for others, she did accomplish a critical step. In the 1950s makers were more or less oblivious to the octave relationship between Modes 2 and 5. In the present day, many makers seem to pay close attention to their tap tones, though perhaps not as many now as in the 1990s and early 2000s. James McKean, a New York luthier, tracked tap tones religiously at one point but came to believe the data was irrelevant—it was interesting but made no difference in the finished violin. He cited acoustician Norman Pickering as having observed that he was convinced it was the very inexactness of the thicknesses in older violins that contributed to the richness of their sound.[16] Whitney devotes significant space to quoting a thread from the Violinist.com blog, posted in 2012, in which luthiers were commenting specifically on Hutchins's almost-but-not-quite tap tone theories. Most notable is that, without exception, they acknowledged the need to credit Hutchins as a powerful voice in promoting the science of violin making, even though tap tones proved to be less prescriptive of violin quality than Hutchins had passionately argued.[17] Anders Askenfelt, now a professor in music acoustics and chair of the department of Speech, Music, and Hearing at the KTH Royal Institute of Technology in Stockholm, who worked with Hutchins from the late 1970s, believes the respect garnered by Hutchins in the scientific community reflects

> a mix of admiration of her efforts to apply scientific methods without being theoretically prepared for doing that, and above all her drive to get things done. An uncountable number of experiments would never have been performed without her, either by herself or by somebody else who became engaged (or was more or less commanded to do it). She did her best, given her level of training in science. Of course. . . she saw what she wanted to see in

Acoustics," typescript. Hutchins Archives, National Music Museum. Cf. Hutchins, "Tuning of Violin Plates Related to Possible Air-Mode Couplings in the Finished Instrument," Eleventh International Congress on Acoustics (1983).

16. McKean, "The Thickness of an Instrument's Top & Back." See n14 above.

17. David Burgess, Marc Cicchetoo, John Soloninka, and Bob Spear, as cited in Whitney, *American Luthier*, 89–90.

measured results, and perceptual evaluations were far from rigorous, etc. . . . her academic Catgut friends took her aside at conferences and tried to correct misunderstandings of acoustical/physical principles and concepts which had blurred her reasoning and conclusions. But all such blunders of various kinds (which effectively would have [ended] the career of a real academic) didn't matter."[18]

Jansson's thinking is along the same lines. He said, "I find it difficult to give a non-biased neutral judgment of Carleen as a scientist . . . [but] as person I found Carleen very good [at getting] things done—[she gave many] workshops and [was an] efficient collector of information. The information collection resulted in two volumes of Benchmark Papers on Violin Acoustics and two volumes of violin research papers [spanning twenty years]."[19]

While Hutchins promoted lutherie through scientific methodology, at the same time, she failed to follow accepted scientific methodology related to the research itself, particularly questions of sample size, repetition and reproduction of results, depth, and double-blind testing. In her later years, she did not always react well to scientific challenges either, as is reflected in the account relayed by several people of an incident at a professional conference in which Hutchins received pushback against her belief that perhaps the single key to making excellent-sounding violins was the tuning of modes 2 and 5 in the free top and back, along with the so-called Delta (the frequency difference between B1 and A1 modes). A number of scientists, including Janssen, argued the plate tuning and Delta at best could be viewed as guidelines, and that much "silent" knowledge learned from traditional violin making was necessary in the making process. However, allowance of intangible knowledge that could not be accounted for with science was an idea Hutchins refused to accept. One scientist finally said to her, "So it is a cookbook recipe." Hutchins became upset and nonetheless insisted, "It's not, it's science!"[20]

Additionally, Hutchins's research facilities consisted of her kitchen, basement, driveway, or under her porch and were far from acceptable laboratory settings, certainly not conducive to results in which there was little possibility of environmental interference. While she worked with

18. Anders Askenfelt, personal correspondence, May 12, 2020.

19. Erik Jansson, personal correspondence, May 20, 2020.

20. Askenfelt, personal correspondence, May 12, 2020.

highly trained scientists, Hutchins herself never was trained in physics, and she never had research privileges in a university laboratory. She did have four honorary doctorates, but no earned doctorate.[21] Her intelligence was remarkable—brilliant even. To learn as much as she did of acoustics on her own was a stunning achievement, and the same can be said of her achievements in lutherie.

Lutherie

In an unexpected twist, Rembert Wurlitzer provided a golden opportunity for Hutchins to continue her inquiries in violin making. For unknown reasons, though perhaps because of contact with one of his employees, Wurlitzer appeared on the Hutchins's Montclair doorstep in early January 1959 and by the end of the afternoon had offered her the opportunity to work with Simone Fernando Sacconi (1895–1973), an Italian violin maker who immigrated to the US in 1931 and joined Wurlitzer's shop in 1951. The deal had strings attached, however. Hutchins told Whitney she was instructed to come on Saturday, bypass the shop level, and go to the third floor and only the third floor, so the other violin makers would not be upset about a woman working with Sacconi.[22] This was the procedure, off and on, for about four years. Later, this secrecy created problems for Hutchins because no one believed her when she said she—a woman—had worked with Sacconi. When Thomas Weinberg published his *Dictionary of American Violin Makers* in 1988, he removed any reference to Sacconi in Hutchins's biographical entry. When Hutchins confronted him on this at a conference later in the year, Weinberg challenged her to provide written evidence that she had worked with Sacconi. Hutchins decided it was worth it to obtain that proof, and she eventually was issued a letter from Lee Wurlitzer, Rembert's wife: "Rembert and Mr. Sacconi would be very proud [of your instruments on display at the Metropolitan Museum], they were both so interested in your work. Mr. Sacconi would be especial-

21. Her use of the honorific title probably did not endear her to the very scientists she was trying to impress and leads one to wonder if, buried deeply, she did feel the inadequacy of her training. She certainly never admitted as much aloud. Hutchins did earn a MA in education from New York University in 1942.

22. Whitney, *American Luthier*, 125.

ly pleased since he worked with you so often."[23] To be fair, Weinberg was not unreasonable in his insistence on evidence of Sacconi's tutelage, but simply to delete the reference on the assumption of falsehood does have earmarks of misogyny.

Hutchins had the same central problem with much of the acoustical experimentation in which she participated, as well as with her difficulty finding acceptance in the violin world in general: well-meaning as she was, even at the height of her lutherie skills, Hutchins's violins were a far cry from being consistently superior-quality instruments. Certainly, a great deal of value can be learned—and *was* learned—utilizing a reasonably well-made instrument like those Hutchins built throughout her life for research. But it is difficult to stretch generalizations discovered on a mediocre violin to conclusions about a master instrument, regardless of when or where the master instrument was built. Nowhere in the dozens of articles Hutchins wrote or in the countless presentations and lectures she gave does she address or acknowledge this obstacle. Nevertheless, in the early years of this experimentation, the whole point was to use science to build better violins rather than continuing to rely on mysterious violin lore and tradition passed down through generations of violin makers, father to his son, master to his apprentice. Hutchins was perhaps poised a bit prematurely at the intersection of theoretical experimentation and practical application. Research in hard science is a protracted, slow process, and the application of results is a long time in coming, born from a different set of questions than those that led to the initial—and necessary—theoretical studies. Hutchins's central thesis was that all matter exists in relation to natural laws. There should be, therefore, an observable, provable, and reproducible reason that any violin is a great one—but the challenge is to make great instruments consistently. Science is a tool with which to analyze what makes an instrument great. Hutchins's critical flaw was pushing theoretical science too quickly to practical application. Regardless, if only by dint of hammering the violin community with study after study, after idea after idea, Hutchins was a singular driving force in bringing violin acoustics repeatedly to the forefront of thinking in the violin world, and keeping it there. Agree with her or not, question her methods or not, she got the violin world thinking about the role of acoustics in violin making. From the luthier's point of view, however, her instruments were

23. Lee Wurlitzer, letter to Carleen Hutchins, July 1, 1989. Hutchins Archives, National Music Museum, Vermillion, SD.

unexceptional. She made several quite lovely instruments, particularly violas, but a luthier's goal is consistent excellence. That was not a feat she could claim. Today, her non-experimental, traditional instruments are available, but some dealers have opted against accepting them for resale because even the traditionally patterned instruments may be just slightly off in the measurements per Sacconi. That makes them hard to play, and even harder to play in tune, because intervallic spaces on the fingerboard are inconsistent. Some other dealers who have accepted traditionally patterned Hutchins instruments have been unable to sell them. One of her cellos auctioned for $8,400 in 2015, while the violins and violas, when they do sell, tend to auction in the low $3,000-range, which would be considered within the realm of decent student instruments or a back-up instrument for a professional.

Early Thoughts of a Family of Violins

In the full spectrum of Hutchins's life work, her focus made several consequential shifts. The first was the shift from hobbyist viola maker to participant in scientific experimentation, and the next—more gradual but nonetheless pivotal—was her passion for a homogenous family of violins, akin to the Renaissance families of instruments such as the recorder or viola da gamba families. By 1958, Hutchins had met the composer Henry Brant (1913–2008), known for his contrapuntal spatial music, in which he considered space as a fourth dimension after pitch, rhythm, and timbre.[24] An extension of those ideas was his interest in composition for multiples of the same instrument, sometimes altering instruments to obtain a timbral consistency. *Angels and Devils* (1931), for example, is scored for three piccolos, five concert flutes in C, and two alto flutes. Not surprisingly, then, he mused to Hutchins about having the timbre of the violin carried across the full range of the piano keyboard, i.e., seven other ranges from a sub-bass to an octave above the violin. When Hutchins was awarded a three-year Guggenheim Fellowship (1959), the deal was sealed for her to undertake what would become her final focus: building the violin octet, eventually known as the "new violin family." The fellowship was awarded for testing musical instruments, as by then she had become so immersed

24. Kyle Gann and Kurt Stone, "Brant, Henry (Dreyfuss)," *Oxford Music Online*. https://doi-org/10.1093/gmo/9781561592630.article.03850. Cf. Brant's *Antiphony I* (1953).

in the acoustics of the violin family that she was not only making instruments on which Saunders could experiment, but was conducting experiments herself and writing bales of letters back and forth with Saunders and others about their experiments. Notably, Hutchins was the first violin maker to receive a Guggenheim.

Saunders's and Hutchins's experiments revealed to them fundamental acoustical differences among each of the traditional violin family instruments: the violin, viola, cello, and double bass. In 1937, Saunders had published research in the *Journal of the Acoustical Society of America* identifying the position of the main body resonance and main cavity resonance in a small number of violins he had tested, but in his collaboration with Hutchins the task was to determine how to tune those resonances in an instrument with some degree of predictability.[25] Hutchins indicated that their first eight years of work together was consumed with testing the various features of violin construction, one at a time. She wrote, "We determined the effect of variations in length, shape, and placement of the f holes, position of the bass bar and sound post, significance of the inlay of purfling around the edges of top and back plates, and frequency of the cavity resonance as a function of rib height and f hole areas."[26] However, Hutchins was also forced to acknowledge that most of that research had been left unpublished because at that point the necessary equipment for definitive testing was not available. Nevertheless, with those test results, work proceeded with four factors in mind:

1. location of the main body and main cavity resonances of several hundred conventional violins, violas and cellos tested by Saunders et al.
2. the desirable relation between main resonances of free top and back plates of a given instrument, developed from 400 tests on 35 violins and violas during their construction (nearly all Hutchins's instruments)
3. knowledge of how to change frequencies of main body and cavity resonances within certain limits (learned, according to Hutchins, "not only from many experiments of altering plate thicknesses, relative plate tunings, and enclosed air volume but also from construction of experimental instruments

25. Main body resonance is the lowest fundamental resonance of the wood structure. Cavity resonance is the resonance of the air in the instrument cavity. Cf. F. A. Saunders, "The Mechanical Action of Violins," *Journal of the Acoustical Society of America* 9 (1937): 81.

26. Carleen Hutchins, "Founding a Family of Fiddles," *Physics Today* 20/2 (February 1967): 23. https://doi.org/10.1063/1.3034148.

Newsletter No. 1
May 1, 1964

7.

CATGUT ACOUSTICAL SOCIETY

List of CHAPTER MEMBERS
as of May 16, 1963

+President: Frederick A. Saunders; - South Hadley, Mass.
Vice- President: John C. Schelleng; 301 Bendermere Ave., Asbury Park, N.J.
Secretary: Carleen M. Hutchins; 112 Essex Ave., Montclair, N.J.

Apgar, Virginia; 30 Engle Street, Tenafly, New Jersey
Baker, Alice T.; 903 Park Ave., N.Y.C.
Benade, Arthur H.; Case Institute of Technology, Cleveland, Ohio
Blatter, Donald L.; 3820 Iroquois Ave., Erie, Pa.
Brant, Henry ; Bennington College, Bennington, Vt.
Brockway, Joan ; Bennington, Vt.
Carboni, William ; 13 Arthur Court, Closter, N.J.
Condax, Louis ; 215 Hoffman Road, Rochester 22, N.Y.
Dautrich, + Jean and Helene ; RR 1, Litchfield, Conn.
Eggers, Frieder ; Bell Telephone Laboratories, Murray Hill, N.J.
Finckel, George ; Bennington College, Bennington, Vt.
Fletcher, Donald ; 1783 Norm Place, Seaford, N.Y.
Fryxell, Robert E. ; 7355 Drake Road, Cincinnati, Ohio 45243
Fuchs, Lillian ; New York City
Geis, Irving ; 4700 Broadway, N.Y.C.
Gorrill, Sterling W.; 50 Colonial Parkway, Manhasset, N.Y.
Haagensen, Cushman ; Piermont, N.Y.
Hegeman, Stewart ; 176 Linden Ave., Glen Ridge, N.J.
Hinckley, Mary W. 35 E. 85th St., N.Y.C.
Hunkins, Sterling ; 302 Eighth Ave., N.Y.C.
Hutchins, Morton A. ; 112 Essex Ave., Montclair, N.J.
Jacobi, Irene ; 1155 Park Ave., N.Y.C.
Kellert, Ellis ; 1055 Brierwood Boulevard, Schenectady, N.Y.
Kimball, Maxwell ; 22 Marston Place, Glen Ridge, N.J.
Kroll, William ; 50 W. 67th St., N.Y.C.
Kvam, Arnold K.; Douglas College, New Brunswick, N.J.
Levine, Julius ; 101 W. 78th St., N.Y.C.
Mankovitz, David ; 36 Hillside Ave., Englewood, N.J.
McDonald, Gordon ; 3914 Sassafras St., Erie, Pa.
Moe, Henry Allen ; 25th Floor, 149 Broadway, N.Y.C. 10006
Monosoff, Sonya ; 125 Hicks St., Brooklyn Heights 1, N.Y.
Mortimer, Harvey ; 109 Alexander Ave., Upper Montclair, N.J.
Pruyn, Peter ; 545 West End Ave., New York City 10024
Rice, Helen ; 15 W. 67th St., N.Y.C. 10023
Robinson, Bernard W.; 366 Goldhawk Rd., London W.6, England
+Rood, Louise ; 35 South Park Terrace, Northampton, Mass.
Scott, William and Ethel ; 44 W. 11th St., N.Y.C. 10011
Skudrzyk,Eugen ; Penn. State University, University Park, Pa.
Smith, J. Kellum ; 131 E. 66th St., N.Y.C.
Stokowski, Leopold ; New York City
Treat, Asher ; 51 Colonial Parkway, Dumont, N.J.
+Wurlitzer, Rembert ; 120 W. 42nd St., N.Y.C. 10018
Zaslavski, Sam ; 2835 Webb Ave., Bronx 68, N.Y.
Zerbe, Louis and India ; 52 Briarwood Terrace, Cedar Grove, N.J.
Montclair State College, Upper Montclair, N.J.

+= deceased

FIGURE 2. Catgut Acoustical Society founding members. (*Newsletter of the Catgut Acoustical Society* 1/1 [May 1964]: 7).

with varying body lengths, plate archings, and rib heights"[27]) and of resultant resonance placements and effects on tone quality in the finished instruments

4. observation that the main body resonance of a completed violin or viola is approximately seven semitones above the average of the main free-plate resonances, usually one in the top and one in the back plate of a given instrument.[28]

As the work proceeded, however, and especially after Saunders's death, the focus turned increasingly from the original idea of looking for the scientific, replicable evidence of what makes a violin "good," to a narrowing concentration on Brant's suggestion of a range—a family—of violins that spanned the compass of the piano keyboard. The project had been adopted in mutual agreement between Saunders and Hutchins because they believed the concept was closely related to their experimental work. Even at that point, a focal shift becomes evident as Hutchins describes the main problem facing them in building a set of eight instruments: to produce the dynamics, expressive qualities, and overall power characteristic of the violin, across the entire frequency range.

The Catgut Acoustical Society

Toward the larger aim of acoustical research in stringed instruments, the Catgut Acoustical Society was formed in May 1963 in Hutchins's backyard, gathered around a ping-pong table.[29] Including those considered as members though not present at that initial meeting, approximately thirty people were dedicated to the "support and development of new musical instruments and improvements on existing instruments"[30] (fig. 2). CAS did not assess dues for several years, and initially some discovered they had simply been added to the membership ranks. Leopold Stokowski, for example, never attended any meetings or contributed to the CAS research or publications, and there is no membership request among ei-

27. Ibid.

28. Ibid.

29. David Schoenbaum erroneously places the first meeting of the CAS in Saunders's backyard (*The Violin: A Social History of the World's Most Versatile Instrument* [New York: W.W. Norton, 2013], 89), but both Laird and Whitney confirm its occurrence at 112 Essex, Montclair, New Jersey (Laird, see n3; Whitney, *American Luthier*, 125).

30. Masthead, *Journal of the Catgut Acoustical Society* 1/1 (1964).

ther the membership papers or the Stokowski papers. However, he was in the audience for at least one performance of the octet instruments and expressed sincere interest in and enthusiasm for the vertical viola on several occasions—and was thereafter found on the membership roll.[31] Another notable founding member and early officer was Dr. Virginia Apgar, an obstetrical anesthesiologist best known as the inventor of the Apgar Score, a quick and simple assessment of newborn baby health. Apgar and Hutchins became fast friends when Apgar was Hutchins's surgical anesthesiologist and they discovered they were both listed in Helen Rice's directory of amateur chamber music players. The most oft told and endearing story of their friendship revolves around thievery: there was a phone booth outside the hospital and Hutchins had noticed the shelf was a beautiful piece of spruce. She had the passing thought that the slab was so beautiful, it should have been a viola. She mentioned it to Apgar, and the two women in short order were down at that phone booth in the dead of night with a saw to get the spruce shelf out. Unfortunately, the plank they had brought along as the replacement shelf was slightly too big, so Apgar smuggled Hutchins into the hospital restroom with her saw and guarded the door, while Hutchins sawed the plank down to size. They pulled the spruce out of the telephone booth, replaced it with the now correctly sized plank, and Hutchins helped Apgar make her first instrument out of that piece of phone-booth spruce. Today it is the viola (SUS 37) in the Apgar Quartet at the Columbia University College of Physicians and Surgeons in New York City.

Hutchins's evident desire to be regarded as a respected scientist led to an ambitious agenda for CAS publications. With a rapidly growing membership, a biannual, peer-reviewed journal was added to the news-

31. In her inimitable way of turning a memoriam into publicity material for her violins, Hutchins wrote about Sterling Hunkins' death in the *CAS Newsletter*: "His wide reputation as a professional cellist was matched by his great generosity and understanding as a person. . . . it was he who came with Henry Brant asking for the new instruments of the violin family. . . . Their musical success can be in great part attributed to Sterling Hunkins. When Leopold Stokowski commented: 'No viola ever sounded like that before. It fills the whole hall,' it was Sterling Hunkins playing the vertical viola. . . ." *CAS Newsletter* 8 (1967): 1. Stokowski was never able to convince performers of the value of the vertical viola, and in late 1968 Hutchins built him a cornerless *da braccio* tenor viola, hoping this might be an alternative that performers would be more willing to accept. It was severely flawed in its balance, however, unstable and difficult to hold. Hutchins met Stokowski at Carnegie Hall in 1969 to test the instrument, and he kept it for about two years. He liked the sound, but "if you can't suit the players, you are out of luck," he said. Cited in Whitney, *American Luthier*, 142.

letter and was published until 2004, when CAS merged with the Violin Society of America as the CAS Forum. Hutchins saw the CAS journal as a source for final publishing of articles on violin acoustics comparable with the *Journal of the Acoustical Society of America*.[32] Some scholars found that notion unrealistic in that both *JASA* and *Acustica* welcomed papers on violin acoustics and had done so for decades. There was no need for an alternative peer-reviewed journal, especially because an academic needed to publish in journals with high scientific reputation; such journals are explicitly ranked by their impact factors, or subsequent citations. "It [the CAS journal] was no longer the (one and only) natural channel for fast and preliminary publishing of new results from full-fledged studies later aimed for the JASA/*Acustica*, or disseminating preliminary insights from fast-and-dirty experiments, or to share not yet fully developed ideas," lamented Askenfelt.[33]

Initially, CAS members gathered once or twice a year, sometimes at first at Helen Rice's Stockbridge home and later at the Hutchins home or at a member's residence in New York, before eventually settling into a more formal annual meeting routine. Hutchins was justly proud of the interdisciplinary nature of CAS membership. By 1967, membership had grown to just more than 100, including physicists, chemists, architects, electronic engineers, violin makers, composers, and performers. At its peak, the Society listed 700 members in its rolls, always reflecting a remarkably diverse group of people. For a substantial period of its existence, the CAS was rather marginalized and not considered to be a conventional part of the violin community. It was only gradually, as Hutchins's proselytizing gained wider audiences and those within the mainstream began to think about scientific approaches to lutherie—whether they agreed with Hutchins or not in the specifics—that CAS was accepted enough enter the fold of the Violin Society of America (2004). In the meantime, the interdisciplinary collaboration unique to the CAS was a hallmark of Hutchins's career, as well as a completely transparent approach to her work. This was a carryover from science, where the concept of teamwork had been prevalent for decades, but it was not typical of work in violins, at least outside of any given shop. Hutchins was characteristically blunt in her observation that sharing knowledge was critical to the continued

32. Hutchins, marginalia on CAS meeting agenda, May 1972, Carleen Hutchins Archives, National Music Museum.

33. Askenfelt, personal correspondence, May 12, 2020.

development of the violin—that is, to what lutherie could become in the future, rather than leaving that future to an obscure world of mystery.

This conglomeration of people in CAS, led by Hutchins after Saunders's death, determined that making a "good" violin entailed finding a measurable physical characteristic of the violin that differed from the viola, cello, and double bass. Their working assumption was that this controlling characteristic, as they called it, was the key—a single key—to what made the violin sound good. Hutchins and her colleagues tested several hundred instruments but could find no commonality in the placement of the two main resonances. Returning to a study she and Saunders had done in the early 1950s on Jascha Heifetz's Guarneri, Hutchins recalled that the main body resonance was near the frequency of the unstopped A 440 string and the main cavity resonance was at the unstopped D 294 string: that is, the two main resonances were near the frequencies of its two unstopped middle strings. With that information, she selected ten violins with their two main resonances within a whole tone of their two open middle strings, and found these to be instruments of particular musical desirability—based, of course, on her own personal opinion and tuning at modern pitch. Records do not indicate which specific instruments were so tested, but she writes that they included "Amatis, Stradivaris, Guarneris, and several modern ones."[34] The violas and cellos tested, in contrast, typically had main body and cavity resonances three to four semitones above the frequencies of their two open middle strings, even though the separation between the two main resonances was about the same (approximately a fifth). From this observation, Hutchins reasoned this relation of main resonances to the frequency of the open middle strings was the controlling characteristic they were seeking, and set about applying this principle to the task of building a set of eight violins that would span the range of the piano (fig. 3).

As Hutchins lays out their research methodology, modern eyes find gaping holes, but even in the 1970s and 80s, Hutchins's research was not universally accepted as sound science. Basing an entire body of work on the assumption that Heifetz's one Guarneri violin must surely carry the controlling characteristic, seeing no problem of logic in accepting a single characteristic as responsible for the quality of a violin, and accepting all this as sufficient evidence based on further testing of just ten additional vi-

34. Hutchins, "Founding a Family of Fiddles," 238.

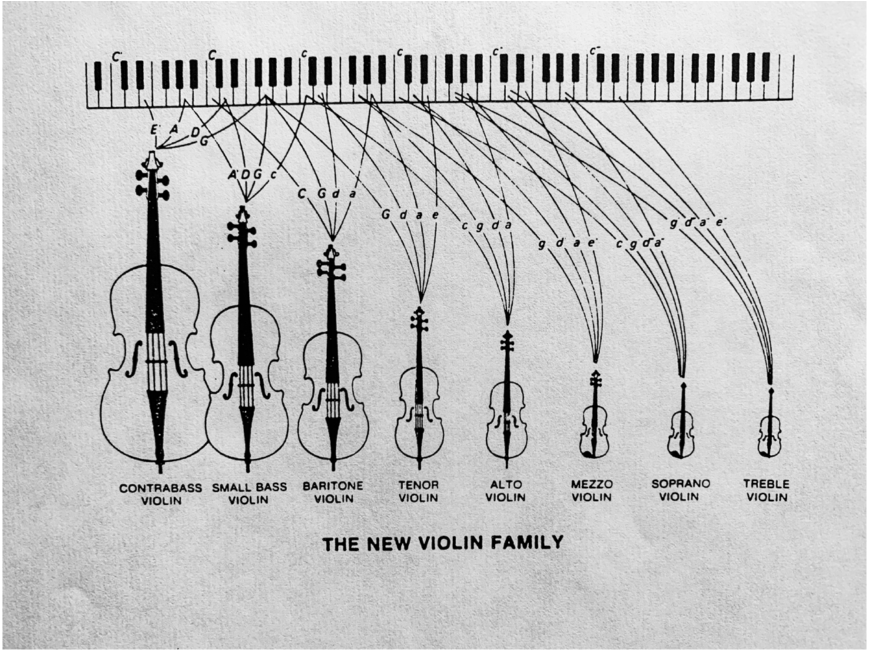

FIGURE 3. New Violin Family ranges. Copy in Carleen Hutchins Archives, National Music Museum, The University of South Dakota.

olins can hardly be considered scientific methodology, regardless of what testing equipment Hutchins was or was not using. Nevertheless, she and Saunders indeed had tapped into a critical theory. As recently as 2015, a group of physicists from the Department of Mechanical Engineering at the Massachusetts Institute of Technology partnered with Roman Barnas, a luthier at the North Bennet Street School, and tested the air resonance of 470 classical Cremonese violins, building on the work begun by Helmholtz and Rayleigh in the late nineteenth century and taken up by Horace Lamb in the first quarter of the twentieth century. The study worked with main cavity resonance and showed that as sound-hole geometry evolved, "the ratio of inefficient, acoustically inactive to total sound-hole area was decimated, roughly doubling air-resonance power efficiency."[35] Hutchins is cited in the article, but only as a source for the history of violin research, rather than for any research she had done herself. In fact, the only violin

35. Hadi T. Nia, Ankita D. Jain, Yuming Lium, Mohammad-Reza Alam, Roman Barnas, and Nicholas C. Makris, "The Evolution of Air Resonance Power Efficiency in the Violin and its Ancestors," *Proceedings A*, The Royal Society (January 2015). http://dx.doi.org/10.1098/rspa.2014.0905.

research from the last fifty-some years found to be useful for this project was that of Jansson.[36]

The New Violin Family

As for Hutchins, the octet project moved ahead, and it is about this time her focus seems to begin its shift, away from acoustical experimentation—pinpointing scientifically replicable factors that consistently produce excellent violins—to developing and promoting her violin octet, which she would eventually call the New Violin Family. She was thrilled when she heard about instruments by the German-American luthier Frederick L. Dautrich (1874–1942). She purchased three from the Dautrich family that fit almost perfectly into the schema.

Dautrich's complaint with the conventional violin family was much the same as Brant's: ensemble music required an ultimate finesse of tonal balance that was sorely absent among violin, viola, cello, and double bass. He found the gap particularly large between violin and cello—the second violin failing to achieve a proper alto voice, and the viola failing to achieve a proper tenor voice—with a secondary tonal gap between cello and double bass. In the 1920s, Dautrich built two instruments, the vilonia (alto) and the vilon (tenor), to fill the gap between violin and cello, and the vilono (small bass) for the gap between cello and double bass. Patent number 237, 017 was filed with the US Patent Office September 9, 1926 for a "Vilonia," described as "Stringed Musical Instruments in the Nature of a Small Cello, Bows, and Bridges Therefor," claiming use since June 1, 1926.[37] His self-published 1935 book, *Bridging the Gaps in the Violin Family*, described these instruments as

> . . . a full sized alto instrument, a new tenor instrument, and a medium-sized bass instrument that is tuned and proportioned between the cello and the bass viol. These new instruments have a quality of tone equal to that of violin and cello tone and are properly used in combinations with these instruments. The instruments have the violin shape, and the principals [*sic*] of construction are the same as those employed on fine violins and violoncellos."[38]

36. Nicholas C. Makris, personal correspondence, April 8, 2020.

37. *Official Gazette of the United States Patent Office* 362/September 27, 1927 (Washington: United States Government Printing Office): 664.

38. Fred L. Dautrich, *Bridging the Gaps in the Violin Family*, rev. ed. (Torrington, CT:

Hutchins found this to be exceptionally good fortune, as Dautrich's instruments encompassed three of the eight ranges she and Saunders had projected for the octet. Tests on the instruments confirmed that the instruments' resonances lay within the parameters of their main resonances theory. She set to work, therefore, altering the instruments over the course of a year to adjust plate thicknesses and rib heights for more precise resonances. The vilono was shifted higher in the series for use as the baritone voice, tuned as a cello with extra-long strings. "Dautrich's pioneering work had saved years of cut and try," Hutchins proclaimed.[39] The projected violin octet had its first four instruments: mezzo, alto (vertical viola), tenor, and baritone. In short order, she added a fifth violin to the family by making a soprano based on tests of three-quarter- and half-sized violins and utilizing high-tension strings made from wire created for NASA in the 1960s. The soprano player needed to wear safety glasses as a precaution against snapping strings. Adequate strings were a continuing challenge for most of Hutchins's instruments. Finding string material that responded well to the length and tension requirements was particularly problematic in the highest and lowest instruments, but Hutchins expressed dissatisfaction even with the strings on the vertical viola. The Kaplan String Company had made the strings for Dautrich's instruments, but these were all plain gut; Hutchins and John C. Schelleng (retired director of radio research for Bell Telephone Labs who was then studying the violin as a circuit) believed the new instruments needed steel strings. Super-Sensitive Musical String Company eventually provided strings for the new instruments and until 2017 still made matched sets for all the octet violins except the two basses, which can be strung with conventional strings. The baritone and mezzo can also use conventional strings, as their tunings and string lengths are similar enough to conventional instruments for the strings to work sufficiently well.[40]

October 1961 found the working group gathered at Rice's Stockbridge

self-published, 1935), 4.

39. Hutchins, "Founding a Family of Fiddles," 238.

40. The Super-Sensitive website still lists the octet string sets among its products for purchase but instead of a radio button for purchases, it provides a link to Robert Spear's violin shop. Spear's site was last updated in 2017 and noted it would sell the "original New Family string set in the green envelope" while supplies lasted but offered a Pirastro and Sensicore alternative. Singing Woods Violin, Robert J. Spear, accessed April 11, 2020. https://singingwoodsviolin.com/parts_3.html.

home to give the first five instruments a trial performance on music composed and arranged for the five violins. It was deemed a resounding success: "The consensus was that our hypothesis was working even better than we had dared to hope! Apparently, the violin-type placement of the two main resonances on the two open middle strings of each instrument was enabling us to project the desirable qualities of the violin into higher and lower tone ranges."[41] "Apparently" is not an adverb with which most scientists are comfortable. While one might argue this was merely a case of casual semantics, its use here was in a written, reviewed, edited, and published periodical, not an instance of informal conversation. It serves as one more evidence of underdeveloped and immature science rushed to application. In fact, later acoustical studies on Hutchins's mezzo SUS 100 show evidence of *less* overall sound radiation than is present in a conventional violin—directly contradictory to one of the goals of the mezzo, which was to provide increased power in the middle frequency ranges. Hutchins and Schelleng laid out this goal in their 1967 article for the *Journal of the Audio Engineering Society*, in which they note the amount of sound projected depends on the area of the plates, which radiate sound into the air. They speculate the reason for capping violin body length at 14" may have had more to do with available string material—gut or silk—than optimal loudness achieved. However, they argued that metal alloy available in the 1960s allowed greater tensile strength in strings. This in turn allowed exploration of ways to create more power within the violin family, enabling projection in large halls and better balance with winds and brass. One of the requirements for the mezzo was that it still sound like a violin, even at 15", and not have the timbral characteristics of a viola. "Saunders Loudness Curve" testing seemed to indicate the goal of increased power had been achieved with a 15" body that retained the standard mensur of the conventional 14" violin. What Hutchins referred to as the Saunders Loudness Curve is more properly known as total intensity curve, and she conducted this experiment by hand bowing with fast, vigorous bow strokes. Hand bowing, rather than automated bowing, presents multiple layers of consistency problems, and there is also a difference between loudness and intensity. Loudness is a measure of the response of the ear to the sound (i.e., amplitude), measured in decibels. Intensity is the sound power per unit area, measured in watts per square

41. Hutchins, "Founding a Family of Fiddles," 239.

meter. Nevertheless, Hutchins wrote, "in trials as a member of the new violin family it was definitely preferred to conventional violins *because of its greater power over the entire range of frequency*."[42] A 2001 study by Lily M. Wang and Courtney B. Burroughs at Pennsylvania State University tested several instruments, including SUS 295 (conventional violin) and SUS 100 (mezzo violin), using near-field acoustic holography to localize regions of acoustic radiation from surfaces of violins. This study employed a mechanical bowing machine, applying force in a manner similar to the actual excitation of a played instrument, generating a complete set of harmonics as well as torsional motion of the string and coupling between the strings, neck, and fingerboard, which are not initiated by electromechanical excitations at the bridge. A significant discovery was that across all frequencies and all violins studied, the top plate served as the dominant radiator of sound energy. The vectors greatest in magnitude always originated from the top plate, producing lobes radiating strongly outwards. Even at the lowest frequencies, which demonstrate omnidirectional behavior, most of the intensity vectors originated from the top plate. The back plate on the Hutchins mezzo violin radiated much less than on the conventional violins; i.e., the mezzo tested with quantitatively less power than the conventional violins in all but certain lower frequencies. However, the lesser sound radiation from the back plate may not affect the overall sound level that reaches the audience; Wang and Burroughs stress that the lack of back plate radiation may affect how the instrument is subjectively experienced by the player.[43] And with that, the argument is brought full circle back to Stokowski's conclusion: if you cannot suit the players, you are out of luck.[44]

According to research reports and studies in the Carleen Hutchins Archives at the National Music Museum, a sixth violin was added within three months of the quintet debut, the so-called small bass. This was a small three-quarter-size bass with its low E (41 Hz) string removed and a high c' (131Hz) string added, creating a tuning of A–d–g–c'. In January 1962, a performance was staged for an audience from the Guggenheim Foundation to compare the six new violins with good conventional vi-

42. Emphasis added. Carleen M. Hutchins and John C. Schelleng, "A New Concert Violin," *Journal of the Audio Engineering Society* 15/4 (1967): 435.

43. Lily M. Wang and Courtney B. Burroughs, "Acoustic Radiation from Bowed Violins," *Journal of the Acoustical Society of America* 110 (2001): 554.

44. Cf. n31.

FIGURE 4. New Violin Family. Copy in Carleen Hutchins Archives, National Music Museum, The University of South Dakota.

olins, violas, and cellos. Brant had composed music for the ensemble. Wisely, the performers had been given opportunity to practice on and adjust to the new instruments prior to the rehearsal and performance. The performance was a success musically, but Hutchins felt much work remained in adjustments, strings, and bows and, of course, creation of the final two instruments, at the highest and lowest ranges of the octet. These were the most problematic instruments because of the extremes of scale but also because no other instrument existed that could be studied or adapted. The treble's main challenge was to keep the body and cavity resonances at a high enough frequency while still keeping the mensur long enough to enable ease in playing semitones. At the other end of the spectrum, the contrabass is 210 cm high (7') but the string length still needed to be the conventional 110 cm so a player of average height could play it with relative comfort. The first performance on the full octet (fig. 4) occurred at a general meeting of the CAS May 24, 1964, at the home of J. Kellum Smith in New York City, with about fifty people in attendance. Following a business meeting, the octet was introduced, played by Sonya Monosoff (treble), William Kroll (soprano), Louis Zerbe (mezzo), India Zerbe (alto), Sterling Hunkins (tenor), Peter Rosenfeld (baritone), Julius Levine (bass), and Ronald Naspo (contrabass). Henry Brant conducted. Patsy Rogers reported:

> . . . the new stringed instruments . . . present an almost unprecedented opportunity for homogeneous tone quality over an enormous range. The concert enabled those present to hear the instruments in four very different kinds of music; in addition to arrangements of a Haydn "Baryton" trio and several short pieces by Byrd, a long piece was written for the occasion by Patsy Rogers, and Henry Brant conducted a short work of his own for soprano voice and all eight instruments.[45]

Yale University music students performed on the violin octet for the official 1965 premiere at New York's Riverdale School, but a performance several weeks later garnered more attention. The octet was included in one piece on the "Music in Our Time" recital at the 92nd Street Young Men's and Young Women's Hebrew Association. Brant had composed "Consort for True Violins" for this and was ecstatic with the contrabass in particular. He said, "I have waited all my life to hear such sounds from

45. Patsy Rogers, *Newsletter of the Catgut Acoustical Society* 2 (November 1, 1964): 2.

a bass."[46] The *New York Times* review of the performance also lauded the bass sound but the reviewer, Howard Klein, remained unimpressed with the other instruments: "The basses produced wonderful rumblings, and the sonorities of the higher violins were good in the high registers. The resonance of the middle range was weak. The high instruments, when playing their lowest notes, sounded tinny and nasal, so there is work to be done."[47] This was the occasion on which Leopold Stokowski heard the octet for the first time and Klein quotes him, "We need to revise all the orchestral instruments. The strings have needed this treatment for a long time."[48]

Except for the treble and the contrabass violins, the original octet instruments were adapted from existing instruments. Therefore, the next step for Hutchins was to build the entire octet from the ground up, now that she had learned the basics. This took another two years and included significant redesign based on even further testing, finally developing the measurements and scaling factors as shown in fig. 5. According to her curriculum vitae, by 1989, she had built ninety-four octet instruments: six complete octets plus four trebles, four sopranos, ten mezzos, seventeen altos, seven tenors, and four baritones.[49] The six complete octets were not necessarily built as sets but may have been assembled into an octet from available New Violin Family instruments. One complete octet is played occasionally by the Hutchins Consort in Encinitas, California, and a consort originally designated for St. Petersburg, Russia, seems to be scattered in several locations now. The remaining four octets are housed primarily in museum storage. Hutchins donated an octet to The Metropolitan Museum of Art (New York) in 1988, and the following year it went on exhibit for four months before returning to storage again until a special

46. Hutchins, "Founding a Family of Fiddles," 243. Brant's biographical entry in the 1985 printing of *New Grove Dictionary* describes the octet as "eight acoustic analogues of the violin covering a range of six and a half octaves." Kurt Stone and Paul Griffiths, "Brant, Henry Dreyfuss," *New Grove Dictionary of Music and Musicians*, 20 vols. (London: Macmillan, 1980) 3: 205. The newly written article in the 2001 edition in Oxford Music Online better describes them as the eight instruments of the New Violin Family, but still without reference to Hutchins. Kyle Gann and Kurt Stone, "Brant, Henry Dreyfuss." https://doi-org/10.1093/gmo/9781561592630.article.03850.

47. Howard Klein, "Unusual Violins in Recital Debut: Composer Invents Strings—Writes Piece for Them," *The New York Times* (May 21, 1965). https://timesmachine.nytimes.com/timesmachine/1965/05/21/97202531.pdf?pdf_redirect=true&ip=0.

48. Ibid.

49. Laird, "The Life and Work of Carleen Maley Hutchins," n83.

Instrument			Length in centimeters			Relative Scaling factors *		
Name	Tuning	Hz	Overall	Body	String	body length	resonance placement	string tuning
Treble	G D A E	392 587.4 880 1318.5	48 ±	28.6	26	.75	.50	.50
Soprano	C G D A	261.6 392 587.4 880	54-55	31.2	30	.89	.67	.67
Mezzo	G D A E	196 293.7 440 659.2	62-63	38.2	32.7	1.07	1.00	1.00
Violin	G D A E	196 293.7 440 659.2	59-60	35.5	32.7	1.00	1.00	1.00
Viola	C G D A	131.8 196 293.7 440	70-71	43 ±	37-38	1.17	1.33	1.50
Alto	C G D A	131.8 196 293.7 440	82-83	50.8	43	1.44	1.50	1.50
Tenor	G D A E	98 146.8 220 329.6	107 ±	65.4	60.8	1.82	2.00	2.00
Cello	C G D A	65.4 98 146.8 220	124 ±	75-76	68-69	2.13	2.67	3.00
Baritone	C G D A	65.4 98 146.8 220	142 ±	86.4	72	2.42	3.00	3.00
Small Bass	A D G C	55 73.4 98 131.8	171 ±	104.2	92	2.92	4.00	4.00
Bass	E A D G	41.2 55 73.4 98	178-198	109-122	104-117	3.09-3.43	4.00	6.00
Contra-bass	E A D G	41.2 55 73.4 98	213-214	130.0	110	3.60	6.00	6.00

* Scaling based on the violin as 1.00

MEASUREMENTS AND SCALING FACTORS FOR THE VIOLIN FAMILY

Catgut Acoustical Society, Inc. 1974

FIGURE 5. New Violin Family measurements and scaling factors, ca.1974. Carleen Hutchins Archives, National Music Museum, The University of South Dakota.

exhibition was mounted in 2002 and ran for three years. She formally donated another assembled octet to the National Music Museum in 1999, and later, several of her experimental violins. An octet performance was presented in 1996 as part of the American Musical Instrument Society meeting at the museum, but the octet instruments have been in storage since then. After a conference performance at the Royal Swedish Academy of Music in 1983, Stockholm's Music Musikmuseet purchased the octet used then and mounted an exhibit in 1985. It was played once again in 1993 for the Stockholm Music Acoustics Conference, but beyond that, and after the merger of three cultural museums into what is now called the Swedish Museum of Performing Arts, neither the precise location nor condition of the octet is known.

Askenfelt recalled the 1993 concert as "actually really good, much because of the artistic leader Chrichan Larsson, who played the vertical viola. At that time, he was the cello player in Pierre Boulez's Ensemble Intercontemporain in Paris. He was keen on new constellations and wanted to perform classical pieces using sounds never heard before."[50] The final piece on the concert was Schoenberg's *Verklärte Nacht*, and Askenfelt noted it as the most interesting performance he heard from the octet and the piece best-suited for an octet transcription. Otherwise, he believed the octet as an ensemble to be a noteworthy musical experiment that came about 100 years too late: "[A]n admirable amount of work was devoted to making the existing Octets, but musically it was a dead end street . . . . When all eight are played together they tend to blend too well and generate a rather boring 'generic' string ensemble sound. In that sense the scaling idea worked well, perhaps even above expectations . . . but perceptually/ musically the result is rather uninteresting to the listener."[51] Ever the scientist, however, Askenfelt pointed out that the blend created by the scaling is definitely a result, and in all experimental work, any result relays important information, even if that information is not the outcome that supports the original hypothesis.[52]

Of the eight instruments, the vertical viola has received the most individual attention (fig. 6). This was the instrument that had captured Stokowski's particular interest, and it drew the notice of Heinrich Roth of

50. Askenfelt, personal correspondence, April 22, 2020.

51. Ibid., May 7, 2020.

52. Ibid.

FIGURE 6. Alto Violin by Carleen Maley Hutchins and Reed Raphael Bernstein. Photo courtesy of Metropolitan Museum of Art (1988.424.4). Gift of Carleen M. and Morton A. Hutchins and the Harriet M. Bartlett Fund of the Catgut Acoustical Society, Inc., 1988.

Scherl & Roth Violins in Cleveland. Roth wanted to offer vertical violas built in their German factory following Maxwell Kimball's CAS drawings, with plate tuning by Hutchins.[53] Hutchins had just received the first instrument from Roth as of November 1965, but no further mention of this partnership can be found, and it does not appear in any of the archival material.[54] Numerous musicians point to the better potential for these individual instruments than for the ensemble, Askenfelt included: ". . . the vertical viola has an outstanding full and powerful tone, but where to find viola players who want to act like a cellist (or vice versa)?"[55]

Indeed, in the mid-1980s, the cellist Yo-Yo Ma had the opportunity to play Tom Knatt's vertical viola, which Knatt had built in violinmaking classes Hutchins was occasionally offering in her home. It took a decade for Ma to muster the determination to use the viola in a public performance of the Bartók viola concerto. The performance was not a critical success. Tamara Bernstein of the Toronto *Globe and Mail* termed the performance a disaster and said the viola was "devoid of the richness and colours of a good viola."[56] Ma decided to try again a year later, this time playing a vertical viola Hutchins herself had made. *Baltimore Sun* music critic Stephen Wigler called the viola a "miniature cello that suffered an accident at the dry cleaner's,"[57] and maintained that the vertical viola had been a poor choice. Ma remained committed to the experiment, and in 1995 he and the Baltimore Symphony won two Grammys for the Sony Classics *The New York Album* (Classical Contemporary Composition for the Stephen Albert concerto, and Classical Instrumental Soloist with Orchestra), which included the Bartók viola concerto played on Hutchins's

53. *Newsletter of the Catgut Acoustical Society* 4 (November 1, 1965): 2.

54. On the US side of the Roth family, Scherl & Roth was acquired by a series of companies and was absorbed by the Conn-Selmer company (itself a subsidiary of Steinway Musical Instruments, Inc.) in 2000. A company representative indicates that the prior company, BMI, destroyed or donated historic records to undisclosed locations and Conn-Selmer has almost no records prior to 2000. Personal communication, April 14, 2020. Wilhelm Roth states that no records of any such cooperation or production exist in the company records in Germany. Personal communication, April 14, 2020.

55. Askenfelt, April 22, 2020.

56. Tamara Bernstein, "Yo-Yo Ma's Performance a Musical Disaster," *Toronto Globe and Mail* (January 16, 1993).

57. Stephen Wigler, "The Cello Master and the Cello Maker—Yo-Yo Ma's Latest Challenge: An Onstage Experiment with an Overgrown Viola," *Baltimore Sun* (February 28, 1993). https://www.baltimoresun.com/news/bs-xpm-1993-02-28-1993059247-story.html.

SUS 130.[58] Hutchins believed the recording to be the "best performance ever of this piece."[59] Despite the Grammy for the album as a whole, some critics still were not overwhelmed with the Bartók. The *Gramophone* review said:

> Ma's decision to use a vertical viola, or alto violin ("a large viola fitted with a long endpin and held like a cello") stems from his apparent dissatisfaction with "the registral displacement" of the authorized cello version (recorded by Janos Starker on RCA, 3/92). Using the alto violin also meant honouring the work's original pitch, although comparison with Wolfgang Christ's superb DG recording (4/94) inclines me towards the earlier performance, which is both richer in tone and more urgently communicated.[60]

Another reviewer, Adam Greenberg, on the other hand, thought the vertical viola might be the highlight of the album.[61] Ma believed part of being a musician is the desire to explore, and he observed that many of the repertoire staples had been written for instruments no longer part of regular contemporary performance. He said, "People have always tried to do things better."[62]

Perhaps the greatest use of octet instruments in recent years has been at the Edinburgh University Collection of Historic Musical Instruments, which acquired an octet that had been in various private hands in Great Britain for a number of years before it was donated to the Edinburgh collection. The acquisition was celebrated in 1995 with a performance, but since then only the alto violin (SUS 126) has been on exhibit. However, Alexander Harker (composer), Mieko Kanno (violin), and Michael Newton (acoustician) collaborated to use the octet in developing a software extension for electric violin called "Octet Violins."[63] The software applies

58. SUS 130 had been built in 1979, tuned and assembled by Laird Carlson. Hutchins retuned the plates in 1991, and in 1993 Peter Tourin "helpt [sic] to adjust post." SUS 130 records, Hutchins Archives, National Music Museum, Vermillion, South Dakota.

59. Ibid.

60. "The New York Album," *Gramophone* (March 1995). https://www.gramophone.co.uk/review/the-new-york-album.

61. Adam Greenberg, "The New York Album Review," Allmusic.com. https://www.allmusic.com/album/the-new-york-album-mw0001792832.

62. Wigler, "The Cello Master."

63. Alexander Harder, Mieko Kanno, and Michael Newton, "Octet Violins (Modeling a Virtual Violin)," unpublished software (2016), accessed January 30, 2018. http://eprints.hud.ac.uk/id/eprint/31506.

impulse responses taken from the Edinburgh octet to an input signal, such as that from an electric violin. Responses can be combined and modified to create a virtual and imagined body for the electronic instrument. Alternatively, as Kanno explains, "You have this violin, but [now] you have at your disposal for your solo violin the entire range of the piano keyboard in the same timbral spectrum. Suddenly in this [one] violin, you have eight instruments."[64] Kanno says the attraction is more than just register but that each instrument inhabits a different sound: "A lot of it is the in-between world that isn't new, but we haven't had access to that sound since instruments like the arpeggione or the larger cellos of the Amatis."[65] On faculty at the Sibelius Academy, University of the Arts Helsinki, Kanno is a specialist in new music. She is excited about the idea that her instrument does not have to stay where it has been for the last 500 years—it can, as she says, move sideways. Hutchins's octet made her think in new ways about her own instrument, encouraging her to change the fundamental parameters. She likes to wonder whether the orchestra as it is now will still be here in the year 2500—will the same core repertoire still be played? If not, what? How will tools change? Kanno points out that Boulez thought about the orchestra not in four string sections but in eight, nine, or ten sections, each instrument having its own musical function, precisely the manner in which Hutchins spoke of the octet functioning musically. It is not much of a stretch to imagine that Hutchins would be wholeheartedly enthusiastic of not only the multi-sectional conception, but also a new scientific and technological application of her beloved new violin family.

Experimentation and Discord

Indeed, the desire to do things better—as Greenberg noted about the Bartók recording—drove Hutchins to continue her experiments and testing. Hutchins and Daniel W. Haines built SUS 184 in 1974 (fig. 7), an experimental violin with a one-piece, unpurfled top made of graphite-epoxy composite with central fiberboard layer. The remainder of the instrument is maple. It was used for acoustical tests and seems to be the first violin made with a graphite-epoxy composite top, although the prototype

64. Mieko Kanno, personal communication, October 11, 2018.

65. Ibid.

No. 10,182

FIGURE 7. Graphite-epoxy composite top violin, SUS 184 (NMM 10182). Violin by Carleen Maley Hutchins, Montclair, New Jersey; Daniel W. Haines, Columbia, South Carolina; and Hercules Materials Company, Inc. (Allegheny Ballistics Laboratory), Cumberland, Maryland, 1974. Gift of Carleen Maley Hutchins, Montclair, 2002. Front view. Photo courtesy of National Music Museum, The University of South Dakota, Bill Willroth, Sr., photographer.

did not result in commercial production. By 2001 Luis & Clark had patented a carbon fiber violin, and in 2009, John Dominy, on the faculty of Engineering at the University of Nottingham, wrote a paper about the development of a carbon fiber violin for the International Conference on Composite Materials and immediately cited Carleen Hutchins's work with this violin (although he erroneously said it was made in the 1980s).[66] Hutchins's last experimental violin, nicknamed "Le Gruyère" (fig. 8), has attracted more general attention than the graphite violin, probably because of its particularly unique appearance, akin to gruyère cheese. In consultation with Edgar A. G. Shaw and Arthur H. Benade, sixty-five holes were cut into the ribs and were plugged or unplugged with cork to test interior cavity resonances. The violin and the team's initial research were presented in 1983 at the Eleventh International Congress on Acoustics in Paris, and numerous published studies followed, spanning eighteen years in which Le Gruyère served science as a test subject.[67]

This work was still in conjunction with the Catgut Acoustical Society, but throughout the next decade, Hutchins faced increasing resistance from the CAS board. Correspondence in the archives at both Stanford and the National Music Museum documents an intensifying frustration with Hutchins's monomania for the octet. The progression of mission descriptions for the CAS that appear in the *Journal* mastheads is instructive. The first masthead claimed the CAS mission was "support and development of new musical instruments and improvements on existing instruments," and in 1987 it was refined to "The Catgut Acoustical Society is a group of people interested in the support and development of new musical instruments and improvements of existing instruments." By 2000, this had changed significantly to "The Catgut Acoustical Society is known for pioneer research in acoustical principles and the application of these principles to the making of fine stringed instruments, including the Violin Octet." It speaks further of "increasing and diffusing the knowledge of musical acoustics and instruments" and to promoting its "practical applications." From this evolution seen in the published mis-

66. John Dominy, "The Development of a Carbon Fibre Violin," *Proceedings of the International Committee on Composite Materials* (2009), accessed October 27, 2018. http://iccm-central.org/Proceedings/ICCM17proceedings/Themes/Industry/OTHER%20APPLICATIONS/A6.2%20Dominy.pdf.

67. Cf. the bibliography in "Violin, *Le Gruyère*," The Carleen Hutchins Collection and Archive, National Music Museum. http://collections.nmmusd.org/Archives/NewViolinFamily/Hutchinscheeseviolin.html#bibliography.

FIGURE 8. *Le Gruyère* violin by Carleen Maley Hutchins, Montclair, New Jersey, 1982 (NMM 10116). Gift of Carleen Maley Hutchins, 2002. Side view. Photo courtesy of National Music Museum, The University of South Dakota, Bill Willroth, Sr., photographer.

sion statements, it appears that as Hutchins released CAS oversight to others—partly because of her age and partly because of her single focus on the octet development. The CAS mission gradually adjusted itself to the interests of current members without Hutchins seeming to notice that shift, while she continued to press for funding to commission music for the octet. By 1996, Hutchins had relinquished her "permanent secretary" position within CAS, moving to the editorial board of the *Journal*. What appears to be a last-ditch effort was made in the form of an application for a grant from the Corporate Contributions Program of The Bank of New York, filed October 20, 1997. The grant sought administrative support for the Violin Octet, referencing "The Violin Octet Development Center." A summary financial report, included in the grant application, reveals the seriously troubling financial situation. Total income generated for CAS in 1996–1997 was $70,018.54 through membership dues, gifts, investments, and a small amount from sales. The office, administration, payroll, and taxes totaled more than $33,000 and costs of the *Journal of the Catgut Acoustical Society* ran to $6, 615. Total expenses for the octet itself, however, came in at $71,347.55.[68] From any point of view, that sort of singular deficit was unsustainable. The Bank of New York did not think it was sustainable, either, apparently, because the CAS was not awarded the grant. At the CAS board meeting a year and a half later, the board voted to suspend any further funding of the violin octet and to center its financial activity on acoustics research related to bowed strings.[69] This research might include the violin octet, but the board believed its mission to be significantly more broad than only the octet and, most importantly, believed its mission was based in research, and not in commercial enterprises like commissioning music, producing recordings, or booking performances for a single subset of instruments.

Then eighty-eight years old, Hutchins decided to split from the CAS and formed the New Violin Family Association (NVFA). However, she remained on the Editorial Advisory Board for the *Journal of the Catgut Acoustical Society* after the journal shifted to an editor plus associate editors and managing editors in 2000. By 2003, she still authored articles

68. J. Maurits Hudig, Proposal for a Grant of $55,000.00 for Development and Operational Support of The Violin Octet Development Center. Submitted to The Bank of New York (October 1997). Hutchins Archives, National Music Museum, Vermillion, SD.

69. Meeting minutes (1999). Hutchins Archives, National Music Museum, Vermillion, SD.

for the journal but was no longer serving in any editorial capacity. Of course, at that point she was ninety-two years old, making it impressive enough that she was still writing articles at all. The NVFA describes itself as "an international group of musicians, scientists, instrument makers, and music lovers, people who want to share in the challenging possibilities opened for the musical world by a consort of eight violins of a new type, from treble to contrabass."[70] Its mission statement, as presented in 1999, included goals such as to educate the public, encourage players, stimulate composers, educate and instruct violinmakers, sponsor the collection and preservation of documents, and make such archives available to the public.[71] The NVFA merged with the Hutchins Consort in 2009. Very little activity has emerged from the NVFA, and the most recent newsletter on the site is from 2007, still with the flashing "new" icon next to the PDF hyperlink. Publications posted in the "Research" tab are all outdated Hutchins publications, and events referenced as future are now nearly a decade old.

Women in Lutherie

Whitney's 2016 biography encouraged a modest resurgence of performance activity and press coverage of Hutchins's life and work, but in the eleven years since Hutchins's death, the violin world still fails to recognize the remarkable contribution Hutchins made to lutherie. Even with Whitney's strong rebuke of the prevalent misogyny, dismissal of Hutchins's work is so widespread that many young luthiers have not heard of her. The German-born violin maker Ute Zahn, for example, first learned about Hutchins in violin making school acoustics class, where she was talked about as something of an oddity, not because she was a woman, but because of the experimental nature of her work.[72] Yet, *The American Violin* (2016), published by the American Federation of Violin and Bow Makers (AFVBM), points to Hutchins as the post-war era woman who was first able to achieve a lasting presence in violin making. That much may be true, as nearly seventy years have passed since she made her first

70. New Violin Family Association, home page, accessed April 16, 2020. https://nvfa.org/.

71. Cited in Whitney, *American Luthier*, 227. Neither mission statement nor goals appear on the NVFA website.

72. Ute Zahn, personal communication, February 10, 2020.

viola, while she is still discussed at least in academic circles. Philip Kass claimed in 2016 that "Hutchins lived in a period where her endeavors were at least accepted…."[73] The accuracy of that statement can be questioned: Hutchins herself talked about the outright hostility with which she was often received. Kass goes on to write, "It is fair to say that, so far as women's suffrage in the world of violin making is concerned, only in the present generation has full equality been realized."[74]

Again, one may question such a sweeping claim about women's experiences, especially coming from a male commentator. When Ute Zahn goes to buy violin making tools and the sales person says, "Well, what are you gonna do with THOSE, little lady?," one is forced to think perhaps full equality has yet to be reached in the world of lutherie.[75] Marianne Jost, a Swiss violinist based in Cremona, points out, "There is no difference between a violin made by a woman or a man. However, one that is made by a man [appreciates faster and is] more expensive [to begin with] . . . why??"[76] Another Cremona maker, Bénédicte Friedman, laments that people still come into her violin shop and ask, "Where is the Maestro?" She answers, "That's me!" And people are surprised.[77]

Kass's claim in *The American Violin* of Hutchins's "lasting presence" rings hollow, like a comfortable platitude. Likewise, his suggestion of a fully equal status for women luthiers. Though Kass *personally* may consider women luthiers equal, that certainly does not seem to be the case elsewhere, including in that very publication. In this publication, touted as a history and documentation of violin making in the United States, not a single instrument by a female luthier is featured among those selected for color spreads and additional commentary. Only scant mention is made of women in the essays, including Hutchins. On the other hand, an 1890 violin by William Bissett is featured, although the analysis is that "Bissett's work is not particularly professional, perhaps due to his initial career in agriculture."[78] This JOURNAL's review of *The American Violin* questions

73. Philip Kass, "Independence and Individuality: The Self-taught Violin Maker in the United States," in *The American Violin* ([Minneapolis]: AFVBM Foundation, 2016), 64.

74. Ibid.

75. Ute Zahn, personal communication, February 10, 2020.

76. Isabelle Wilbaux, "The Evolution of Women in Violin Making," unpublished remarks (May 2019).

77. Quoted ibid.

78. Christopher Germain, "Violin Making in the Western States," *The American Violin*

why the AFVBM would want to feature work that is not particularly professional while virtually ignoring the work of *any* of the comparatively few women in the field.[79]

Perhaps Hutchins did not make significant in-roads on this front because her lutherie skills never reached a point of enough consistent excellence to make the male-dominated field take adequate notice. Maybe it is completely unrelated to gender, and Hutchins has been side-lined because the violin world simply has not been ready to hear her fundamental message that science can help violin makers craft modern instruments that are equal to the old Italian masters. In fact, Hutchins believed science should help luthiers make instruments *better* than those instruments. As early as 1962, she wrote, "I believe that, without ignoring the precious heritage of centuries . . . we really ought to learn how to make consistently better instruments than the old masters did. If that challenge cannot be fulfilled, we should at the very least find out the reasons for our limitations."[80] Sales of modern violins are strong, in part because the quality of craftsmanship, as well as expertise in materials and sound production among violin makers, has risen in response to the robustly competitive environment—which is, in part, because of a significant number of violin makers who now embrace scientific practice as an element of their craft.

Conclusion

Fan Tao, Director of Research and Development for D'Addario & Company and past president of the Violin Society of America, believes Hutchins's legacy to be not so much her science *or* her instruments but her relentless devotion to a vision in which science and lutherie supported one another: "Carleen's main contribution cannot be underestimated, and that is that she got a lot of really bright scientists interested in violin acoustics, and at the same time, she popularized violin acoustics such that it's quite surprising how many professional violin makers were inspired by these papers—not just by Hutchins but by all those scientists she brought

([Minneapolis]: AFVBM Foundation, 2016), 85.

79. Allison Alcorn, review of Christopher Germain, Philip J. Kass, Darcy Kuronen, Dameron Midgett, and John Montgomery, *The American Violin* ([Minneapolis]: AFVBM Foundation, 2016), this JOURNAL 43 (2017): 222.

80. Hutchins, "The Physics of Violins," *Scientific American* (1961): 93.

into the work—to go into violin making."[81] Without question, securing the cover article for the November 1962 issue of *Scientific American* was the catalyst of Hutchins's career as a luthier acoustician in the public eye. In 1981, another Hutchins article on violin plates was accompanied by a *Scientific American* cover depicting the "Chladni patterns" discovered some 150 years earlier.[82] These cover articles brought Hutchins attention, accolades, and many further contacts for her all-important network. *Scientific American* has always been a popular science magazine rather than a scholarly journal, and this underscores Tao's point. Her strength, and maybe even her calling, was popularizing the idea of science in lutherie. Two *Scientific American* articles and her two Benchmark Papers volumes (compilations of music acoustics journal articles) did precisely that.[83]

Samuel Zygmuntowicz, an award-winning luthier in the forefront of using science to inform his violin making, is forthright about the lack of any direct influence from Hutchins in his work. Ute Zahn and Carrie Scoggins are representative of violin makers who learned briefly of Hutchins in violin making school but acknowledge knowing little about her. But nearly every violin maker today can point to some scientific research they have at least thought about, and some scientific studies that have informed their work in one way or another. That is a far cry from the days when Jacques Francais would throw Norman Pickering out of his shop, saying that acoustics had no place in violin making.[84]

Hutchins's direct contribution in scientific work has been, in the end, minimal. The impact of the New Violin Family is slight, and the influence of her traditional instruments is nominal at best. When Gabriel Weinreich, professor of physics and acoustician at the University of Michigan,

81. Fan Tao, personal communication, July 20, 2018.

82. Carleen M. Hutchins, "The Acoustics of Violin Plates," *Scientific American* 245/no. 4 (October 1981).

83. Cf. Carleen M. Hutchins, "The Physics of Violins," *Scientific American* 207/no. 5 (Nov 1962) and "The Acoustics of Violin Plates," *Scientific American* 245/no. 4 (Oct 1981) as well as *The Physics of Music: Readings from Scientific American*, ed. Carleen M. Hutchins (New York: W.H. Freeman & Co., 1978). The Benchmark Papers in Acoustics was a series of fourteen books that culled the scholarly journals for seminal papers in acoustics. Hutchins edited the two volumes related to the violin family, contributing an introduction to each paper or set of papers. Hutchins's introductions were a key component of the influential publications, providing synthesis and clarity for complex issues. Cf. *Musical Acoustics: Violin Family Components*, ed. Carleen M. Hutchins (vol. 5) and *Musical Acoustics: Violin Family Functions*, ed. Carleen M. Hutchins (vol. 6). Benchmark Papers in Acoustics, 14 vols., ed. R. Bruce Lindsay (New York: Dowden, Hutchinson, & Ross, 1975/1976).

84. Cited by Fan Tao, personal communication, July 20, 2018.

said Hutchins had "no respect for authority, a long attention span, scrupulous honesty, enthusiasm for intellectual collaborations, and the willingness to spend a lifetime beating a path through the jungle,"[85] he was approaching the core of Hutchins's gift to the violin world. Whether or not today's luthiers can trace the genealogy, and whether or not the goals of luthier and acoustician are polar opposites, Carleen Hutchins provided the bridge in the twentieth century between acoustics and the violin world. She hammered at the ideas so long and so hard, it was impossible not to become aware that acoustics may have something to offer lutherie. It was Carleen Hutchins who, by sheer force of personality, passion, and determination, brought dozens of acousticians into violin research and dozens of violin makers into acoustics. The butterfly effect has carried it from there. Carleen Hutchins's legacy is a musical world opened to possibility—a violin world in which all ideas and knowledge can be brought to a common table, a community of musicians that reasonably and appropriately embraces what can be learned about art from science. And together science, the violin, and the luthier move forward into the future.

Appendix

Selective Bibliography of Work by Carleen Hutchins

All works include Hutchins (CH) as author. When other names are listed, the work was a collaboration. Seventy-one articles (not including book reviews and obituaries) written for the CAS newsletter and journal are found easily on the digitized database at the Stanford University Special Collections Library (https://searchworks.stanford.edu/view/8492395) and, therefore, are not included here.

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85. Gabriel Weinreich, cited in Jennifer Ouelette, "All in the Family," Cocktail Party Physics (Sept 27, 2009). https://cocktailpartyphysics.com/.

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