The 40-year existence of the Catgut Acoustical Society represents a tiny but important segment of man’s age-old fascination with and need for understanding sound, not only for survival but also for communication and enjoyment. Primitive man created stringed, wind, and percussion instruments that have become further sophisticated in various ways in different societies over many millennia.

Research related to CAS objectives can be traced back to the work of Michael Praetorius in 1619 [1], and to numerous scientists and mathematicians of the 18th, 19th, and early 20th Centuries (please see my paper entitled “The History of Violin Research” [2]). This important work set the stage for the eventual founding of the CAS in 1963.

SAUNDERS BEGINS HIS STUDIES
Our story really begins in 1930, when Harvard Professor Frederick A. Saunders became interested in violin research. A friend of his, Henry Shaw, who was then treasurer of the General Radio Company that was making electronic test equipment, came to him asking if he could measure the difference between a fine early cello and a fine modern cello. At the time, Saunders thought this would be easy. However, he was man enough to say thirty-three years later “I have not yet found the answer [3].” Saunders pioneered research in violin acoustics on this side of the Atlantic working in the Cruft Acoustical Laboratory at Harvard University where he had special testing areas and equipment (fig. 1). His students at the time were Leo Beranek and Harry Hall, later well known in acoustics. With a specially constructed harmonic analyzer and an automatic bowing machine (fig. 2) constructed by Beranek and Hall, Saunders made many response curves of fine instruments, including violins by Stradivari and Guarneri del Gesu. He early turned to hand bowing because musicians complained that the automatic bow was inadequate. Response curves were produced by bowing each semitone for four seconds and recording the amplitudes of the first ten harmonics of each note produced through the analyzer for an octave on each string. These were combined to give the overall response curves. Several hundred such curves were recorded by Saunders in his notebooks while at Harvard, although these seem to

Figure 1. F.A. Saunders testing a violin in the Cruft Laboratory, Harvard University, 1930’s.

Figure 2. F.A. Saunders’ automatic bowing machine with a group of arched celluloid discs turning against the strings and driven by a direct current motor. Speed and force on the strings could be adjusted.
have been lost. Saunders’ experiments were the basis for a series of publications on violin acoustics [4,5,6,7,8]. Saunders also corresponded widely with other researchers in the field including as Irwin Meyer, H. Backhaus, and H. Meinel in Germany, and G. Pasquini in Italy.

MY STORY
My interest in chamber music, and particularly in playing a stringed instrument, developed in 1937 when I was teaching science to the first six grades at the Brearley School in New York. I was offered an opportunity to design and build a science room. There was a lot of string music in the school as well as teachers who liked to play quartets in an apartment after hours. However, my instrument through high school and college had been the trumpet. When I showed up with my trumpet in a New York City apartment to play chamber music, my friends laughed at me and said “Carleen that thing is far too loud with strings even though it’s wonderful out on the street with the Star Spangled Banner. What we need is a viola. Why don’t you get one and learn to play it?” I borrowed the school viola for a while, which was too big, and finally found a $75 viola at Wurlitzer, but it did not measure up to the sound of the big one.

One of the important people in the early development and functioning of the Catgut Acoustical Society was Helen Rice, known in the New York and Massachusetts music circles as the “Great Lady of Chamber Music.” Helen was not part of the research itself except that she provided help at every turn in the road and made possible many musical sessions where our research results could be evaluated musically by amateur and professional performers. Raised in a family dedicated to chamber music, Helen was never happier than when she had a string quartet or a “Brandenburg evening” at least once a week in New York in the winter and summers at her family home in the Berkshires. There is a book about her by Rustin McIntosh [10] that lists the nearly 2,000 amateur and professional players who came to share in the joy of these playing sessions. There is also a Helen Rice Library of Chamber Music at Oberlin College, Ohio.

In 1945, Helen Rice, already well known for her violin playing and interest in chamber music, became the new head of the music department of the Brearley School. At about the same time I had an idea that I could make myself a better viola than the one I bought for $75. So I wrote to my uncle who had made violins as a hobby all his life to see if he could help me make a viola. He said he did not know how to make a viola but sent me to a violinmaker down on the Bowery in New York City. The violinmaker was a Russian who didn’t think much of a woman making an instrument, but he grudgingly sold me some wood, a blueprint, and a book (Violin Making as it Was and Is, by Edward Heron-Allen [11]). The book contained full-scale drawings, which he showed me how to use and told me a bit of how to begin to make the form and the ribs. I worked for two years out of that book, following the meticulous instructions and came up with an instrument that was rated the work of a good carpenter, which I was at that point (1949).

After my viola was all strung up and in playing condition I took it over to Helen Rice’s apartment to see what some of her music-playing friends thought about it. Several of them tried it and were surprised at the amount of sound it had, but I could tell that it was not doing a particularly good job. Broadus Erle, who was then the leader of the New Music Quartet, played my viola with considerable interest, and asked me if I would be interested in getting some help from an experienced maker. At the time, Erle was playing a partially varnished violin by Karl Berger, who had a shop in the Steinway Building.

A few days later, I went to Berger’s shop and showed him my pride and joy, which had taken me two years to produce. He put a bow on it and played a few notes, then tapped it all over and looked at me with a smile and said, “I think I could help you make it better if you would let me. It’s good work and you ought to be able to make it sound better.” So I agreed. He then removed the fittings, strings, pegs, etc. and much to my astonishment took a knife and ran it around it around under the edge of the top plate, expertly removing it from the ribs. Berger felt all over the wood, particularly the back plate, which he did not remove. As I watched his fingers, I could see he was feeling for something special, but did not know what or why. To my further astonishment, he handed me the pieces saying if you will do this and this and put your instrument back together it will sound better. And it did (Note: This scene is dramatized in a film by Barbara Hobbie called “Luthier in the Light of Science,” however the scenario in the film is slightly different from my own memory of it 53 years later).

That started a wonderful association with Karl Berger who was willing to help me at every stage along the way in making my next...

Figure 3. Carleen M. Hutchins making violins in her kitchen in Montclair, NJ, circa 1960.
instrument. I could manage a trip to see him once every week or two and still take care of my family. Gradually he gave me the principles of good violin making and an understanding of the time, energy, and patience it takes to do a good job (fig. 3). I worked happily under Berger's direction for over five years, making some 35 instruments.

The following summer Helen Rice offered to take me to see Dr. Frederick Saunders, who had researched violins acoustically since the early 1930s. Louise Rood, a marvelous viola player and professor of music at Smith College had suggested that Helen and I come up and she would take us over to see Professor Saunders, who had retired from Harvard and was continuing his violin research in a small lab at Mt. Holyoke College near his home.

Saunders looked at my precious viola, tapped around on it, both sides as well as the ribs and the scroll, and then handed it back to me saying, “young lady I’ll be interested to see your next one.” I had not planned to make a next one! I was only interested in making one for myself to play. He told me a good deal about his work and how he had been testing instruments, showed me some of his instruments, and gave me a handful of reprints of papers he had written.

I had studied enough physics and chemistry to understand some of what he was writing about, but I had no knowledge of acoustics at the time so I could not understand very much. However, one thing stood out for me, which was that in all his experiments over the years he had never been able to do anything to change the fundamental characteristics of an instrument. He could stick a bit of oil clay or chewing gum on the bridge to change the quality of the sound, but was careful not to let it get on the varnish for fear of damaging it.

It occurred to me that perhaps I could make an experimental instrument Saunders could cut into in various ways to see what would really happen to the sound. Several weeks later when I asked him about this possibility he said he thought it would be too much work and wouldn’t help very much; so I went ahead and made an instrument anyway—a 16 inch viola with the basic elements of a good instrument but no fancy carving or purfling around the edges (Note: Purfling was first described as the ornamentation on the bishop’s cuff in Chaucer. In violins, it consists of three pieces of wood carefully inlaid into a channel cut around the edges). When I told Saunders I was making an instrument anyway he said he would be interested to see and test it. That started the very fruitful research program that I worked on with Saunders until his death 15 years later.

This was the beginning of an interchange of information between Saunders and Robert Fryxell, a fine cellist who played with Helen Rice’s quartets regularly during the summers and was interested in research as he was a trained chemist. As Saunders and I worked with various experimental instruments that I built, we were privileged to try out our experiments musically in the summers, meeting with Helen Rice and her group of musicians in Stockbridge, Massachusetts. Saunders enjoyed this particularly because he was a good violin and viola player himself and especially interested in the sound qualities that resulted from the structural changes we were making in the violas as I constructed them. For example one viola with very deep ribs was compared with another made with very shallow ribs and we wanted to hear what happened with the tone qualities.
Figure 6. Experimental viola with flat plates, external bass bar, and Saunders’ buzz-wheel purfling groove cut around the edges, and f-holes of traditional length and central area that we called our “spiral nebulae.”

**SCHELLENG’S INVOLVEMENT**

During the 1950’s and early 1960’s, John C. Schelleng, a fine cellist and an electronics engineer with the Bell Laboratories (fig. 4) who was instrumental in developing the overseas radio telephone, started corresponding with Professor Saunders and began to share in some of the work we were doing. Another electronics engineer, Alvin Hopping, was helping to test the work using some electronic equipment he had developed for testing violins. Saunders was using his Loudness Curve to test the instruments as they were made and changed. This curve was a result of bowing an octave of semitones on an instrument string to the breaking point of the sound and recording the maximum decibel value of each semitone with the C weighting of a loudness meter (fig. 5). Saunders was extremely careful to keep all conditions of this bowing test similar so that the results could be compared with considerable accuracy. He went on to make many tests on the instruments I made for him to cut into and change, keeping careful records of every test in his notebooks, which are now in the Catgut Musical Acoustics Research Library (CMARL) at the Computer Center for Research in Musical Acoustics (CCRMA) at Stanford University. These tests provided a wonderful base of information when we were trying to find out what certain changes would do to a sound. An extensive four-way correspondence developed between Saunders, Schelleng, Fryxell, and CMH, which was carefully kept in a notebook that became nearly 3 inches thick (eventually it was sent to CMARL).

Schelleng had been corresponding with Saunders on a project he had initiated of trying to put the functioning of a violin into electrical circuit theory. He apparently had worked a good deal on it and had the idea that it could be used as a musical instrument. He thought that by 1962 he published his monumental and definitive paper called The Violin as a Circuit [12]. This was the first time we knew of that anyone had tried to analyze the violin in terms of its entire function and as an active system. Michael McIntyre, a highly recognized astrophysicist and Fellow of the Royal Society in London, has worked over this paper in considerable detail and says that the information in it has nowhere nearly been developed by anyone. When McIntyre retires, he plans to go on with the kind of definitive thinking that John Schelleng did on the actual function of the violin.

Schelleng had a wonderful sense of humor. One day when Schelleng, Fryxell, Saunders and I were struggling with ideas and wondering what to do experimentally to try to explore them, Schelleng said, “Why don’t we call ourselves the ‘Catgut Acoustical Society,’ just for the fun of it?” The name seemed highly appropriate and years later it was officially adopted as the formal name of the organization. It has had several advantages over the years in that it appeals to people’s attention as well as their curiosity and separates out the people who have a sense of humor from those who do not. A few individuals, who did not like the name and could not put it on their resume without being laughed at, tried to get us to change the name.

**WORK ON IMPROVING TONE**

An interesting series of experiments initiated by Saunders’ curiosity involved the effects of a purfling groove, the channel that is cut around the edge and into which three strips of wood are carefully inlaid. It had long been thought that this was just protection for the edge of the instrument, particularly to keep the top plate from splitting at the edges. However, Saunders noticed, on some fine old instruments he had been privileged to handle, that there was a hairline crack around the purfling in the upper and lower bouts. He reasoned that this might be due to the effect of vibration at this line. So we decided to cut a groove around the edge similar to that into which the purfling is inlaid. Saunders did this with a buzz wheel around the edge of a flat-topped viola that we had been experimenting with (fig. 6). A variety of experiments had been done on this instrument but nothing seemed to give it a good tone quality. The instrument was demonstrated by a professional player before the groove was cut and it was rated as having poor tone. After the groove was cut, the tone improved amazingly and we were all surprised and delighted. Saunders had been careful in cutting the groove to keep it the proper distance from the edge and to leave the prescribed millimeter and a half of wood under the bottom of the groove. This meant that just inside the glue line the wood of the top plate was very thin as compared to the 2 ½ to 3 millimeters of the interior of the plate. With the successful change in tone quality produced by the first purfling groove around the edge Saunders decided to put in a second groove to see if the tone got any better, but there was no further improvement. Saunders also put the grooves into the C bouts and around the back as well but it did not alter the tone quality markedly. About 100 experiments...
were done with this instrument as various changes were made. It finally produced a good viola sound, but somewhat different from conventional ones due to different overtone structure from flat plates. The instrument is now in the collection of the National Music Museum in Vermillion, South Dakota.

This change in tone quality set us all to thinking. Could we get away with doing this on a finished instrument and what would the result be? Again, Saunders came up with an idea. He had noticed that Mount Holyoke College had two violas the students used but that they had poor tone quality. So he got permission from the college to let us take one of them apart and cut a groove on the inside of the top plate which would leave the wood approximately the same thickness as cutting the purfling groove on the outside. We removed the top spruce plate and found the area inside the edge to be three millimeters thick. So we decided to thin a narrow area inside of the edge to two millimeters around the upper and lower bouts. When the instrument was glued back together, the tone was remarkably better, so much so that the students at Mount Holyoke would practically fight over who was going to play that viola rather than the unchanged one. The college finally persuaded Saunders to have us change the other one as well.

This experiment worked so well that we were encouraged to try putting a similar groove in other instruments where we could have knowledge of the before and after playing qualities. Saunders called it “ditching,” and reported the whole process in a paper called “On Improving Violins[13].”

This experiment of ditching worked well on practically all the instruments where we tried it, except one or two where the wood of the top plate was already too thin near the edge, and we didn’t dare go any thinner. This experiment has considerable importance today in terms of understanding the effects of plate tuning and control of the edge thickness just inside the glue line of both top and back plates. I developed the plate tuning method based upon Italian violin making practices that I learned from Simone Sacconi. This meant that the edge of the instrument plate must be kept thin almost all the way to the glue line so that the thinnest part of the plate was around the inside of the edge. This has recently been shown in thickness graduation maps and CT scans of classic old Italian instruments.

On the other hand, the German school of violin making teaches that the thinnest area of the plate should be about a centimeter in from the edge with the wood thickening up to about three millimeters at the glue line, so that there will be a strong joint between the plate and the ribs. This means that there is a big difference between Italian and German violin making regarding how vibrations are reflected from the edge of the glued plate. Since the plate tuning method that I developed is based upon Italian violin making practices, we are finding that it doesn’t work very well with the German method of thickening the plates at the edge. This is causing some German trained violinmakers to say that plate tuning does not work.

**FURTHER EXPERIMENTS**

During the 1950’s Saunders and I did over 200 experiments on the expendable instruments, six experimental violas and one violin that I had made for the purpose, so that we could check tone qualities as a result of the alterations we had made to the actual structure of an instrument in playing condition. Several of these instruments were changed to the point where they fell apart, while others have survived as museum pieces. A violin with ribs thinned down in stages finally became so thin that we called it “the pancake.” The tone quality had deteriorated to the point where we decided that it was not a fruitful way to go. This instrument is now in the collection of the Metropolitan Museum of Art in New York City. However, “the pancake” did lead to further experimentation when we developed what is known as “le Gruyere.” “Le Gruyere” (“Swiss cheese violin”) is named because, even though it is a normal violin of a Stradivarius pattern, it has 65 five-mm-diameter holes drilled in its ribs. It can be played with all holes either open or all plugged with corks or foam plugs and any combination of holes can be left open or shut. This was the most important instrument I ever made because we did at least 100 experiments, maybe more, on it and learned an awful lot that has proved quite valid ever since. A great deal of information has been generated with this instrument and it has been studied by other researchers including Gabriel Weinreich who has sent it to its final resting place in the National Music Museum.

Another experimental instrument was called the “monster” (fig. 7). It was an ergonomically adjusted viola designed at the request of Conductor Leopold Stokowski. The idea was to have the same tonal qualities as the 20-inch alto, but redesigned so that it could be played with ease up to the tenth position. The instrument was the same overall dimensions as the 20-inch alto with all the elements placed at an angle to the centerline. Stokowski said the tone quality...
was great, but the instrument was difficult to play. It is now in the Metropolitan Museum of Art.

In my first major paper, shared with F.A. Saunders [14], I reported my use of Felix Savart’s finding of a whole tone to a semi-tone spacing of the tap tone mode (No. 5). I had also found that even better violins resulted when the X mode (No. 2) matched in frequency between a given pair of top and back free plates. I experimented with this method on each of the instruments as I made them during the 1950’s and found that reasonably good instruments did develop. However, I soon found that instruments with better tone and playing qualities resulted when mode No. 5 in a pair of top and back free-free plates matched in frequency as well as did mode No. 2. Then even better ones resulted when the matching modes No. 2 and No. 5 were an octave apart in both plates. This was the start of my investigation of plate tuning that I reported in Scientific American in 1982 [15]. By then I had records on the free-free plate tuning frequencies as compared to final instrument tone and playing qualities of over 300 violin family instruments of all sizes made in my shop, over 30 years, by me and my students.

During that time, I found a paper written in Romania by Ion P. Beldie where he had worked out the shape of the first six or seven vibrating modes in an arched violin-shaped plate [16]. This put a completely new light on the subject because instead of working at one mode as the main tap tone, I was looking at a series of vibrating modes, six or eight of them, at different specific frequencies. In addition, Karl Stetson had come to me suggesting that a new method he had developed of visualizing vibration patterns in vibrating plates, called “hologram interferometry,” could be effectively applied to violin plates. Our work with this was reported in the CAS Newsletter and it opened up a new field for research in violin acoustics.

**DEVELOPMENT OF THE NEW VIOLIN FAMILY**

In 1957 when I had finished some fifty instruments, mostly violas, but including 10 violins and 1 cello, Composer Henry Brant came to me asking for a violinmaker crazy enough to try an idea he had. He wanted a set of seven “violins,” graduated in size at each half octave over the range of written music. He envisioned an assemblage of stringed instruments that would each carry the clarity, brilliance, power, and evenness on all four strings of the violin. He did not want the tone qualities of the traditional viola and cello, beautiful as they are. After a half-hour discussion, I agreed to try to do what Brant wanted. It took me ten years! I could not possibly have created these instruments without knowledge of two important air and wood modes of the violin, as distinguished from those of the viola, cello, and bass. Nor could I have done this without the experience of working with Saunders on moving various frequencies around as we experimented with different sized instruments and rib heights. Nor could I have done it without free plate tuning, or the expert advice and help of over 100 associates in the Catgut Acoustical Society.

When I first turned to Schelleng and Saunders with the idea of trying to make the instruments that Henry Brant wanted, both were skeptical. Saunders said that he doubted that such instruments could be made to have good tone and playing qualities. Nevertheless, both agreed to help me try to find some measurable differences in the acoustics of violins that had been tested as compared with that of violas and cellos. We searched through over 100 tests that Saunders had made, plus those of various researchers such as Backhaus and Meinel in Germany. We concluded that what Saunders was calling the “main wood and air resonances” of a violin were different in frequency placement from those same modes in the other three instruments. Further search through Saunders’ loudness curves showed that these two important modes were on the two open middle strings of the 1740 Guarneri Del Gesu violin played so beautifully by Jascha Heifetz. We decided to try to see if this placement of Saunders’ main wood and air modes would work for the new sizes of instruments.

The first one to be finished and in playing condition was an enlarged viola made from a cut-down 16th size child’s cello, which cellist Carl Aue was willing to sell to me for experiments. We had found that this instrument had the placement of the main wood resonance on its open second string, but that the air resonance was much too low because of the deep ribs. So I went to work and cut the ribs down about two inches at a time, sawing the ribs off and then relining them and replacing the back until I got the air mode up to where we predicted we wanted it. This meant that the “main wood resonance” was on the open second string (A note; 440 Hz) and the air mode was on the open third string (D note; 297 Hz). When the instrument was glued up and in playing condition, Schelleng was willing to try it (with some misgivings). However, when he put a bow on it he was amazed and excited because it had wonderfully expressive sounds especially in its lower range. We had never heard such sounds from a viola before!

At that point, both Schelleng and Saunders were convinced that I had something valid to work with, so we set to work trying to develop an instrument in the tenor range an octave below the violin. The story of this effort to develop new instruments is in my paper “Founding a Family of Fiddles [17].”

At about this time we were introduced to the work of Michael Praetorius thru the book Syntagma Musicum [1] written in 1619. Praetorius not only described a series of various sized geigen (violins) in seven tone ranges but also pictured them giving their size in Brunswick inches, which when translated into our measurement system showed the “Gross Bass Geige” of Praetorius’ time in exactly the same dimensions as our large contra bass; also an instrument with exact dimensions, string length and all, as our baritone! The musicologist Steven Bonta became extremely interested in this coincidence as it represents violinmakers nearly 400 years apart coming up with much the same results! Bonta subsequently borrowed our baritone and used it for several years in his lectures on the history of instruments. Finding the historical
The background of the Octet made us realize that such a consort of violin family instruments has been in the minds of creative musicians for over 400 years, only now with the help of modern acoustic science is it possible to bring this age-old concept to fruition.

In designing each new instrument of the violin octet, we used these basic parameters of having the two strongest bowed tones (AO and W) of each instrument within a semitone to a tone of its two open middle strings. Saunders’ bowed tests of Heifetz’s Guarneri violin showed AO exactly on the open D or third string and W on the open A or second string. Saunders commented at the time that this situation helped to impress audiences with Heifetz’s sound as he tuned the instrument even before he started playing. In addition, we have had players, particularly of the alto or vertical viola, complain that putting the strong resonance on the open A string made that tone hard to control. In developing the new instruments, Schelleng and I decided to use Saunders’ loudness test for checking resonance placement in each instrument. This consisted of bowing each semitone as loudly as possible for an octave on each string, without the tone breaking and recording the decibel value of the output of each note on a sound level meter using the C weighting. This produced not only the output of a bowed violin, but also loudness values based on the Fletcher-Munson curve of hearing. This curve gives what a normal person hears relative to frequency.

Over the next five or six years I worked almost exclusively on the development of the different sized new instruments, with much help from my violin making associates and acoustical scientists. Particularly valuable in all this was an opportunity to get together with other players and try the instruments (figs. 8, 9). Helen Rice made this possible in her home in Stockbridge Massachusetts during the summers, where she would set up quartet sessions and other musical groups so we could try the instruments and have various players give us their reactions. In her studio in New York during the winters, she let me bring some of the musicians who were familiar with the instruments to play in her Brandenberg Concerto Evenings.

India Zerbe, a fine cellist, and her husband, Louis Zerbe a violinist, who were teaching at nearby Montclair State College, New Jersey, were playing the new instruments (fig. 10) and helping me to develop them so that they were comfortable for musicians to play. This meant a great deal because I wasn’t just making boxes with the sounds in them that we wanted, I was making instruments for people to handle and enjoy playing. This meant all sorts of adjustments: string lengths, shapes of fingerboards, sizes of necks, clearances of bowing related to bridge heights, and sizes of C bouts, etc. India and Louis Zerbe, as well as Ronald Naspo, a bass player who also taught at Montclair State, were in the first video filming of the Octet instruments. This was done by a group from the California Academy of Sciences who came to Montclair to tape the instruments after reading the description of them in my Scientific American article of 1962 [15].

The new violin family concept raised many questions. For instance, how would traditional classical music sound on them? At first, we transcribed pieces by composers such as Mozart, although this caused some problems. Mozart had written so well for the first and second viola parts in his viola quintets that these parts did not sound well when we tried to play a quintet with the resonances moved away from where Mozart had counted on them. Even Yo-Yo Ma, when he wanted an especially expressive passage as he performed the Bartok Viola Concerto, found that the strong sounds of the instrument are somewhere else.

This means that music specifically composed for the new instruments will always have more true expression and tone color than classic pieces that have been transcribed.
Carleen M. Hutchins — The Catgut Acoustical Society Story

**FOUNDING THE CATGUT ACOUSTICAL SOCIETY**

By 1962, Schelleng had published his definitive paper, *The Violin as a Circuit* [12] and I had published the first Scientific American Paper, *The Physics of Violins* [15]. As both of these were international publications, they generated a good deal of interest in other countries as well as in the USA. This Scientific American paper was a breakthrough in the whole process of our research because it brought a practical application into focus that was publicized around the world beyond our possible hopes. Irving Geis who illustrated the paper did a magnificent job of getting across all the information we were working with, especially the New Violin Family. Geis himself was so excited about it that he would often come from New York to our home in Montclair in the morning. About ten o’clock at night his wife would call saying, “please would you tell Mr. Geis to come home.” I received more than 200 letters expressing interest in all facets of the experimental work we were doing. Both Schelleng and Saunders helped me to answer these letters. This gave considerable impetus to our acoustical research. Thus, the group working with Saunders gradually enlarged and we decided to form the Catgut Acoustical Society.

On May 16, 1963, the Catgut Acoustical Society was formally founded by twelve members of the original technical group. The meeting was held in conjunction with the New York meeting of the Acoustical Society of America, so we could lure some of the people attending that meeting to attend the official founding in Montclair. We sat around a ping-pong table in the garden at 112 Essex Street and talked steadily for about five hours about problems of violin acoustics and the possibilities that lay ahead. Lunch was served in between by four cooperative wives, Virginia Benade, Connie Hegeman, Elinor Schelleng, and Sally Smith. The group consisted of Robert Fryxell (elected vice president), Carleen Hutchins (secretary), Virginia Apgar (treasurer), Arthur Benade, William Carboni, Louis Condax, Donald Fletcher, A. Stuart Hegeman, Maxwell Kimball, John C. Schelleng (fig. 11), Eugen J. Skudrzyk, and J. Kellum Smith. Four members who were unable to be present at the original meeting were Frederick A. Saunders (elected president in absentia), Jean Dautrich, Louise Rood, and Rembert Wurlitzer.

Discussions centered on the following subjects:

- Development of instruments of the new violin family octet, as well as musical comments obtained from one of Helen Rice’s Brandenburg sessions where they were played (details are in CAS Newsletter No. 1 [18]).
- Schelleng corresponded with Robert Scanlon of Princeton and Maurice Hancock in England on theories of plate vibrations and the testing of free versus clamped plates.
- Fryxell was continuing the testing of wood strips.
- Benade studied air resonance of various experimental violas as compared to the new alto violin.
- Kimball and Condax (fig. 12) were working on ways of measuring bows and the possibility of constructing new ones for the octet.
- Schelleng and Hutchins had been in contact with Lottermoser in Germany (fig. 13) on his many measurements of violins.
- Condax continued his research on varnish.
- Hegeman had made a test fixture large enough to accommodate the contra bass plates.
• Carboni was doing tests on the relation of plate tap tones to tone quality in assembled new and old instruments.
• All these researchers felt that musical research was the next area where real work was needed.

Because of publicity, Life magazine had written a short article, and the Cornell News and the Newark Sunday News had published articles on the New Violin Family and C.M. Hutchins. The California Academy of Sciences had made a television program on Hutchins researching the New Violin Family with Louis and India Zerbe and Ronald Nasbo playing the new instruments at Montclair State College. The final discussion concerned funding for the work going on as the $9,000 of Hutchins’ two Guggenheim grants had been used up mainly on research equipment and materials to develop and build new instruments as well as expenses for duplication, mailing and supplies. Since there were no official dues, a contribution to defray expenses was welcomed.

Comments on this first meeting: It is especially interesting to note that many of the problems we are still working on were in the thinking of the founding group. For example, wood testing in various ways, plate testing in relation to tone quality, varnish research, bows for the new instruments, theories of plate vibrations, air modes of the viola as compared to the vertical viola, and other topics which are still in our thinking and probably will never be completely understood.

OUTREACH
The Society grew to a maximum of 885 members in 1988, including hundreds of international members. The increase in membership is partly attributed to publicity engendered through various media. Specifically, there was considerable media interest in results from studies of various elements that relate to the sound of a good violin. Some of our accomplishments during the first 15 years (1963-1978) are as follows:

• Research laboratories in Australia, Canada, Germany, Great Britain, France, India, Japan, Poland, Sweden, USA, and the USSR had been focused and consolidated through the efforts of the Catgut Society in five international technical symposia.
• Distribution of 12,000 copies of the CAS newsletter, which by 1978 had become an archival reviewed journal.
• 122 lectures and demonstrations on violin acoustics.
• Two Benchmark volumes [19] of definitive papers in violin acoustics
• Over 20,000 reprints had been distributed, and the Catgut Office averaged more than 1500 mailings each year

Special projects sponsored by CAS included the following:
• Construction of two sets of the New Violin Family octet with 54 more individual instruments underway: One set of the NVF was being researched musically and technically in

Figure 12. Maxwell Kimball (l) and Louis Condax (r) discussing violins (1970’s). Both had made and tested violins and were helpful in developing the New Violin Family instruments.

Figure 13. Professor Werner Lottermoser with his violin testing equipment at the Musical Acoustics Laboratory, Braunschweig, Germany. Hutchins worked with him for several years comparing test methods and results on many violins.
the UK with new compositions and arrangements of music and commercial recording of the NVF in progress.

- Successful development of a graphite epoxy soundboard for violin and guitar (fig. 14). Martin Guitars made the guitar with a conventional structure except for the composite top, and Hutchins did the same for the violin.

- Development of eigenmodes in free violin plates for control of playing qualities in all members of the violin family.

- Application of acoustical principles to improve the tonal output of children’s violins.

- Interpretation and publication of research findings for violinmakers and teaching of technical violin making.

In October 1981, the publication of the Scientific American article, *The Acoustics of Violin Plates* [21], stimulated a completely new series of requests for lectures and demonstrations in various countries. That article was translated into Italian and Japanese, and has helped violinmakers worldwide to make considerable progress in the development of fine sounding instruments.

I gave more than 200 invited lecture demonstrations and concerts on acoustics and the NVF throughout the USA, Canada, and Europe (fig. 15). Elizabeth McGilvray and I organized and helped to conduct numerous conferences (fig. 16), including 12 International Symposia on Musical Acoustics (ISMA). Appendix 1 gives selected presentations from the more than 200 listed in CM Hutchins’ Curriculum Vitae. These lectures, demonstrations, and octet concerts give an idea of how worldwide this development has been. The audiences ranged from local schoolchildren through technical groups in many countries.

**THE CAS OFFICE**

Over the years, the CAS office with all its operations, correspondence files, records, reprints, and equipment was maintained at 112 Essex Avenue, Montclair, NJ courtesy of Morton and Carleen Hutchins.

In recent years, Deana Campion ably served as office manager, and Barbara McMillan worked as assistant secretary to handle the computerized membership records and dues mailings. In 1999, when the New Violin Family Association was founded, the CAS office was moved to 55 Park Street, Montclair. The Montclair CAS office was officially closed in February 2004 and duties were transferred to the Violin Society of America office in Poughkeepsie, NY.

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**Figure 14.** Graphite/epoxy topped violin and guitar (resulted from National Science Foundation grant to Dr. Daniel Haines, University of South Carolina, 1975). The violin is now in the collection of the National Music Museum.

**Figure 15.** Henry Brant conducting the first major public concert of the New Violin Family Octet at the 92nd Street Y in New York City, May 20, 1965.

**Figure 16.** Snapshot of part of the CAS group at first Mittenwald conference (1974), Germany (photo: J. Woodhouse). From left to right, Walter Reinicke, Ion-Paul Beldie, Jurgen Meyer, Ingeborg Meyer, Daniel Haines (in back), Ingeborg Meyer, unknown, Lee Schumacher (boy in front), Carleen Hutchins, Morton Hutchins, Robert Schumacher, Ian Firth, Linda Schumacher, Carolyn Schumacher, Maurice Hancock, Erik Jansson, unknown, Elizabeth McGilvray, Dugald McGilvray, Michael McIntyre, unknown string teacher from the Geigenbauschule, with his wife, unknown, Mrs. Helmut Muller, Mr. Muller.
The CAS Secretary of many years, Elizabeth McGilvray, and her husband Dugald McGilvray kept track, not only of all the comings and goings of the CAS, for some 35 years, but also of financial records. Both were well trained—Elizabeth as a legal secretary, who filed every piece of paper, and Dugald was a certified public accountant. Their enthusiasm and devotion to all this work meant more than most of us will ever realize. It meant far more than one day’s paid work a week. It involved long hours of planning and arranging for international symposia as well as keeping meticulous records of individual memberships and all the paper work that went through the office. We all owe a debt of gratitude to the indefatigable McGilvrays for their devotion and enthusiasm for the Society. Elizabeth kept a card on each member, their interests and qualifications as well as addresses, etc. and their yearly contributions to the CAS. Her cards on members amounted to over 3000 people.

Elizabeth’s records of every piece of mail that was sent out of the office each week show a huge volume of correspondence. Much to my amazement, her records for some of the busiest years show the following (Elizabeth said that mailings sometimes contained two or three pages of specific information):

<table>
<thead>
<tr>
<th>Year</th>
<th>Mailings</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>2502</td>
<td>826</td>
</tr>
<tr>
<td>1985</td>
<td>2957</td>
<td>831</td>
</tr>
<tr>
<td>1986</td>
<td>2701</td>
<td>783</td>
</tr>
<tr>
<td>1987</td>
<td>3056</td>
<td>—</td>
</tr>
<tr>
<td>1988</td>
<td>2466</td>
<td>885</td>
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<tr>
<td>1989</td>
<td>3597</td>
<td>—</td>
</tr>
<tr>
<td>1990</td>
<td>2965</td>
<td>729</td>
</tr>
<tr>
<td>1991</td>
<td>2501</td>
<td>—</td>
</tr>
</tbody>
</table>

Records also show that overall special contributions and expenses for 35 years of CAS were over half a million dollars (income sources other than member dues and contributions):

In 1974, Harriett Bartlett gave the CAS $40,209.75 and by 1978 her total grants amounted to $110,923.36.

<table>
<thead>
<tr>
<th>Expenditures</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special funds given to CAS including the above</td>
<td>$309,495.22</td>
</tr>
<tr>
<td>Interest 1974-98</td>
<td>122,684.08</td>
</tr>
<tr>
<td>Rental of instruments</td>
<td>4,242.50</td>
</tr>
<tr>
<td>Sale of CD’s #1 and #2</td>
<td>4,747.50</td>
</tr>
<tr>
<td>Sale of reprints</td>
<td>60,318.09</td>
</tr>
<tr>
<td>Sale of recordings and tapes</td>
<td>907.44</td>
</tr>
<tr>
<td>Blueprints and photos</td>
<td>5,980.34</td>
</tr>
<tr>
<td>Return of loans on instruments sold</td>
<td>23,464.79</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$531,839.96</strong></td>
</tr>
</tbody>
</table>

Other expenditures, special funds for meetings, octave concerts, music, salaries, the Journal, etc. which were detailed in the accounts: $354,407.48

ARCHIVES

By the second CAS Symposium in Mittenwald in 1989, so much valuable information was piling up in reprints and special articles in addition to the CAS Journal that the attendees, who came from many countries, voted to establish a permanent archive where research materials could be available.

Joan Miller and Carleen Hutchins discussed this with Max Mathers who had retired from Bell Telephone Laboratories and was working at the Center for Computer Research in Musical Acoustics (CCRMA), a worldwide organization on the campus of Stanford University in Palo Alto, California. With considerable planning and further discussion, CMARL was formed and a volunteer librarian, Gary Scavone, agreed to take charge. Funds were raised and files purchased to house the collection, which under the guidance of Joan Miller, has grown to be quite sizeable.

In 1996, The Shrine to Music Museum (later named “National Music Museum”), in Vermillion, South Dakota, was given a full octave as a gift from the Harriet M. Bartlett fund of the CAS and Morton A. and Carleen M. Hutchins. In 2001 when I was planning to move from New Jersey to New Hampshire, I invited André Larson, Director of the National Music Museum, to come and see if the museum would like to have any of the experimental instruments, correspondence, files, and technical records that had accumulated over the years. André looked all around and said, “We would like all of it! It is an amazing record of a whole era in violin acoustics.”

Elizabeth McGilvray and I sent 45 boxes of reprints and correspondence to the museum before my big move to New Hampshire in 2002. There is at least that much more to go. The museum staff under curator Margaret Downey Banks is cataloguing the whole thing as a permanent archive available to researchers.

This brings up a big question: Should we try to combine the two archives or cross-reference them? Joan Miller cataloged the CMARL holdings as they were sent. However, the future of these is uncertain. André Larson would like to have both archives at the National Music Museum, where the whole body of information could be maintained in one place! This is my preference as well.
CONTRIBUTIONS TO VIOLIN ACOUSTICS AND VIOLIN MAKING

Since 1963, the CAS has correlated and stimulated research on all facets of violin acoustics and construction, making much of it understandable enough to be directly applied to violin making methods and materials. The CAS has made possible the progress I have made in both violinness and acoustics. Forward-looking violin maker Robert Spear, who studied with both CMH and Karl Roy of the Mittenwald School, said in speech to the Acoustical Society of America (ASA), “Hutchins has forever changed the way violins are made.” Gabriel Weinreich and Robert Schumacher wrote in the encomium for Hutchins’ Honorary Fellowship, the highest award the ASA gives, that she has had “a career that changed the face of violin acoustics.”

A wealth of information, written both for the violin maker as well as the scientific community, is contained in 80 issues of the CAS Newsletter and the CAS Journal, a peer-reviewed technical publication, respected worldwide. Four volumes of technical reprints assembled and edited by C.M. Hutchins have been published. The first pair of volumes, covering violin research from 1800 to 1975, were published as part of the Benchmark Series [14] and edited by Carleen Hutchins and John Schelleng (Note: Schelleng refused to have his name on this, as CMH had done most of the work, but Schelleng helped enormously with editorial comments). Many of the early papers had been assembled by F.A. Saunders through his wide correspondence with other members. Other papers were dug out of reprints and libraries worldwide by CMH.

The second pair of volumes, “Research Papers in Violin Acoustics 1975-1993,” [22] was assembled and edited by C.M. Hutchins with the help of Virginia Benade. It contains 121 papers and 400 annotated references along with an essay on the history of violin research that shows the connections between the general scientific climate of the times and the musical status of the violin. These two volumes were published by the Acoustical Society of America. Gabriel Weinreich, Professor Emeritus (acoustics) of the University of Michigan said “this pair of volumes brings together two separate elements: A collection of reprints of research papers that appeared after the well-known Benchmark collection was published, and a historical essay by Carleen Hutchins, herself one of the guiding spirits of violin research, plus her annotations for the individual sections.”

CONCLUSION

The violin is undoubtedly one of the most effective as well as elusive results of man’s age-old desire for beauty in all forms. The 20th century development of the vacuum tube, electronics, and computer technology allowed the CAS to build a solid foundation of scientific measurement under many aspects of violin making, through the correlation and focusing of the efforts of several thousand members. Members have been willing to share freely their research findings and enthusiasm, as well as helping violinmakers to adapt some of the information to the construction of more effective and efficient instruments.

An amazing body of knowledge was assembled and disseminated by CAS members through the enormous correspondence of the CAS office. However the most far-reaching and memorable effects of all this have been through the many personal contacts and friendships formed through meetings and worldwide visits over the years. This amazing flow and exchange of challenging ideas with wonderful people has kept alive my life-long dedication to violin acoustics and violinness.

I’d like to conclude with a sampler of good times I remember when I think of the CAS:

- Neville Fletcher at the first international meeting at 112 Essex Ave., Montclair, NJ, singing Australian songs and showing us how to throw the boomerang.
- Herbert Meinel and myself in Budapest unable to understand each other’s language, pounding each other on the back to get ideas across when translators were unavailable.
- The Stockholm evening boat rides through the archipelago with good food, music, dancing, and Johan Sundburg singing in his etherized falsetto.
- Abe Segals’ beach party steak roast on the sands of Australia.
- Michael McIntyre playing the new soprano violin with great pleasure in the Pigotts Concert put on by Bernard Robinson in England.
- The thrill of hearing the violin octet performed by professionals in the concert hall of the St. Petersburg Conservatory of Music, where greats such as Rubenstein, Rimsky-Korsakov, Tchaikovsky, Rostropovich, Stravinsky, and Heifetz had performed.

REFERENCES

APPENDIX 1
Partial list of selected meetings, lectures, demonstrations, and octet concerts organized or supported by the CAS, 1960-2004. Conference organizers names are given in parentheses. Lecture or presentation was given by C.M. Hutchins unless otherwise stated.

1960-1961 Music Educators Association of New Jersey
                Watchung School, Montclair, NJ, Sixth Grade

1964-1965 Pennsylvania State University, State College PA, Physics Colloquium Princeton Junior Museum
                Acoustical Society of America, Musical Symposium, New York, NY
                University of Toronto, Royal College of Music, Toronto, Canada
                University of Western Ontario, college of Music, Physics Department, Ontario Canada

1966-1967 Case Institute, Cleveland, OH, Major University Lecture Series
                Massachusetts Institute of Technology, Physics and Music Departments
                Broadcast Tapes for Radio Free Europe and the Voice of America

1968 American Philosophical Society, Lecture and concert on Violin Octet Instruments, Fall open meeting
                Princeton University, J. Edward Farnum Public Lecture Series
                American Symphony Orchestra League, Annual Meeting, Pittsburgh, PA

1971 Seventh ICA (International Congress on Acoustics), Budapest, Hungary
                Technical University, Lothar Cremer and Acoustics Research Group, Berlin Germany


1975 American Association for the Advancement of Science, Annual Meeting, Invited lecture, New York, NY

                ISMA, Cambridge, England. (McIntyer, Woodhouse)

1977 Hamilton College, Departments of Music and Physics, Clinton, NY
                Ninth International Congress on Acoustics, technical paper, Madrid, Spain

1979 The University of Western Ontario – Departments of Physics and Music, Television and press interviews
                The University of New Hampshire, Division of continuing Education, Lecture on acoustics of violins at Violin Making School Session, Durham, NH
                The University of Ottawa, Departments of Music and Physics, colloquium, Ontario, Canada

1980 Acoustical Society of America, Joint meeting with Acoustical Society of Japan, Honolulu, Hawaii, CMH demonstration of Suzuki size violins played by one of Suzuki’s early students and her group of children

1981 The University of New Hampshire, Division of Continuing Education, violin Making School Session, Durham, NH

1982 Royal Academy of Music of Sweden – symposium on violin making and acoustics; lectures, demonstrations and concert presenting The New Violin Family, Musikmuseet, Stockholm, Sweden
Technical University – Trondheim, Norway
University College of Cardiff, Conference on violin acoustics, Cardiff, Wales

1980
ISMA, Wollongong, Australia (Segal)
NASA Goddard Space Flight Center, Engineering colloquia, Greenbelt, MD
University of Wollongong, Department of Physics Colloquium, Wollongong, Australia
St. Andrews Presbyterian College, Invited symposium speaker, VISIONS, Laurenbrug, NC

1982
ISMA, DeKalb, IL (Rosing)
Acoustical Society of Japan, Tokyo, Japan
Institute of Theater, Science and Technology, violin makers, staff of Research Group, Beijing, China
Members of the Acoustical Society of China, violin makers in Beijing (5) lectures to over 75 violinmakers and acousticians
Chinese University of Hong Kong, Hong Kong – Physics colloquium
TV Recording for “3-2-1 Contact”

1983
11th ICA (Xavier Boutillon) Paris, France (“Le Gruyere” violin demonstrated by Jurgen Meyer)
University of Iowa, Music and Physics Departments, Concert/demonstration/lecture, Iowa City, IA
SMAC ’83, Stockholm, Sweden
Conference with Francesco Bissolotti, President, Associazione Cremonese Liutai Artigian Professionisti and Bruce Carlson, Cremona, Italy, and luncheon for their associates.
Hamilton College, Physics and Music Departments, Clinton, NY

1984
Concordia University, Science College, Public lecture, Montreal, Canada

1985
Acoustical Society of America, contributed paper; Discussion leader, Modal and finite element analysis, Austin TX

1986
ISMA CAS/Hartford (Robert Meyer)
XII International Congress on Acoustics, Invited paper (Violin Octet/concert/lecture, Toronto, Canada
Massachusetts Institute of Technology, Presentation of Violin Octet/concert, Metropolitan Symphony Orchestra members, Cambridge, MA
Women’s Project of New Jersey, Douglas College, concert/presentation of Violin Octet, New Brunswick, NJ
East Devon College of Further Education, Acoustics of Bowed Stringed Instruments, Two invited papers, Tiverton England
Technical Violin Making Seminars, 1, 2, 3, 4, Shop of Thomas Knatt, West Concord, MA, Robert & Deena Spear, Accokeek, MD, Montclair, NJ, and Curtin & Alf, Ann Arbor, MI

1988
Acoustical Society of America, Session Chairman,

1989
ISMA, Mittenwald, Germany (Cremer, Muller)
Acoustical Society of America, Pennsylvania State University, Two contributed papers, State College, PA
Stamford University, Center for computer Research in Musical Acoustics (CCRMA), Research Visit, Stanford, CA

1990
ISMA, Annapolis, MD (Neustadt, Elder)
Concordia University, Research visit and commencement address, Received Honorary Doctorate of Laws, Montreal, Canada
Sent set of Violin Octet instruments to Shrine to Music Museum, Research conferences, Vermillion, SD
McMillan Science Project, “Waves of Sound” with Joshua Bell, violinist
Violet Society of America/Catgut Acoustical Society joint meeting, Organizer, Panelist, Invited lecture, Cromwell, CT

1991
SMAC Stockholm (Askenfelt, Jansson)
Materials Research Society, Spring meeting, April, Invited paper
Stanford Linear Accelerator Center, Stanford, CA
Sent set of Violin Octet Instruments to St. Petersburg Conservatory of Music, St. Petersburg, Russia
“Parallels in Creativity” – Violin Octet Concert/Lecture to Harvard-Smithsonian Center for Astrophysics, Cambridge, MA
St. Petersburg Conservatory of Music, Violin Octet/week of concerts and lectures, St. Petersburg, Russia
Catgut Acoustical Society/Michigan Violinmakers Association joint conference, Technical paper, Dearborn, MI
Elementary school, Lecture to sixth grade class, Moultonboro, NH

1992
ISMA Edinburgh, Scotland (Meyers, Campbell)
Acoustical Society of America, 133rd meeting, June, Lecture to Fellows Luncheon, State College, PA
Acoustical Society of America, Seattle, WA, and ISMA,
Leavenworth WA (McGilvray)

1999  ISMA, Japan (Nakamura)
2000  SMAC, Stockholm, Sweden (Askenfelt, Jansson)
2001  ISMA, Italy (Stanzial)
2002  ISMA, Mexico (Zenker, Castro-Sierra)
2003  SMAC, Stockholm, Sweden (Askenfelt)
2004  ISMA, Nara, Japan (Taguti)