FoMRHI Quarterly

BULLETIN 87
Bulletin Supplement
Notes for contributors
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1505 Goodacre’s razor and undercutting woodwing finger holes

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FELLOWSHIP OF MAKERS AND RESEARCHERS OF HISTORICAL INSTRUMENTS
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FELLOWSHIP of MAKERS and RESEARCHERS of HISTORICAL INSTRUMENTS

Bulletin 87  
April, 1997

LIST OF MEMBERS: The new list comes to you with this Q. Do use it; make contacts with colleagues, especially when travelling, and do take advantage of the information in it. One thing that isn’t in it this year is the usual last page, our Notes for Contributors. The List runs to exactly 24 pages, so rather than waste three pages, I’ll suggest to Eph that the Notes appears in this Q., perhaps as the back page here. Check your own entry please and do let me know if it’s wrong. Each year, when I’m revising it for the next year, I find a few errors and omissions and wonder why the people concerned haven’t complained!

LOST MEMBERS: Magyar Istvan of Budapest is still lost. If anyone is in contact with him, please let me know—it’s a pity to lose our sole contact in a country. In which context, our sole member in Finland has not resubscribed—anyone know if there is any interest in early music there? I have an ethnomusicology conference there in the autumn (in Jyväskylä) and if I can make any further contacts I will.

Piero Mazzotta of Oakville, Ontario is also still missing.

FURTHER TO: Bull. Suppl., ‘An editorial matter’: We do need to emphasise from time to time that Eph is the Editor—things for the Bulletin must come to me, because as Secretary I compile it, but Comms, while they are welcome to come to me to save a separate letter, are editorial matter.

Bull.86 p.4: ‘Materials available’: Martin Pühringer says that the price he quoted should have been Austrian Schilling (öS) 850 per square metre. There is still time to order, I gather.

CONGRATULATIONS: One of our older members, Edgar Hunt, has been awarded the American Recorder Society’s Distinguished Achievement Award for 1997. Long overdue, I’d think, for no one else has done so much for the recorder. It was due to Edgar that the traditional fingering overcame the German fingering, and it was he (here perhaps the over-sensitive to squeaking should stop their ears) who developed, for Schott, the plastic-headed descants which made the enormous spread of recorders in primary schools practicable. On the more serious note, his book on the recorder is still the standard history. And perhaps, if I may add a more personal note of thanks, few people know that I called his collection of instruments within the Bate Collection the Edgar Hunt Accession because, while it was ostensibly a purchase, when I went to his house to collect what we had bought, he kept saying ‘Do you have one of these?’ and adding gift to gift, so that a good half of what we finally came away with was gifts—no way after such generosity, could I label it the Edgar Hunt Purchase!

QUERIES: Paul Hailperin is starting to look at the Viennese oboe of the 19th century, and especially whether it retains the contracted bell lip, characteristic of baroque and classical oboes, and at what stage it opens up to a plain flare like the modern French oboe. He thinks the Koch instruments would be a good case study and asks for information on any Koch oboes anybody knows of—what sort of bell has it? Plus, of course, any information which would help to date it.
Carl Willetts asks ‘How do I stop pewter plugs on my Wm Henry Potter flute sticking?’ Only the day before yesterday, a query, also on lubrication for metal/wood contacts, on the CIMCIM Listserv, drew three responses which all suggested graphite. Any other suggestions? I’d be grateful, as well as Carl, to receive any responses and I’ll pass them on here.

**MATERIALS etc AVAILABLE:** Moony Kara (in the List of Members) of Northern Crescent says that ‘once again we can offer small quantities of African blackwood for repair work or small manufacturing.’

I am asked to tell you that ‘the Belsize Music Rooms, 67 Belsize Lane, Hampstead, London NW3 5AX (0171-916 0111; fx 0222) are available for teaching, rehearsals, etc.’

Marc Vogel (Talgäße 2, D-79798 Jestetten (07745/8156; fx 1669) is offering, for DM 189, a new digital sliding caliper, both metric and inch, with ‘a repeatable precision of 0.01 mm with a maximum deviation of 0.02 mm at a length of 100 mm.’ The caliper is Swiss, but he doesn’t say what it’s made of; I assume metal if it’s that precise, but the zero can be reset so that one could add plastic sheathes to the jaws. He also sells humidifiers and a high-precision Hygro-Thermometer as well as other harpsichord etc making equipment.

John Rawson asked me ‘Did you see this on HPSCHD-L? Someone ought to chase it up and see if it would be really useful to us: International Atomic Energy Agency and United Nations Educational and Scientific and Cultural Organization, INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS, NONLINEAR INTERNAL FRICTION, CHAOS, FRACTAL, AND MUSICAL INSTRUMENTS, Z. Q. Sun and C. W. Lung, International Centre for Theoretical Physics, Trieste, Italy, and International Centre for Material Physics, Institute of Metal Research, Chinese Academy of Sciences, Wenhua Road 72, Shenyang 110015, People’s Republic of China. ABSTRACT: Nonlinear and structure sensitive internal friction phenomena in materials are used for characterizing musical instruments. It may be one of the most important factors influencing timbre of instruments. As a nonlinear dissipated system, chaos and fractals are fundamental peculiarities of sound spectra. It is shown that the concept of multirange fractals can be used to decompose the frequency spectra of melody. New approaches are suggested to improve the fabrication, property characterization and physical understanding of instruments.’

**HARPISTS OF THE WORLD UNITE:** The 1998 Harp Almanac is looking for information about harpists, harps, and anything relevant. Basic listing is free. Contact Maxemillian Productions, POBox 40275, St Paul, MN 55104 (+1-612-227-6041; fx -0320; schlomka@well.com) for further information. Deadline for listings is August 1st.

**HARPSICHORD & FORTEPIANO:** This magazine has been revived (again) under a new team of editors, Alison & Peter Holloway, 3 Ventnor Terrace, Lincoln LN2 1LZ, and should reappear, they hope, by the end of this month. Unexpired subscriptions will run on.

**MEETINGS:** The biennial meeting of the American Bach Society will take place at Yale University in New Haven, Connecticut, on April 24-26, 1998. The theme of the conference is ‘J S Bach and the musical instruments of his time.’ The Society invites proposals for papers. A one-page, double-spaced abstract should be sent by October 15, 1997, to Prof. Kerala J.
Snyder, Eastman School of Music, 26 Gibbs Street, Rochester, NY 14604. Papers on all aspects of Bach research are welcome, although special consideration will be given to those that deal with the theme of the conference.

The Edinburgh Collection and the Galpin Society are organising a colloquium on historical musical instrument acoustics and technology, 22-23 August in Edinburgh. Information, booking forms for both conference and, if you need it, accommodation from Arnold Myers. There’s a very interesting list of papers in the provisional programme. Conference fee is £30 and bed & breakfast from £21.50 up according to standard.

COURSES: Andrew van der Beek is organising his usual Serpent weekend, 16-18 May (Can-tax House, Lacock, Chippenham, Wilts SN15 2JZ).

The Bate Collection seems now only to be doing Bow-Making. There’s a rehairing weekend next week (there’ll doubtless be others, so get on to them – Faculty of Music, St Aldate’s, Oxford OX1 1DB – to go on the mailing list), and a bow-making week 6-11 July.

Kenneth Sparr writes [I have reduced this; full text available from him or Arne Lindberg]: The lutebuilding-summercourse (the 19th) at Marholmen outside Stockholm takes place between July 14th - August 1st. The course is open for everybody who wants to spend 19 days (and nights) working on building an own lute. The instruments are based on lutes by Hans Frei or Martin Hoffmann. The ambition is to reproduce instruments that in construction and choice of material are very close to the way that the instruments of the period once were built. Important is also to make the sound and playability as close as possible to the originals. That doesn’t mean we are making exact copies of the originals but instruments of the same spirit. The course is held about 80 km north of Stockholm in a small island (Marholmen) at the countryside in the archipelago. We work, eat (very high standard) at the school and sleep in nice single-bed rooms. It is about half a minute walk to the sea and the sauna. The price for all this, depending on what instrument you build, will be about 10 500- Swedish crowns. This includes accommodation and all material. Interested will please contact: Arne Lindberg, Vargvagen 16, S-122 47 Enskede, Sweden. Or e-mail: a.l@sonans.se.

Orpheon Accademia di Musica Antica has a course in Bolzano, 1-10 August, with tuition on most of the obvious instruments. Information from Orpheon, Praterstrasse 13/13, A-1020 Wien (t&f 00431-21 430 21; orpheon@geocities.com)

West Dean College (West Dean, Chichester, W Sussex PO18 0QZ) has its usual summer school in Early Music Performance, 16-22 August, but not this year any of their musical instrument making courses.

REALLY EARLY MUSIC: Some of you may have seen reports in the last few days in the papers of a Neanderthal flute, between 43,000 and 67,000 years old. It is said to play four notes, but the only evidence of original length is that of a bear’s thigh bone, and it has only two holes plus possible traces of two others (though one could be a mouth) at the broken ends. It looks to me as though they’re trying to build too much on too little evidence, whereas without all the hype it would be fascinating enough, for it is far older than any other known wind instrument.
There's a very full report in the latest Ethnomusicology Research Digest (ERD 255, vol. 8 no. 5, 5 April 1997). More information is available from Bob Fink, who has written a large article on it, much of which is in the ERD report at green@webster.sk.ca, and the website: http://www.webster.sk.ca/greenwich/fl-compl.htm and something will appear in Bel Canto magazine. ERD is accessible as listserv@umdd.umd.edu.

**CODA:** I think that's about it. I've already done the List of Members, so this can go straight off to Eph. Meanwhile the sun's shining, so that now this is all done I can go out in the garden!

**DEADLINE FOR NEXT Q:** 1st July as usual, please.

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**BULLETIN SUPPLEMENT**

Ephraim Segerman

**CD-RoM museum pictures**

I don't have a CD-RoM on my computer, so I lent the one Jeremy sent to someone who had, and he reported to me. I was wrong to say 'dots', and should have said 'rectangular pixels'. Jeremy is wrong to say the pixels are on the reading machine, and not on the representation of the picture on the CD-RoM. Here is a sample:
The 'Renaissance' guitar?
We have been using the name 'Renaissance guitar' for the plucked or strummed four-course flat-(or flattish-) backed guitar that emerged in Spain in the first quarter of the 16th century and became popular all over Europe by the middle of the century. June Yakely has reminded me that this instrument was specifically catered for in editions of the famous guitar tutor written by Amat as late as 1760. Since it was in active use throughout the baroque, the name we have been using for it is obviously inappropriate. The authentic name for it was 'guitar' ('gittern' in English) or 'Spanish guitar' during much of the 16th century, but when the larger 5-course guitar was developed late in that century, and took the name 'Spanish guitar', the 4-course smaller one was called names such as 'chitarrino' (a 5-course guitar of similar size was called 'chitarra piccola').

Calling it just '4-course guitar' could confuse it with the quill-plucked medieval guitar which also had 4 courses but was round-backed. Calling it 'chitarrino' would be inappropriate because of its extensive Renaissance use when there wasn't a larger size for it to be smaller than. Calling it 'gittern' is inappropriate because this name applied to a cittern-type instrument with metal stringing in the 17th century. "Renaissance-baroque 4-course guitar" or 'gittern-chitarrino' would do the job but they are rather cumbersome. Other possibilities are 'late 4-course guitar' (medieval being early) or '4-course Spanish guitar'. Any comments or other suggestions? It is a lovely-sounding, cheap, versatile little instrument (essentially a double-strung baritone ukulele), and deserves wider use in early music. It is not impossible that its acceptance has been hampered by not having an attractive simple appropriate name.

Cittern controversy
Peter Forrester tells me that he is tired of our cittern controversy. So am I. Neither of us is going to convince the other, or attract more recruits to his cause. Peter’s Comm. 1496 in the last Q corrected me on Fludd, but my hypothesis given in the Bulletin Supplement of Q 85 can easily be modified to include the corrected information. Fludd was writing in a transitional time when Mueller’s wire was getting scarce, so the price must have shot up. Some cittern players still had supplies of Mueller’s wire or could afford to buy replacements, and so they could still play at the high pitch. Fludd mentioned the use of citterns in Consorts, where the high pitch appears to have been essential (because the Consort declined simultaneously with the high pitch). Others had broken their strings of that wire, could get no replacements that they could afford, and tuned a fifth to an octave down with whatever strings they could get. Iron strings on the first course would work as well as brass (the cittern that Virchi wrote his music for couldn’t have been much bigger than the English cittern because of the stretches asked for in the music, and its first course was iron at the low octave). The citterns playing at the low octave probably mostly included barber’s citterns.

This is all very speculative, but it is good history to speculate to fill in the gaps in the story where evidence is lacking. The more different reasonable speculations (consistent with the evidence) there are, the better. If there is no single solution to a problem, the total of all possibilities (of what the solution might be) is the best solution we can now have. Avoiding thinking about the problem (considering it a mystery) until the right evidence comes along is just burying one’s head in the sand. Good scholarship involves extensive use of one’s imagination besides collecting and relating evidence.

A DIY maker of gut lute strings
From Reading Records, Diary of the Corporation Vol III (1896), ed. J.M. Guilding, in the minutes of a meeting on Friday, 7 November, 1634, is the following entry:

‘At this daye Mr. Awsten Alexander, Robert Griffen, William Cantrell and Widowe Limboe, did complayne against William Hayes for annoyeng them with stinkes by useinge the makeinge of lute-stringes with gutte, and misuseth Mr. Alexander in wordes, &c.

Uppon the hearinge of the cause he promiseth to desist and not to use the makeinge of lute-stringes any more after morowe senight.’
ACB, 1912-1997

When we started FoMRHI back in 1975 we thought that maybe some slight cachet of respectability might be useful and indeed that it might persuade people that it was worth joining us. So we asked two 'father-figures' in old instruments if they’d be willing to be honorary members, patrons as it were. We did also think that it might be an idea to show our appreciation of all that they had done for all of us.

One of them was Eric Halfpenny, the founding Honorary Secretary of the Galpin Society and the author of many articles in that Journal and elsewhere on woodwind, brass, and string instruments.

The other was Anthony Baines, that same Journal’s editor for many years and author of the book that no woodwind person could ever leave far from his or her hand (I seem to look something up in it almost every day) and, as well as many other essential books and articles, that wonderful museum within the covers of a book, *European & American Musical Instruments*.

Eric died not that long afterwards, but Tony remained one of our staunchest supporters, even going so far as to say at a Galpin Society AGM (he was their editor at the time) that there was no need for the Journal to continue because now we had FoMRFU taking its place. I had to say that we had a different function, but we had by then to some extent replaced GSJ in some of the nitty-gritty articles which it had published in its earlier days, days that I think Tony regretted when he kept getting what he referred to (I slightly bowdlerise his remark) as undigested undergraduate thesis articles from American students.

Now Tony has left us. He died on February 3rd after suffering a stroke.

As you all know, he was my predecessor as curator of the Bate Collection, to which he had been immensely generous, giving many of his own instruments and putting all the rest in on loan, where they still remain. Nobody could have had a better predecessor, every time he came in he found something to praise. I don’t want to make this too long (we don’t have a tradition of obituaries in FoMRHIQ) – perhaps it’s enough to say that as a scholar in our field, nobody could equal him.

Patricia, his widow, has asked that instead of flowers, people should make donations to the Bate Collection. I have offered them, in his memory, my Adolphe Sax alto saxophone, because that came to me as a memorial to Dorothy Crump, whose orchestra I conducted in her last years, an orchestra which his brother Christopher told me, Tony had also conducted just after the war. Patricia hopes that they’ll be able to buy something else they want in Anthony’s memory, so all donations (cheques made out to the Bate Collection and sent to them at the Faculty of Music, St Aldates, Oxford OX1 1DB) will be very welcome.
FoMRHI Comm. 1503

Jeremy Montagu


This weighty tome (just over three kilograms on the kitchen scales) is a superbly detailed history and description of the Paris Conservatoire museum. The museum existed, perhaps more in theory than in fact, for almost exactly two centuries, for it came into being, at least as an idea, on 18 brumaire 1793, when the genesis of the Conservatoire was first proposed, with a cabinet d'instruments Antiques, modernes, Etrangers, et à nos Usages. It closed in May 1990 and on 5 January 1993 the decree for the establishment of the Cité de la musique, with its new museum, was issued.

While this is of course a history, it is by no means dry and dull. The text is very readable and Florence Gétrau pulls no punches. Two examples: as she says, in all that time only one catalogue was ever issued, that of Gustave Chouquet in 1884, with its three supplements by Léon Pillaut, since when nothing else has appeared, no guides, no handbooks, no nothing. And: 'G.Thibault [Mme la comtesse de Chambure] va sortir le Musée Instrumental d'une léthargie quasi chronique.'

Part 1 is devoted to a brief but detailed history, from the initial establishment in 1795 as a depot for instruments seized from executed aristocrats, or discarded by émigrés. Inventories by Bruni and Weckerlin are quoted in detail. Some of these instruments were sold off in 1797, as were some of the survivors in 1822, some were burned (a couple of dozen harpsichords kept the first classes of the new Conservatoire warm), and some were kept for the use of those classes. A dozen or so of these original instruments survive in the collection to this day.

There were discussions for the establishment of a proper museum from 1819, and this came finally to fruition in 1861 with the purchase of the Clapisson collection. Gétrau gives summary financial accounts for every year from 1862 to 1973: Clapisson was paid 2,000 francs a year as curator until his death in 1866, whereafter this payment continued to his widow and 3,000 went to his successor, Hector Berlioz; a few hundreds went to the garçon, who was the only other member of staff. Brief, but again detailed, biographies are given for each of the curators, from Sarrette and Bruni in the 1790s down to the last one, Josiane Bran-Ricci, and her famous predecessor Geneviève Thibault, Comtesse de Chambure whose own collection was eventually so much to enrich the museum with 71 instruments in lieu of what we used to call death duties, and a further 730 by purchase.

Part 2 describes the collections themselves, beginning with that of Clapisson, with illustrations of a number of the instruments as they are today. Many are of great importance, for example the first instrument in the catalogue, the 1612 or 17 Jan Ruckers harpsichord; others, such as the pochette that doubles as a fan, are more fun. Later instruments came from a variety of sources, purchases, gifts, and bequests, often from professors of the Conservatoire, so that the collection includes Berlioz's guitar, Brod's oboe, Viotti's violin, and so on, and gifts from makers, for example Vuillaume's giant octobass. Others came from sales, for instance those of Coussemaeker, Adolphe Sax, and Vuillaume.

While few of these accessions are noted in detail at this point in the book (but see below), many instruments are mentioned, always with their catalogue numbers, and some of them are illustrated. One detailed list is of instruments which have disappeared, whether by theft, unknown occasion, or the disastrous deaccession by Georges Migot in 1957, when some 250 instruments left the museum.

Part 3 describes work done in, from, and by the museum, with a complete list of all
restorations known to have been done from 1862 to 1973. Usually all that is known is ‘recolle partout’ or words to that effect, but sometimes considerable detail is recorded. Also recounted is the history of Mme Chambure’s efforts to establish a proper conservation laboratory within the museum. Then comes a description of the galleries and display of the museum, followed by accounts of all the temporary and special exhibitions that have taken place. Much detail is given for the joint V&A and Conservatoire travelling exhibition of 18th century French and British instruments in 1973, which many of us will remember at the Horniman Museum in this country, with some lengthy comments on my own review of it in our Comm. 9, in Q2, January 1976 – it is nice after so many years to have so much of my critique agreed with!

There follows an account of concerts, recordings, etc, which have taken place either in the museum or using its instruments. Many of the restorations referred to earlier were, as they tended to be in most museums until very recently, comprehensive and sufficient to put the instrument into full working order (‘rée­faite entièrement’).

A comprehensive bibliography cites all the sources used for this extraordinarily complete history of the museum. I do not know of any comparable work on any other museum in the world, with so complete and detailed a history and account of all aspects of its existence. It is indeed fortunate that so much of the original archives survive and wonderful that Dr Gétrau has been able to ferret them out from the libraries and other sources whether they were dispersed from the Conservatoire by less historically-minded curators and librarians.

To crown everything, a wonderful achievement, there is then a complete list of all acquisitions to the museum, in catalogue order, the E numbers, with cross reference to the Chouquet numbers, from the very beginning in 1862. The provenance is given, wherever it is known, as is the price paid for all instruments which were purchased, although only for those acquired before 1970, and with only a global price for multiple purchases. Also noted, very briefly, is what has happened to them within the museum. The list is complete from the Clapisson purchase of 1862 to an electronic organ, ‘don de M. Constant Martin, 28-12-1993.’ Thus at last, and for the first time ever, we have a complete list of everything acquired by this museum (NB for cross-checking the list mentioned above of things that have subsequently gone missing). There is also a list of the Chouquet numbers, followed in turn by each of the Pillaut supplements, cross-referred to the inventory numbers (the E numbers), so that everything can be found or traced by whichever numbering system anyone uses. And finally a detailed index.

It would be difficult to over-estimate the value and importance of this book. I regret that I do not have a definite price figure for it (I’m told it’s around 800 or 900 francs); it’s available from Tony Bingham at £120 and doubtless from other similar very specialist sources at a comparable figure. It is not only that it is a complete description of one of the world’s most important musical instrument museums, its history and its contents. It is also unrivalled in museology, the science of museums, as a history and a description. I know of nothing else like it and it serves as a model for all museums to emulate, not just those of musical instruments. We may think that organology, the science of musical instruments, is a fairly recent innovation, but museology is a good deal more recent. Hats off, from both -ologies to Florence Gétrau for a magnificent achievement, a worthy tribute to two centuries of the Musée Instrumental du Conservatoire national supérieur de musique de Paris, and a true welcome to the new Cité de la musique and its Musée de la Musique.

Well, at first, my congratulations to Thomas Lerch that he has written this monograph, and that this work could be published (in German language) in a fine and thick (532 pages) book. The publisher is the institute where Thomas Lerch works, the 'Staatliches Institut für Musikforschung, Preussischer Kulturbesitz, Musikinstrumenten-Museum'. Address: Tiergartenstrasse 1, D 10785, Berlin, Germany. The price of the book is DM 78,-, without forwarding-charges. The ISBN-number of the book is: 3-922378-14-5.

The title of the book is in translation: 'comparative research of bore profiles of historical baroque recorders'. Lerch compares the bores of more than 60 instruments (mostly alto recorders), by Van Aardenberg (3 ex.), Bressan (11 ex.), Johann Christoph Denner (4 ex.), Jakob Denner (4 ex.), Gahn (8 ex.), Heytz (7 ex.), J.W. Oberlender (8 ex.), Johann Schell (4 ex.) and J.J. Schuchart (3 ex.). Also some instruments by Haka and Kirnberger are discussed, in an other chapter.

Of all of these instruments extensive data are given, such as the lengths of the joints, tenons and sockets, place and size of the fingerholes, dimensions of windway, window and labium; full measurements of the bore (in tables and in graphics) and also the outside diameter of the recorder at important places, such as the window and the fingerholes. There are no drawings of the profile (turned details) of the instruments, and there are also only a few photo's of the instruments. So, who wants to make a copy has to go to the collections and buy the drawings (drawing selling institutes have not to worry too much). But for any woodwind maker (or researcher) the tables in this book are important and useful, and there are listed some interesting instruments from private collections, where not many people have access.

A chapter with tables of measurements makes not a dissertation. There must be a main question to be answered, and the main question in this book is how to compare the acoustical qualities of the instruments, without playing them (because playing ist often forbidden, or impossible because of damaged windways and labia, etc.).

What Thomas Lerch did was trying to find objective criteria in comparing the bores, just as the title of this book says. Therefore, he has written a rather comprehensive introduction about woodwind- and especially recorder acoustics. What happens with a bore when it is made narrower at some places, how must wave lengths be calculated, considering the correction factors for labium or mouthhole (on traverso's), the end-correction at the far end of the bore, etc. This chapter is not easily to understand, but the information is necessary for the following chapters, where Lerch has to manage with the exact position of sound waves in the bore of recorders.

Lerch says (chapter 5): the mathematical approximation of the physical processes (in a woodwind instrument) has always been a great problem for acoustical researchers and also for the woodwind makers. Further: it is indeed so that scientific results of acoustical research only proved what woodwind makers already knew by their (sometimes centuries old) practical experience.

The answer of Lerch to overcome this difficulty is based on a statement of Arthur H. Benade (see his book: Fundamentals of Musical Acoustics, 1976 New York): it is possible to analyse exactly the changes in acoustical behaviour of a recorder if you change the size of the bore in different sections of that instrument.

Well, this is what many recorder makers do: by pulling or pushing a 'flute fish' (Sverre Kolberg) or some other stuff through the bore, making the bore narrower, and thus finding the places of the nodes and anti-nodes of the sound waves of the various notes of a recorder. Narrowing the bore on a node makes a tone flatter, on an anti-node sharper. Reaming the bore on the same places has the opposite effect.

(An example: for a recorder an important section of the bore is that from the thumbhole upwards to the tenon corner - just the place where on old instruments so often tenon contrac-
Narrowing the bore here - where are the nodes of the waves of some fundamental tones, and the anti-nodes of the first harmonics - gives lower octave intervals (a1-a2 to d2-d3 on an alto recorder), but the effect can be that the f3 speaks not so well. Widening the bore can also change a little the pitch of the top notes of the first register, such as e1, f1 and f#1, g1 on the alto-recorder - fan B.)

The effect of narrowing the bore can be shown in a graphic as a so called 'W-curve'. Tom Lerch made an elliptical narrowing device (16.5 mm long, 12.5 mm thick), which gave a narrowing effect of 41% in a recorder with a cylindrical bore of 19.0 mm. Then he measured (in cents) the effect of sharpening or flattening the tones. The W-curve of the bottom tone (the first partial tone) of the instrument has a simple shape: narrowing the bore in about the middle of the recorder makes the bottom tone sharper, there is no effect at about 1/4 and 3/4 of the length, and narrowing the bore at the upper and lower end flattens the tone clearly. The W-curve of the second and higher partial tones are much more complicate, because these tones have more nodes and anti-nodes.

But Lerch is not so much interested in the pitch of recorder tones, and also not in the speaking of them. What he wants to do is analysing the effect of changing the diameter of bore-sections on the sound of the instrument. And, so he says, important is therefore the relation between the 2nd (octave) and the 3rd (duodecimo) partial tone. Narrowing the bore on some places reduces the loudness of the 3rd partial tone more than that of the 2nd partial tone, giving a different sound. Renaissance-type recorders have mostly an octavial sound, (later) baroque instruments have a more duodecimal sound.

The result of the effects are given in a so called 'K-curve', what exactly is the difference in sound pressure (measured in decibels) between the 2nd and 3rd partial tone in various places of the bore of a recorder. And Lerch says that just these K-curves can give information about the sound of a recorder, as it was intended by the maker. Important for woodwind makers: from the graph you can see how the sound quality may be changed if you are manipulating the bore on a particular point.

In chapter 6 Thomas Lerch is trying to see if his calculations really work. Here, he introduces the term AV ('Akustisches Verhalten' = acoustical behaviour). On several places in the bore (with intervals of 2.5 %, the sounding length of the instrument being 100%), he multiplies the 'degree of changing of the bore diameter' (what is in fact 1 - d', where d' is the bore diameter on that point as a percentage of the maximal bore diameter at the window of the recorder, this is a necessary correction for conical bores), with the value of the W-curve on that point.

So he calculates the AV-value for the fundamental (1st partial tone), for the 2nd and for the 3rd partial tone. For all places between 0% and 85% (from the lower end of the bore, with intervals of 2.5%, so there are 35 calculating points; between 85% and 100% the information is not important) he adds these values (they can be positive, or negative), and the sum of all these values (see page 60 of the book) for each partial tone gives us an indication of the degree of the 'Verstimmung' (being out of tune) of that tone.

For all historical instruments of this book, the AV-values of the first three partial tones on all 35 calculating points are given in the tables.

On page 65 Lerch introduces another term, important for evaluating or calculating changes in the sound of a recorder. He takes the values of the K-curve (see above), and multiplies (on the same 35 points as before, between 0% and 85% of the bore length, starting at the lower end) with the same 'degree of changing of the bore diameter' (see before), and the sum of all of these calculates values gives the K-value (in german: K-Wert). This added up K-value is on most recorders a negative number.

For two modern baroque recorders (with a duodecimal sound), the K-value was -0.8 and -0.9. A modern 'copy' of a renaissance recorder had a K-value of -0.18. Later in the book, Thomas Lerch is using these K-values to compare the sound of Bressan with J.C. Denner, where Denner seems to be more modern (lower K-value: J.C. Denner -0.89, Bressan about -0.75) and duodecimal in sound.
W-curve

- First
- Second partial tone
- Third

K-curve

difference in pressure between 2nd and 3rd partial tone
Example of a (part of a) table with AV-values and K-values

<table>
<thead>
<tr>
<th>L%</th>
<th>L</th>
<th>D</th>
<th>D/Dmax</th>
<th>AV-1PT</th>
<th>AV-2PT</th>
<th>AV-3PT</th>
<th>K-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>85%</td>
<td>423.1</td>
<td>19.75</td>
<td>0.987</td>
<td>-0.0087</td>
<td>-0.0004</td>
<td>0.0072</td>
<td>0.0006</td>
</tr>
<tr>
<td>82.5%</td>
<td>410.7</td>
<td>19.80</td>
<td>0.990</td>
<td>-0.0058</td>
<td>0.0018</td>
<td>0.0066</td>
<td>0.0000</td>
</tr>
<tr>
<td>80%</td>
<td>398.3</td>
<td>19.85</td>
<td>0.993</td>
<td>-0.0035</td>
<td>0.0028</td>
<td>0.0028</td>
<td>-0.0003</td>
</tr>
<tr>
<td>etc. with steps of 2.5%</td>
<td>etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45%</td>
<td>224.0</td>
<td>17.70</td>
<td>0.885</td>
<td>0.0662</td>
<td>-0.1033</td>
<td>0.0208</td>
<td>-0.0771</td>
</tr>
<tr>
<td>42.5%</td>
<td>211.6</td>
<td>17.65</td>
<td>0.883</td>
<td>0.0567</td>
<td>-0.0813</td>
<td>-0.0170</td>
<td>-0.0807</td>
</tr>
<tr>
<td>etc. with steps of 2.5%</td>
<td>etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5%</td>
<td>12.4</td>
<td>12.06</td>
<td>0.603</td>
<td>-0.4665</td>
<td>-0.4319</td>
<td>-0.3952</td>
<td>-0.0673</td>
</tr>
<tr>
<td>0.8%</td>
<td>4.0</td>
<td>13.20</td>
<td>0.660</td>
<td>-0.4270</td>
<td>-0.4270</td>
<td>-0.4270</td>
<td>-0.0910</td>
</tr>
</tbody>
</table>

**L** = Length, measured from lower end
**D** = dimension of bore (Ø)
**AV**: Acoustical Value
**1PT**: first partial tone (etc.)

Well, this was the theoretical heart of the dissertation, and I find it difficult to give a judgement. Do we really need such elaborate calculations for characterizing recorders? Long ago I have learned that Bressan-recorders have a -in average- wider bore than those of the Denner family, and therefore you play Handel-sonata's better on Bressan, and Telemann on those german instruments. And the differences between the strongly conical (late-) baroque recorders and the less conical or cylindrical predecessors is so obvious that you need no formula at all.

A problem for me is the fact that all these K-values of Lerch are related to the whole bore of the instrument, being important for the sound of the bottom note, the f1 on an alto-recorder. For other tones, the waves are shorter, the places of nodes an anti-nodes are different, and also the sound properties can vary rather much. In fact, for a recorder maker it is sometimes difficult to have a good balance ('égalité') between the tones of different registers in his instrument. I have seen many factory-made instruments, and also historical alto recorders with obvious differences in sound between f1, g1 and a1: the g1 rich on harmonics, the a1 poor, the f1 between those two. But there are many good instruments, where these tones have a much better balance - and that has not always to do with the properties of the bore. Finishing of the windway and tone holes has sometimes a huge effect. Thomas Lerch doesn't go further in this matter, and that is a pity.

But the book goes on. In chapter 7 the technology of making bores is discussed. Bores can be reamed out (with reamers or spoon drills) out, or turned out with a 'Spitzstahl' (a tool with a sharp
point, adjustable or not). Bressan made instruments with a great conformity in bore profiles, Heyt (famous for his use of tortois shell veneer on his recorders) worked more freely, using other tools than reamers, causing some rough bore surfaces in his instruments. Of course Lerch pays attention to all problems with contraction and shrinking of the wood of recorder joints. Every maker or researcher has to find solutions to make corrections in case of warped bores.

Chapter 8 deals with the development of the baroque type of recorder. Kynsecker was one of the first woodwind makers in Nürnberg (Neurenberg) making instruments in more than one joint, and with a modern and more elaborate profile, but the construction of the bores of his instruments was primitive, mainly consisting of two cylindrical sections. But J.C. Denner went further. A soprano recorder in one joint (Eisenach) has an old appearance, but the bore is clearly conical over the whole length. This instrument dates from 1682, and that is before Denner (as he stated himself) made acquaintance with the new french instruments.

An interesting instrument is a recorder in München (Munich), with the lower joints by Hotteterre, the head joint by J.C. Denner. This head joint has a remarkable narrow bore, and here Lerch comes with the theory that Denner has made a new head joint for this instrument, wishing an other, more duodecimal sound, without changing too much the pitch of this instrument. The AV-value (indicating pitch differences) of the new combination differs only slightly with a complete and original Hotteterre-recorder, but the K-value (indicating sound qualities) had changed remarkably.

In chapter 9, 110 pages long, the recorders of Van Aardenberg to Schuchart are discussed. Here, Lerch is hardly using his formula's, but what he actually does is comparing several instruments by one maker, using the graphs of the bores. So he concludes that one of the alto recorders by Van Aardenberg (collection Haags Gemeentemuseum) is older than the other two; that the Bressan alto recorder in the Horniman Museum (London, ex Arnold Dolmetsch) is shortened; that the anonymous recorder nr. 1124-1869 in the Victoria & Albert Museum (London) is not by Bressan but perhaps by Oberlender; that Bressan and even more Jacob Denner made their instruments in a very rational and standarized way; that Johann Benedikt Gahn made two types of alto recorders; that the recorders of Oberlender have 'X-shaped' bores of both head- and foot joints (the narrowest point of the bores being not at the lower end, but more or less in the middle of these joints). These are some examples of the way that Lerch draw some conclusions in this chapter.

Chapter 10 deals with proportions and the theory of tonehole positions. Here Lerch concludes that on almost all recorders the proportion of the visible parts of the joints is 2:2:1. But on most instruments the head joint is a little shorter and the foot a little longer. However, what Lerch not indicates is that for instance on the Van Aardenberg-alto's there is a clear golden section on the transition from the head- to the middle joint. For the fingerhole positions Lerch takes as starting-point for calculating the proportions the distance between hole 0 (thumbhole) and hole 6 (lowest hole on the middle joint), and he differs here from Herbert Heyde (see Heydes book: 'Musikinstrumentenbau', 1986, Leipzig, where Heyde takes the distance between hole 1 and hole 6).

In the last chapter, no. 12, Lerch returns to the K-values of the instruments. The most important conclusion he draws here is the importance of Johann Christoph Denner for the development of the baroque recorder; for instance, Bressan was more 'conservative', maybe because he had his schooling somewhere in France, perhaps together with Jean-Jaques Rippert, as Maurice Byrne states in the New Grove (part 2, page 250).

Conclusion: I have not enough experience with acoustical theories to overlook all implications of the use of K-curves and acoustical values, such as Lerch has developed. In fact, in his 9th chapter he hardly uses these values and actually we do not need them so much when we compare the bores of recorders. I remember here the theory of Herbert Heyde (see page 11 and 12 in his catalogue of flutes and recorders in Leipzig: 'Flöten', 1978, Leipzig), where he divided the seize of the
fingerholes 1 to 6 by the diameters of the bore on the place of those fingerholes. These 6 calculations could be put in a graphics, and Heyde was able to draw conclusions from these graphics. But nobody followed Heyde with his 'relative fingerhole tendency'. I suppose that the way of thinking of Thomas Lerch has a better acoustical fundament; but if this is enough for intensive use by other researchers, I don't know.

Some comments: the graphics of recorder bores in the book are a little vague (thin lines, grey background); I would have appreciated more photo's of instruments. And at last: there is no feedback with the real sound of the discussed instruments. We know now everything about the bores, but the recorders stay completely silent. I know, this book is no catalogue, and even in museum catalogues it is very difficult to give a vivid impression of the character of a woodwind instrument. But musical instruments are made to play music on it, and for me the musical value of an instrument is at least as important as the 'acoustical value', K-curves or W-curves.

But nevertheless, again my congratulations to Thomas Lerch, and his institute to write and publish this book. The tables with measurements are understandable also for English speaking people, if they use the drawing on page 253, where all German terms are explained. This drawing was taken from the catalogue of Dutch recorders of the Haags Gemeentemuseum, and was used by Lerch with permission of Moeck, but in fact the drawing was made by me on my historical non-sense PC. No problems about that: I am glad that I have contributed to an interesting book!

FoMRHI Comm. 1505  
Paul Hailperin

Goodacre's Razor  
and  
Undercutting Woodwind Finger Holes

Good old Goodacre, that's an ingenious tool he designed back in 1995 (Comm. 1375). My belated thanks are due to him and to Mathew Dart, who gave me my first rollpin. Equipped with that non-verbal translation, I went to my local industrial supplier and got a stock of the standard sizes. It turned out that what I was looking for, a size which would negotiate the wing joint holes of a bassoon, was not in production. In the depths of disappointment it occurred to me that the rollpin itself was not so important as Goodacre's concept of a tubular knife. Another source of tube might do the job, in fact the tool only needs the tubular form at the very tip. That's when I decided to bore up a piece of steel rod, and this is the little extension to Goodacre's invention which I would like to share with you. My favorite source of tool steel for all the little jobs around the shop is silver steel. It is easy to work, holds a reasonable edge for my modest demands and is readily available in 1 mm diameters (sometimes even in 0.1 mm diameter increments) with 1 meter length. So you can easily make up any combination of diameter/length you might need. I took a piece of 3.0 mm Ø, length 55 mm plus whatever
is now hidden in the handle. (By the way, in trying to make the most of a rollpin, I found that a pinvise will hold it securely with somewhat less loss of functional length than a wooden handle.) The bore of my tool is 2.0 mm Ø going in about 5 mm. That's a really quick little job on the engineering lathe, a tool I imagine most of our members will have available either at home or at a friend's place. The rest is just as Goodacre described. On my first attempt, the edge bent under the force of cutting. With a slightly less acute angle of the bevel it now works fine. I'm not yet sure, but here might be one slight advantage of the rollpin made from hard spring steel. If necessary, it might be possible to improve the silver steel version by having some form of surface hardening applied. I would be interested to hear from anyone who has ready access to hardening facilities and experience with Goodacre's Razor. The other response I would look forward to would be comments on the use of undercutting of oblique tone holes of bassoons. In general they look cylindrical or, on old instruments, slightly contracting toward the bore, which I take to be an unintentional result of the drilling technique. Yet a little unobtrusive work on the inside end of the tone hole can do wonders to the playing qualities. What do you think of this? Does anyone find it unhistorical?

Approaching the subject of undercutting woodwind tone holes more generally, I would like to report that I still find a sharp carving knife to be the optimal tool (except for working at the depth of bassoon finger holes). My general purpose tool is a standard carving knife with blade length 35 mm, curved back, originally straight edge. I have ground the edge down to a concave shape, the breadth of the blade going from about 1.5 mm at the tip to 5 mm at the butt. When finely ground and well honed - this point, known from nearly all cutting tools, may seem unduly elementary, but I am amazed at how often I have neglected it - this knife cuts freely, which reduces any danger of slipping into the outside edge of the hole, removes material efficiently, produces a smooth finish and can be used to cut nearly any shape required. I find it comfortable for holes down to about 4 mm Ø. For holes as small as 3 mm or 2.8 mm Ø I use a Japanese carving knife, "Kogatana," of 3 mm blade width. The edge, with double-sided bevel, is ground at 12° to the length of the blade, which gives a long narrow point to get into the very smallest holes.

More recently I have tried using fraises, the tool more commonly known from "modern" instruments. These are straight-sided conical routers inserted through the bore. As will be obvious, their flexibility is very limited; they cut at a predetermined angle, symmetrically all around. My hope was that they might save time and effort in roughing out the undercutting of a small series of oboes. As with so many tools, I find that it takes a while to get to know them, to think of the various uses they might be put to. In this case I am rather surprised at the variety of sizes I would need to even approximately fit all the holes I standardly bore; I have 5 sizes and could probably use twice or thrice that number. The tools I have are from the firm Josef Böhm, D-91443 Neustadt/Aisch, who sell a set of 6 for DM 468 or special sizes on order at DM 120 - 130 per piece. It is a finely made tool, a pleasure to handle, but still extraordinarily limited. At that price, I don't imagine many of our members would find it economically interesting. The only reasons I can think of for its widespread use in the "modern" scene are the possibilities for standardization, and the simple regular pattern it cuts. It seems that straight lines and perfect circles have come to be the sign of good workmanship. I'm amazed at how much is sacrificed in the process. The sharp carving knife still remains my favorite tool.
Response to Comm 1500

May I thank Denis Thomas for his interest in Comm 1486. In an article that was already long Paul Madgwick and I decided against giving the historical background to recorder bell keys. Hence no mention was made of Agricola, Cardanus and other early writers who mentioned blocking the south end of a variety of wind instruments for a variety of reasons. For similar reasons of space no mention was made of Comm 1430 by Denis nor of numerous others who had written on the bell key. Nor was Juritz mentioned because his claims to have made the first bell key prompted three people [to my knowledge] to state they had invented a bell key before Juritz. And maybe there are others unknown to me who would claim even earlier discovery of the bell key.

Denis Thomas clearly explains some of the shortcomings of the patented ‘side mounted bell key’ and why Carl Dolmetsch opted for the unpatented end mounted model. The suggestion that a longer foot be used for the side mounted key does indeed solve some problems, but presents others including the intonation of a few notes - mainly those involving the right hand.

The first sentence of the final paragraph by Denis is very true - that the end mounted bell key has failed to gain popular support among makers and players. It is not easy to be certain why this is so. I tend to believe that it is not where the key is mounted that has influenced its lack of popularity. In my opinion all bell keys wherever mounted and however operated would not prove popular, simply because a huge and overwhelming majority of recorder players have not the slightest need for them. Many serious players who could profit from having a bell key, avoid situations which require it, making such an expense unnecessary. All of which is a great pity for recorder makers and those who make keys. A tidy income could be derived by such people if no more than 10% of the world’s recorder players opted to have bell keys fitted to two or more instruments. But like echo keys and the latest recorders with ranges in excess of three octaves, bell keys are for the few. The humble unadorned recorder will, in my opinion, continue to be the model that appeals to most players. It meets well their modest needs.

Response to messrs Heavens & Segerman

In Issue 85, Comm 1485 I outlined a method of dividing a circle’s circumference into five equal parts. In Issue 86 [p2] Steve Heavens informs readers the method is flawed, resulting in an arc length error of 1.7%. In the same Issue [p6] Ephraim Segerman advises that Steve Heavens is mistaken and goes on to prove that the method I outline is correct. If this is the start of a lengthy correspondence would future contributors please not refer to Alec Loretto’s method [as Steve Heavens did] but rather to a method outlined by Alec Loretto. As Comm 1485 pointed out, the method came to me from an African tribe via a Dublin student who had worked with the tribe for the United Nations. I can assure readers that any method I devise to divide the circumference of a circle into $x$ equal parts would contain errors far in excess of 1.7%.
Recorder Window Size

Following the appearance of Comm 1485 I’ve received a couple of letters asking for further information about recorder window sizes.

The size of a recorder’s window is related to the instrument’s \( \text{bd@b} \), that is the \textit{bore diameter at the blockline} - see Figure 1 in Comm 1485. If one draws a circle to represent the \( \text{bd@b} \), divides the circumference into five equal parts, and then connects the points as shown in the diagram below, then AB gives the width of the window, while CD represents its height, or \textit{cut up} to use organ building terminology. [It was Sverre Kolberg, the Norwegian recorder maker with considerable mathematical talents who first drew my attention to this, over twenty years ago.] This rule-of-thumb, while providing a useful starting point, needs to be modified to meet the demands of different recorders. For example, medieval, renaissance, van Eyck, Ganassi and baroque recorders having the same \( \text{bd@b} \) do not require exactly the same size windows. A maker copying an original is very much guided by the original’s window size and would need very good reasons for modifying it. But one building a recorder loosely based upon an original might wish to use the above general rule to approximately determine the window size in the prototype. And then, by modifying the width and/or height of the prototype’s window, an experienced maker finds the optimum size for the sound he/she is trying to produce. But a useful starting point is this method of constructing a pentagon within a circle and proceeding from there.
Trust but don’t believe what you see in pictures

Iconography is a very important source of information for musical-instrument historians. In the Bulletin Supplement of the Q85 is Peter Forrester’s comments on Baschenis’s paintings. He mentioned several versions of some of these copied by Baschenis’s students. Peter commented that apparent variations in instrument design amongst these versions was useful as a measure of how much the design details in these paintings can be trusted. The more closely one looks at such an exercise, the less objective it appears. What are we investing trust in? How do we measure that trust? How do we use that trust? The problem is that in the all-too-human quest for certainty, guesses that seem to work as answers with the evidence available initially, all-too-soon become beliefs which prevent objective consideration of alternative candidates for being answers, and of further evidence that is contradictory (that tends to be rejected as ‘untrustworthy’). Deeply believing in one’s own judgment is too much in fashion amongst researchers.

Peter is apparently addressing himself to how close to a photographic reproduction we can trust the painting to be. As researchers of history, we want to know what was, and a photograph would be more objective than the artist’s representation. But we will never know what the appropriate photograph would have looked like, so we will have to do with the artist’s representation. I suspect that Peter assumes that the original picture is closest to the reality then, and the differences in the copies are distortions due to carelessness or different ways of approaching artistic goals. But the instruments involved were contemporary, and the differences could just as well reflect experiences with different examples of real instruments that the different artists had. Thus, unless there is evidence of the depicted instrument being unworkable, there is no objective basis to judge that any one picture is any closer to a real instrument than any other. Standardisation of instrument design is a very modern phenomenon, and a judgment that the design shown in one depiction is more trustworthy than another because it is more ‘normal’ is not objective. All depictions are approximations to (and potential distortions of) reality, and an objective assessment of their value to history is that each is as true a picture of that particular instrument as we will ever get (unless there is evidence otherwise). Of course it is good to know historical evidence about why artists in that school made their depictions, and how they worked (pattern books, etc.), but how can we objectively use this information about potential deviations from reality?

An instrument maker is in a different situation than an historian. Suppose that she (yes, I am capable of being politically correct!) wants to design and build an instrument that is as historically correct as is practical when no examples survive to copy. The most popular approach has been to look at lots of pictures and design one oneself that looks rather like many of them and incorporates attractive features of several. The problem with this approach is that the designs in the pictures come from a range of places, instrument makers, artists and times, probably affected by local fashions which change, so the particular combination of features chosen may not have ever possibly existed. When historians eventually map out these local fashions, such a bastard design will lose historical respectability. More historically respectable is to choose one picture and reproduce it as an instrument. The judgment behind that choice properly takes into account how attractive it looks to modern eyes and how well it will serve the needs of the intended (or potential) modern player. Here, judgments that are a hindrance to the proper study of history are absolutely necessary.

To do a good job, an instrument maker (or musician) needs to believe in what she is doing. If historical accuracy is highly valued, that believing has to go far beyond what can be justified by objective history. If one wants history to approach objective truth and not just current fashions of thinking about the past, instrument makers (and musicians) wanting to contribute constructively to history with the research they do, would have to be able to adopt a radically different mind set than that necessary in their professions.

We are usually not in a position to control or monitor how others fulfil their professional or
personal responsibilities towards us. We either trust them or the relationship breaks down. We are forced to trust even though there could possibly be very good reasons not to. We really have no choice. That does not mean that we believe that they are 100% trustworthy. We know that they are quite capable of neglecting responsibilities, of incompetence in executing them or of acting in self interest in ways that are against our interests, but life is too short to try to do much about it. We give them the benefits of our doubts and just trust without believing that the trust is fully justified.

This is the approach that maintains maximum objectivity towards evidence in scholarship. We trust because there is no alternative, but we don’t fully believe it. The same is the case with the theory that best explains all of the relevant evidence. If new evidence or a new theory appears that apparently says differently, we should be able to be completely fair in our evaluation, without giving that which we have trusted for so long any advantage because of that trust history. We trust because we have to, but being realistic, cannot fully believe.

This is not comfortable for us because we are humans, and throughout the history of our species, in our longing for an understanding of how the world around us works, we have grasped for the comfort of answers we can believe in, and then defended these answers by treating supporting evidence as proof and found ways of rejecting contrary evidence. We are naturally believers, and when we become disillusioned with previous beliefs, we easily can go too far in the other direction, becoming skeptics with minds just as closed as believers. To learn from, and contribute to, advances in scholarship, it is important to be objective and to trust in the cautious way described above (with respect to the responsibilities of others to ourselves). It helps to have special training, the earlier in life the better. That is why we need better training in schools for increasing the pupil’s repertoire of ways of thinking for use in different aspects of their lives.

FoMRHI Comm. 1510

Chaos, fractals and musical instrument acoustics

John Rawson e-mailed to Jeremy the following abstract of a paper called ‘Nonlinear internal friction, chaos, fractals and musical instruments’ that he found in HPSCHD-L (an e-mail group who correspond about harpsichords). Jeremy passed it on to me for comment. I will try to clarify what the abstract says, but will not chase down the full paper because I won’t understand the mathematics, and so can’t verify how well the authors have achieved what they claim to have achieved. The paper is by Z. Q. Sun and C. W. Lung of the International Centre for Theoretical Physics, Trieste, Italy, and the International Centre for Material Physics, Institute of Metal Research, Chinese Academy of Sciences. The abstract follows, with my comments sentence by sentence:

—‘Nonlinear and structure sensitive internal friction phenomena in materials are used for characterizing musical instruments.’—

ES: This apparently means that they have formulated general equations in their particular mathematical language that relates sound spectra and internal friction to material properties and instrument structure. Internal friction is what happens in the material when it is flexed by sound waves. The material absorbs sound energy and consequently becomes slightly warmed. It is nonlinear when the energy absorbed is not proportional to the sound energy.

—‘It may be one of the most important factors influencing timbre of instruments.’—

ES: Initial transients, resonance characteristics of the materials and construction are more important.

—‘As a nonlinear dissipated system, chaos and fractals are fundamental peculiarities of sound spectra.’—

ES: They have successfully used the mathematical languages of chaos and fractals in their equations. A dissipated system is one that absorbs energy.

—‘It is shown that the concept of multi range fractals can be used to decompose the frequency spectra of melody.’—

ES: It is not clear here as to whether they have used fractal theory to analyze spectra of single
notes or the spectral relationship between sequences of notes. If it is the first, they have used fractal theory to describe frequency spectra in terms of a few parameters. If it is the second, they have found relationships between these parameters in a sequence of notes.

—'New approaches are suggested to improve the fabrication, property characterization and physical understanding of instruments.'—

ES: They think that their equations and the deduced parameters might possibly be useful.

It is the job of mathematicians to develop new mathematical languages. They have done this with chaos and fractals. It is the job of theoretical physicists to explore the usefulness of different mathematical languages in describing physical systems. Whether what they develop is useful or not depends on whether describing the physical systems in these languages leads to equations which make calculation of what one wants possible or easier, or gives deeper insight into how the physical system works.

If they succeed in facilitating calculations that practical physicists want to make, what they’ve done is immediately accepted as an advance. The last sentence of the abstract seems to offer this, but it is much more likely that they are just trying to get the practical physicists interested enough to look at what they have done and try to use it for their calculations.

As for deeper insight into how the physics works, the authors believe they have found it. Of course they would, just because they have been able to formulate equations. They then have to convince others that their theory is somehow better than previous theories in describing the physics of musical instruments. It will not be easy.

To illustrate what fractals are, let me give a simple example of my own. Some time ago I noticed that little decorative passages in early music moved in similar patterns when they were in semiquaver, quaver and crotchet motion. This is an example of fractal behaviour with respect to time. Fractal behaviour is when similar patterns exist on different scales, such as similar raggedness of coastline patterns on maps at different magnification scales. I enjoyed that insight and felt that I understood music history a bit better. I commented on this parenthetically in a publication (I don’t remember which).

I doubt whether many readers understood what I wrote, and doubt whether those that did happen to understand it felt that this added anything to their understanding of music history. Insights of pure understanding can be very personal things. The situation would be different if people thought that they could use the idea. That could be the case if people decided to add faster-note decoration to repertoires in which such decoration was known to have been used but was very rarely notated. Then the common slower-note patterns could be used as models. But people aren’t doing that, and like most other creative ideas, if others aren’t interested and the creator has better things to do than to try to convince them to be interested, it is not pursued.

Chaos theory involves finding statistical regularities in systems that evolve in apparently haphazard ways because of very small and uncontrollable variations in how they start out. If one can recognise known patterns in the statistical regularities, one might be able to say something interesting about the small variations. I am skeptical about the usefulness of this approach to musical instruments, but would be happy to be wrong about this.

What the authors are offering are new tools to do jobs that could be done by other tools. That is why fashion and selling of ideas is so relevant. They will get some attention because chaos (largely because of its name) and fractal theory are quite fashionable nowadays. The relevance to the science (scholarship) of musical instrument acoustics is that it might offer a simpler explanation for the measurements (evidence), and so be preferred (in the sense of Occam’s Razor).

The authors of the paper are being creative with their mathematics, as Raudonikas was, but the chances of it being a real advance in the field are very small. Nevertheless they are to be encouraged. No-one can tell when a theory is going to be a winner.
2.2. Ephraim Segerman

A correction and simplification for Comm. 1493

R. K. Lee has written to me in response to Comm. 1493, indicating that he hasn’t had the time to thoroughly consider it, and enclosed a graph that shows how well his equation fits the experimental data. It is undoubtedly a good fit, but that does not prove that the equation expresses a correctly developed theory. Lee’s theory was wrong in that he did not properly eliminate tension from his equations, transferring it to $\Delta L_1$ in his equation (3) in Comm. 1480, and then improperly losing the $\Delta L_1$ in going from his equation (8) to (9) by making it equal to $dL$. By eliminating tension properly, I got an equation that is the same as his (10) except that $f/L_1$ is subtracted from the right side. It turns out that with iron wire, this second term is very much smaller than the first term, and using the correct formula does not lead to a significant improvement. With materials having a much lower $E/\rho$, it would make a difference.

A much more straightforward derivation of my formula follows:

By Hooke’s Law: $E = \text{stress/strain} = (\Delta T/A)/(\Delta L/L) = (L/A) dT/dL$.

so $dT/dL = EA/L$.

By the Mersenne-Taylor Law: $T = 4f^2L^2\rho$.

Take the derivative of the M-L Law: $dT/dL = 4\rho A(2f^2L + 2L^2f df/dL) = EA/L$ (from Hooke).

Reorganising gives my formula: $df/dL = E/8\rho f L^{3/2} - f/L$.

(The g in Lee’s formula and not in mine comes from his measuring force in mass units of Kg or lb. This is relevant since the units for E are force per unit area.)

Lee was wrong in interpreting his equation (10) as implying that $df/dL$ was proportional to $1/L^3$ because the other variable, $f$, needs to be replaced by whatever function of $L$ that it happens to be, and then only when the right side has one variable ($L$) only can proportionality be considered. I was wrong in Comm. 1493 to invoke harmonic (or Pythagorean) scaling because we are discussing variation of frequency with length on a single string. The way to go is to integrate the equation $df/dL$ to get $f$ as a function of $L$, and then substitute the result for $f$ in $df/dL$. Then we can see how $df/dL$ really varies with $L$.

On integrating, I get $f = (1/L)^3 \{E/4\rho [\ln(L/L_0) + f_0^2L_0^2] - \sqrt{E/4\rho [\ln(L/L_0) + f_0^2L_0^2] - \sqrt{E/4\rho [\ln(L/L_0) + f_0^2L_0^2]}}\}$. The dependence on $L$ is complicated, with $1/L^2$ multiplying all the rest, and the rest having ln($L/L_0$) terms in it. We can get some idea about it by looking at limits. When $L$ is very close to $L_0$, $\ln(L/L_0)$ is close to 0, and $df/dL$ varies as $1/L^2$. But $E/4\rho$ is much bigger than $f_0^2L_0^2$, and $L$ doesn’t have to be much bigger than $L_0$ for $\ln(L/L_0)$ to become important. If the difference is big enough, $f_0^2L_0^2$ can be neglected. The term $\ln(L/L_0)$ can be approximated by $(L/L_0)*$, then $df/dL = (1/L^2)\{(1/2)\sqrt{(E/4\rho)[1/(L/L_0)^3 - \sqrt{(E/4\rho)[L_0/(L-L_0)]}}\}$. From this we can see that the second term (after the $-$) is much smaller than the first, and so can be neglected. So after all this simplification, we can say that for larger $L$-$L_0$’s, $df/dL$ is proportional to $1/[L^2\sqrt{(L-L_0)}]$. This is still far from $1/L^3$.

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$L = L_0 + \Delta L$, so $\ln(L/L_0) = \ln(1 + \Delta L/L_0)$. Now $\Delta L/L_0$ is still much less than 1, and if we expand $\ln(1+x)$ in a series ($x = \Delta L/L_0$), we get $\ln(1+x) = x - (1/2)x^2 + (1/3)x^3 - ...$. and if we neglect higher orders of $x$, we get $\ln(1+x) = x$. Thus $\ln(L/L_0) = \Delta L/L_0 = (L-L_0)/L_0$. 
Sealing Harpsichord Soundboards

Apart from Grant O'Brien ("Ruckers – A harpsichord and virginal building tradition") none of the books that I have consulted suggests what substances should be used for sealing the soundboards of keyboard instruments. O’Brien suggests gum arabic, egg white, varnish, shellac and glue size as possibilities.

I decided to take the opportunity of the 1995 (sic) early Music Exhibition to ask some of the exhibitors what they used. I asked eight* makers, and report the results here in case others should find them useful (or, alternatively, that they might provoke fierce argument!).

Shellac (5 makers): all soundboards I saw were pale in colour, and it was clear that a pale shellac was used. Lemon shellac and blonde shellac were mentioned. Two makers liked to sand the shellac to a flat finish whilst others were content with a more shiny end product. Two makers were concerned about the danger of a blue cast from the dye in methylated spirit and suggested, respectively, isopropanol and industrial meths as a solvent.

Egg white (3 makers): One used two coats whilst another used one coat of diluted egg white (with maybe a little yolk to give a more yellowish colour).

Danish oil (1 maker): A thin coat, with egg yolk added for colour.

Nothing (1 maker): This maker used thin watercolour for colouration, but no sealant.

For what it is worth, my own two instruments received respectively (a) one coat of french polish, which I would not use again as the result is too dark, and (b) one coat of undiluted egg white, which gives a pleasing finish, though it is yet to stand the test of time. One egg was unfortunately not quite sufficient and I had to crack open another.

(* some makers mentioned more than one method)
Instruments in 18th C. Canada and a String Maker of New France.

One consequence of the American Revolution was that thousands of colonists who had remained loyal to the British Crown - their property and possessions pillaged and plundered by the Americans - were forced to flee to the relative security of Nova Scotia, Quebec and lands to the West, there to establish new settlements.

This large influx of English speaking settlers produced a political imbalance in Quebec which resulted in the Canada Act of 1791. This Act created the Province of Canada, an area divided on ethnic grounds into Lower Canada to the East (now the Southern part of Quebec) and Upper Canada (present day Ontario) to the West. While Lower Canada was to continue to retain its French traditions, language, law and religion, the vision for Upper Canada was that it should be a class society the "very image and transcript of British 18th C. society and government".

In this society, as in Britain, music and dancing was a popular diversion for all classes according to the many diarists and correspondents of the time. Nevertheless, research into the kinds of musical instruments and their origins, used during these formative years, is hampered by lack of detailed historical record. While we can be sure that some instruments were being made locally, the majority, no doubt, would have been imported from Britain and Europe.

An advertisement in the 'Montreal Gazette' dated June 2 1791, while not being a comprehensive listing of all the instruments and accessories that would have been imported at this time, nevertheless gives some idea of the range of articles available. The advertisement (Fig 1) reads as follows:

"Recently imported and for sale by FREDERIC GLACKEMEYER, N° 18 Mountain street close to the stairs leading to the lower Town, the following articles viz:
An Excellent Tenor with Case and bow
Violins, German Flutes, and best screw'd fiddle bows
A choice collection of new music for the Harpsychord and German Flute,
and a few copies of the newest Vauxhall's Songs.
Also on Sheets; strings for the Harpsychord, Piano Forte, Tenor and fiddle Bassoon, Hautbois and Clarinet Reeds.
Ruled paper and Music books.
Rosin Boxes (?) and Mutes, Tuning hammers and Pitch forks.
(?) Bridges for Tenor and Violins.
Quebec 30th May 1791"

Prior to the capture of Quebec city by the English in 1759, the colony of New France - founded in 1608 by Samuel de Champlain - was a feudal domain, governed by the Company of New France, concerned primarily with fur trading. Agricultural settlement was encouraged to provide a level of self sufficiency in order to better support and maintain this endeavour.

Records of 1663 show that domestic breeds of animals - oxen, cows, pigs, sheep, dogs, cats, hens and pigeons - were being imported from France and that the colony was beginning to attract habitants (settlers) who were not only farmers but skilled artisans.

Music making and dancing were also important social activities in this society and we know from early accounts that instruments such as the hurdy-gurdy, fiddle, and guitar were popular. The diaries of Champlain even refer, on one occasion,
to a member of his party playing the guitar to the savage Indians - with apparently soothing effect!

Many of these instruments would have been brought to the colony by the habitants themselves. Due to the relative isolation of the colony, however, imports of instruments would, at best, have been irregular - the vagaries of weather in the Atlantic, freeze up of the St Lawrence river during winter and the ongoing conflict between England and France, all playing a part.

In the light of this situation, therefore, it is perhaps no great surprise to learn of an instrument string maker who was active in Quebec city around the middle of the 18th C.

A recent preliminary document search of the archives of the Bibliotheque nationale du Quebec uncovered the 'recensement des marchands' of 1758 for Quebec city - a list of merchants and artisans active in the city during that year - which includes one Jean d'Avril, Boyaudier, who was operating from premises in the lower town. His registered brand or mark, in the form of a fish, is represented in Fig 2.

We know that the d'Avril family arrived in New France, together with the elite Carignan-Salieres regiment, in June 1665 and that they came from the Loire valley region near Lyon.

Little more is known at present about Jean d'Avril but it is possible that, as a member of the local militia, he may have perished at the hands of English troops under General Wolfe on the Plains of Abraham in 1759.

Tradition has it among the few hurdy-gurdy players active in Quebec today, that the grand bourdon strings of a vielle used to be made occasionally from the guts of a "chat sauvage" - a material presumably equal to sheep's gut for this critical duty and used when the latter was not available (1). A "chat sauvage" could mean a wild cat such as a cougar, a feral cat (a domestic cat gone wild) or in colloquial French of Quebec, a racoon (2). We can not be certain, therefore, which of these animals was used for string making or if this type of string was ever made by the d'Avril establishment.

My best guess is that the material source was the feral cat for we know that the city of Quebec was unusually plagued by black rats during the first half of the 18th C - infestations which may have followed in the wake of heavy demand for vielle bourdon strings at a time of short supply.

Also, as any visitor to Quebec city will attest today, the common domestic cat of the city is of an unusually large breed (bodyweight often exceeding 30lb (14kg) in males) and of rather unfriendly disposition. These could very well be descended from those original felines used for instrument string making in earlier times.

More on this in a later Comm. pending further research.
Notes:

(1) Such strings, being made from collagen bearing materials, would have been an acceptable substitute for strings made from sheep's intestines (see Comm 1476). Collagen is a gelatinous substance found in connective tissue, tendon and bone i.e. glue.

(2) See "Dictionnaire de la langue quebecoise", Leandre Bergeron, VBL Editeur, Montreal, 1980. This work is a compilation of the words and phrases used in Quebec today that would not be found in a modern French dictionary. Many of these words are either direct adaptations of English or slang. Some words, however, now obsolete in France, are said to date back to the 16th C. One example is the verb "catter", one meaning of which is to dredge the bottom of a waterway with 'une chatte' (a kind of grappling iron without barbs or ears) in order to recover a chain or an anchor. Clearly this word is related to cattin the anchor in English nautical terminology, subject of discussion in Comm 1320.

Fig 1
'Montreal Gazette' Supplement, June 2 1791. Cut advertising the sale of instruments and accessories.

Fig 2
Registered brand of Jean d'Avril, gut string maker, Quebec city 1758.
There's a general agreement that Eph and I don't comment on Comms appearing in the same issue, because it gives us an unfair advantage. On the whole, we keep to this, though occasionally we seek special permission to make some comment or riposte. But are we allowed to be inspired by a Comm? I'm not sure, but I'll take a chance.

Donald Gill says, herewith, "I was hoping that eventually some historical evidence would be found which would help to clarify the murky area between the later 17th century gittern / citterns and the 18th century English and German guitars".

This is a question that has long concerned me, partly because of the auctioneer's inveterate habit of calling them all citterns, which further confuses the whole issue, but chiefly because it isn't just "English and German" (as of course Donald would immediately agree). There are the French instruments, though the most important of those are the basses, the archicestres which don't seem to turn up in the English tradition, though I have come across German ones but which, I suppose, are a survival of, or answer to, the later manifestations of the theorbo, and perhaps an ancestor of the German 'luthars' as someone once christened them, the Wandervogel's theorbo-shaped, extended-neck, bass guitars on a lute-like body (but with only single strings) which were popular through the early years of this century and into the Nazi period. Interesting instruments, though not what I want to write about today - I had one once, but it had to go to pay for something I wanted more, rather to my regret ever since.

What I'm most interested in are the connexions between the English guitarr and the Portuguese guitarr. The English instrument was initially tuned with lateral pegs, but these were replaced by the watch-key mechanism of a worm travelling on a screw thread for each string. It was allegedly Preston who devised this machine tuning in the 1760s - I say 'allegedly' because, although the casing is normally marked PATENT, there is no relevant patent listed in the Patent Office Abridgements, though Richard Wakefield patented something similar for keyboard instruments in 1771.

While the English instrument has this screw mechanism operated by a watch-key, the Portuguese instrument has exactly the same mechanism, and I do mean exactly, but operated by a fan of fixed screw pegs instead of by a watch-key. The instruments are also very similar in other respects, though more recent Portuguese examples (the guitarr is still in use) have rather larger bodies. It would seem possible that the difference in tuning operator, between a watch-key and a fixed peg, could be due to the fact that the English instrument was an upper-class one and every English gentleman of course had a pocket watch and therefore would have a watch key handy, whereas the Portuguese instrument had a wider distribution and perhaps pocket watches were less widely worn.

Now what has puzzled me for years is which way was the connexion. It is not credible that two similar instruments with an identical complex mechanical tuning mechanism should have been invented in two countries more or less simultaneously, especially when at least two very important commercial commodities, port and cork, were passing between those countries. So does anyone know whether the guitarr came to England with port or whether port factors (many of whose names are English and still survive in the trade) took the English guitarr to Portugal?

There are further complexities, of course. How did either the English or the Portuguese instrument start? (Whichever was the first, of course). Did we/they derive it from the German or the French? Or vice versa? Where does the Spanish bandurria come into this? It's another similar instrument, though rather smaller in body, deeper in profile, and normally tuned with guitar-style machines, and ear-
lier, like the guitar, with dorsal pegs. Or for that matter the flat-backed mandolin, which also tries to get into the 'late cittern' act and seems to have had geographic links with the Sicilian half of the Two Sicilies, rather than the Neapolitan half, where the lute-back mandolin is the more common. It is also very popular in America, of course — was the Sicilian influence greater there than the Neapolitan?

This is a very large murky area, filled with all sorts of flat-backed, wire-strung, parallel-profile instruments (ie not true citterns, with the wedge-shaped profile). They appear quite widely over Western Europe, all at much the same time, some with surprising differences (eg the archicistre), and others with even more surprising similarities (eg the English and Portuguese).

Where did they all come from? Who started it? Why were they suddenly so popular? We all know the Kirkman story of harpsichord sales falling off until he bought a couple of dozen guitars and gave them to the 'ladies of the town', but it wasn't just in England that they leaped into fashion, and surely it wasn't just the harpsichord they replaced. One might expect them to have replaced the lute, as a cheaper, easier, plucked instrument, but, pace Sylvius Weiss, there wasn't so much lute around at that time, and anyway if there was, the Spanish guitar (in Portuguese called viola, which emphasises the connexion between the vihuela and the guitar) was already doing a good job there. OK, wire strung has considerable advantages over gut for a popular, 'short order' instrument, hence the popularity of the original cittern and before it the citole (pre-Laurie Wright gittern), but that doesn't seem reason enough for such a rush of flat-backed pear-shaped instruments.

Any ideas?
To FoMRHI Quarterly

Dear Sir,

For at least ten years now I have been making the summary of the FoMRHI Bull. for the BOUWERS KONTAKT in the Netherlands. I have just finished an article for that Bouwbrief about parchment roses, of which I send you an English version as an answer on Queries in Bull. 86. You can use it in the Bull., if you wish, or send it to W. Hendry.

FoMRHI Comm. 1515

Ed van Weerd.

Parchment Roses in Citterns, lutes, baroque guitars and harpsichords.

The Rose in a soundhole of an instrument is an important ornament.
In lutes, the rose is almost always cut directly from the soundboard. If a lute has a rose glued to the board, it might be a repair or the original has been a failure.
In citterns, there can be a rose cut directly from the soundboard, but more often a parchment rose has been glued inside.
In baroque guitars the rose almost always is made of parchment but in harpsichords, there are many possibilities, of which parchment is just one.

A parchment "tart" is built up from disks of different diameter, glued together. They are held together with vertical strips. Instead of parchment, very thin ivory or bony disks have been used. The disks are cut in fine filigrain patterns, overlapping each other.
The little tower in the middle is made of small disks in the form of flowers, built up around a little stave or tooth-pick. The illustration should make it clear.

Normally I first make a try-out of a new design in strong drawing-paper. Often the parchment from the bookshop is in fact paper and is of no use. The vellum from the bookbinder is too yellow, so you will have to find thin clean white parchment. In the Netherlands a good address is: Heemraadsingel 255 a, 3023 CE Rotterdam, Holland, phone: 010 425 39 24

The parchment is cut with a surgery scalpel. Round holes or the end of ellipses etc. are made with a pair of tongs (intended to make holes in a trouser-belt), or with punches made from brass tubes of different diameter, for sale in shops for modelbuilding.
A good example of a parchment rose is to be found in the cittern made by Gasparo da Salo in 1560, now in the Hill Collection of the Ashmolean Museum, Oxford.
By making your own design you must realise that all parts should connect. Even parchment does not fly.

Illustrations:
1-4 Parts of horizontal disks
5 Vertical strips with glue margin
6-7 Top and bottom flower of the tower.
8 straight through
9 part of a rose, top view

← Diagram on previous page
I am grateful to Eph for explaining my hangup about cittern history to me. I did not realise that I just wanted to keep it simple; I was under the impression that for the last twenty years I had been more interested in a number of other categories of instruments.

I am suspicious of so much having to depend on Meuler's wire. Eph admits that he initially expected it to have a breaking pitch that fitted his preordained pitches, and (Comm.1497) explains to us how he felt free to ignore a clear Praetorius statement about pitches 'whenever it seemed appropriate' because he could not imagine how the statement could possibly be consistently true. When further inconsistencies arise, the problem is solved by the suggestion that the strength of Meuler's wire 'was not consistent', and 'at least some batches distributed in England were inferior to those available in Brunswick'. Do we have any objective evidence for this? Do we know who used Meuler's wire? Or is it that it must have been used otherwise we can't explain our preconceptions?

In my Comm.1482 I was not hoping that people would come up with 'other ideas'. I was hoping that eventually some historical evidence such as instruments, tablatures or other contemporary writings would be found which would help to clarify the murky area between the later 17th century gittern/citterns and the 18th century English and German 'guitars'. Meanwhile I remain puzzled that two instruments (the Englisch Zitterlein & Cithrinchen), of similar string lengths, must be regarded as being tuned an octave apart, on the strength of the Praetorius evidence alone.
I have been using semitone steps in the calculation of stringings for some time, and it makes things so much easier that I would like to encourage others to use it as well. The way it works is that if we express ratios of string stops, frequencies, diameters and tensions as semitone steps, we can just add or subtract steps. Steps are of length (fret lengths), frequency (semitones of pitch), diameter and tension. Each step represents a ratio of the 12th root of 2 (about 1.059, or a difference of about 6%).

The frequency ratios of pure intervals is useful here as common examples of ratio equivalents of number of steps in any variable. So 2 steps is an interval of a second and represents a ratio of 9/8, 3 steps (minor third) is 6/5, 4 steps (major third) is 5/4, 5 steps (fourth) is 4/3, 7 steps (fifth) is 3/2, and 12 steps (octave) is 2/1. Thus a string that is 7 steps thicker than another is 50% thicker (3/2 times as thick). Half an octave is 6 steps, so the ratio is the square root of 2, or around 7/5. Eight steps (a minor sixth) is an octave minus a major third or 2/(5/4)=8/5, 9 steps (a major sixth) is an octave minus a minor third or 2/(6/5)=10/6, and 10 steps (a minor seventh) is an octave minus a second or 2/(9/8)=16/9.

If one has a string on each of two gut-strung instruments where the vibrating length of the second is S(L) steps greater than the first (what is in the parenthesis is what it is steps of), the pitch of the string on the second is S(F) steps higher than the string on the first, the diameter of the string on the second is S(D) steps thicker than the string on the first, and the tension of the string on the second is S(T) steps higher than the string on the first, then by taking the logarithm to the base of the 12th root of 2 of the ratios in the Mersenne-Taylor formula, we get:

\[ S(L) + S(F) + S(D) - (1/2)S(T) = 0 \]

It is important to be careful about being consistent about which is the first string and which is the second string being compared, and if the second is bigger than the first in the relevant characteristic, the number of steps is positive, and if it is less, the number of steps is negative.

One common use of this formula is when comparing different strings on the same instrument (with parallel nut and bridge). Then S(L) = 0. If the tensions are equal, S(T) = 0, then we have S(F) = -S(D). The ratios are the same but the other way around, and so inverted. As an example, a viol 3rd is a fourth lower than a 2nd, so S(F) = -4 (giving a ratio of 3rd to 2nd of 3/4), then S(D) = +4, so the 3rd is 4/3 as thick as a 2nd. If the tensions are not equal and we know S(F) and S(D), we can calculate the tension ratio. Thus if a violin 1st is the first string and the violin 2nd the second string, S(F) = -7, and if S(D) is 4 (as is common), by the equation, S(T) becomes -6, so the violin 2nd has 6 steps lower tension than the 1st. The ratio is 1/1.4 or 0.7, so the tension of the 2nd is 0.7 times the tension of the 1st.

It has been empirically found that if one has a family of instruments of different sizes and type of construction, for balanced sound output between them, the tensions of corresponding strings is roughly proportional to the string stops (I have been calling this the Tension-Length Principle). Thus when comparing two members, S(L) = S(T). This allows us to eliminate S(T) from the general equation above, giving:

\[ (1/2)S(L) + S(F) + S(D) = 0 \]

As an example, let us find the string diameters of a modern alto viol (original treble size) with string stop of 40 cm) from strings that work well on a modern tenor viol (string stop 50 cm). The player wants to play it as a tenor viol, so S(F) = 0. It is 4 frets shorter, so S(L) = -4. From the equation above, S(D) = -(1/2)S(L) - S(F) = +2 - 0. So corresponding strings (i.e. 1sts or 2nds or 3rds etc.) on the alto would be about 2 steps heavier.

Semitone steps are displayed on adjacent lines in the NRI general string catalogue, on the NRI string calculator and pitch-frequency tables. Counting rows does the multiplying for you.
Stradivari’s book *I “Segreti” di Stradivari* (1972) contains a catalogue of materials from Stradivari’s workshop held in the Museo Civico in Cremona. Soon after it was published, I wrote to the museum saying that I was researching the history of strings and would appreciate it if they would send me measurements of the strings contained in the packet that was Exhibit N 309. The catalogue states that the packet contained 3 violoncello strings, and written on it in the handwriting of a son of Stradivari was *Questa sono le mostra del tre corde grosse quella mostra che sono, di budello va filata e vidalba*. I received no reply to the letter.

A few years later, when I was finishing up my PhD in the Physics Dept. at U.M.I.S.T., I mentioned this to a lecturer there who had worked in Italy and knew the language. He told me that museum officials in Italy usually got their jobs by patronage and nepotism, were very poorly trained, and wouldn’t do anything for anyone unless he had clout (so that a complaint would be taken seriously in the halls of power), or there was something in it for themselves. Many could not read English.

He suggested that I try again. He translated my letter into Italian and typed it on Departmental letterhead paper (with the Professor’s name on it), which I signed. In a few months, the Professor was bewildered by receiving a letter in Italian from Prof. Mosconi at the Cremona Museum. It included the following measurements: Two strings were plain gut with diameters 1.2 and 1.7 mm, and the third string had a gut core of 1.4 mm with a metal winding having a helix pitch of 1 mm.

I analysed this information in the last of my three articles on the history of strings for the violin family in *The Strad* (April 1988). It was strange that these strings were no thicker than Stradivari’s violin strings, and the possible explanations I gave for this seemed rather unlikely.

Recently, Mimmo Peruffo was given access to these strings, and he sent me his measurements. They are quite different from what had been sent to me previously, and I believe are much more trustworthy. All three strings were wound with silver wire of diameter 0.21 mm. The one with the thinnest core, which was 1.17 to 1.21 mm in diameter, was partially close-wound and partially open-wound (very irregularly). The other two were close-wound, one on a 1.3 to 1.31 mm diameter high-twist core, and the other on a 1.74 to 1.75 mm very-high-twist core. Let us call these strings (I), (II) and (III) in this order of increasing core diameter. Of course, there was no floss between the core and the winding, since that was a mid-20th century invention. Mosconi must have ignored the close-wound regions on the bits of string ends.

If we assume that all three strings were close-wound, we can calculate the solid gut equivalent diameters (ED’s) for these strings, they are 2.7, 2.85 and 3.4 mm. This doesn’t make sense as the lowest three strings of a cello. The number of semitone steps in diameter between the first two is only 1, and that between the last two is only 3. These numbers would both be 7 in equal tension on a cello, and I’ve never come across this number being less than 6 between adjacent lower strings on a cello, or less than 4 between such strings on a violin.

These measurements would make better sense if there is an unnoticed bit of space between the windings on string (I), and that the intervals between adjacent strings were smaller than a fifth - at most a fourth. Frisoli (*G.S.J.*, XXIV, 1971) thought that these strings were for the model of cello (‘B’) that included the “Pawle” (1690) and “Tuscan” (1731), and perhaps he got the idea from association of this Exhibit with the previous one (308), which is a template for the neck and scroll that served for both a cello (model ‘B’) and a bass viol (inscriptions for both are written on it). The solution of the problem I thought of is that these were the lower 3 strings for this very small bass viol (that neck is about 20% shorter than other bass viol neck templates). To make string (I) the appropriate 5 diameter steps from (II), the winding angle would have to be about 84°, and the helix pitch about 0.39 mm., leading to an ED of 2.13 mm.
Such close open-winding, with the space between windings less than the winding diameter, can easily be mistaken for close-winding. The ED's of these strings are very heavy, about 7 steps thicker than the strings we put onto modern bass viols.

I've shown this analysis to Mimmo Peruffo, and he insists that if string I was open-wound, as I suggest, he would surely have noticed it. The next hypothesis that makes maximum and reasonable use of the evidence is that strings I and III are the wound lowest two strings of an instrument tuned in 4ths, and string II is the single wound lowest string of an alternative set for that same instrument at a much lower tension.

The collection has templates for several instruments that were called viols. The instrument that the strings appear to be associated with was called 'viola della Signa Cristina Visconta' and was dated 1707. There doesn't appear to be a surviving template for the body shape, but the template for the neck and scroll (labelled both for this instrument and the 'violoncello ordinari') has a neck length of 26.9 cm. Both of these templates survive for the 'viola da gamba' dated 1684, where the neck length is 33.4 cm while the body length is 69.1 cm. The sum of these measures (i.e. the distance from the nut to where the instrument is supported on the legs) is a better indication of nominal viol size than either if them, and when compared to the measurements in the Talbot ms, this viol (dated 1684) appears to be a lyra viol in English terminology (string stop about 72 cm). The neck lengths are about the same as this one in the 1701 and 1737 instruments with 7 strings called 'bassa de viola alla francesa'. From the comparative lengths of neck, the 1707 instrument apparently associated with the strings would appear to be of tenor-viol size (about 60 cm string stop).

We have previously come across a 6-stringed instrument of this size tuned like a bass viol with particularly heavy stringing. Its unusual stringing (with all catlines) was described in the Talbot ms where it was called 'Lewis's bass violin made for Lord Abergenny'. It was probably usually used to play bass in fiddle bands during processions, where its heavy stringing made it loud enough and its small size made it portable enough for this purpose. When strapped so that the back was against the right shoulder with the neck sticking down angled 45° to the left and bowed up angled 45° to the left, it was sometimes called 'viola da spalla' (meaning 'shoulder viol').

Stradivari kept templates for parts of instrument he made so that there would be less work if another similar order came in. He would only have kept bits of strings so that he could specify them again if he made another such instrument. This strongly implies that the instrument or stringing was unusual, and the stringing at least was not standard for his instruments in general production. In his day in Italy, metal wound strings were only common for the single lowest string on viols and bass violins (including cellos). The earliest evidence for a metal-wound violin 4th in Italy is given by Ricatti (1767). Stradivari's specification of three lowest strings having metal winding on this instrument is consistent with the need for greater projection on a low-pitched small-sized instrument like the viola da spalla.

I can't help wondering what Signa Cristina Visconta did with the instrument. Perhaps she had earlier learned to play the viol but had only a fiddle band to play with in 1707. Maybe she liked playing in processions too. Perhaps she didn't play but one of her musicians was a violoncino (division viol) player, and she wanted an instrument for him to play in processions. We will probably never know.

One would not expect that Stradivari artifacts would be of relevance to French viol history, but his two neck and pegbox templates for French 7-string viols are likely to be relevant to estimating their usual sizes. Only one says nothing about usualness, but two at similar sizes must be taken seriously as evidence, though it is far from conclusive. Such a size is rather big for domestic use as a substitute cello, which has been the reason for survival of most of the original bass viols that we still have. So we would expect, as with English bass viols, that the survivors are almost exclusively the ones that were unusually small when made. The normal original sizes of French baroque viols needs to be sorted out, and this evidence can help.
Thick gut strings, playing harmonics and stopping in mid air

A cellist customer researching baroque repertoire came across a sonata by Martino published in Paris in 1748 that notated harmonics that divided the 1st, 2nd and 3rd strings into 3, 4, 5, 6 and 8 parts. A v-shaped mark above or below the written note indicated that the string was to be touched rather than pressed against the fingerboard, and the note written was the note that would sound if the string was pressed against the fingerboard. This is another example of tablature, indicating where to put the finger, and not the note that actually sounded.

The request was for authentic strings that might make the harmonics more easy to get, hopefully as easily as with modern strings. The problem was mostly with the highest harmonic, the one that divides the string into 8 and sounds 3 octaves above the fundamental, and more with the highest string than with the others. I had not investigated this before, and focussed on the worst situation - that harmonic on the 1st or A string. I found that the twist on the string had little effect but, as expected from which strings were easier, the heavier the string, the easier it was and the fuller the sound. Her stringing was heavy modern baroque, but original baroque was much heavier. It was not perversity that made Prin (1742) use a string 4 mm thick on his trumpet marine, an instrument with string stop of about 1.25 - 1.5 m. that was made for playing harmonics.

The practical difference between gut and modern strings is in the accuracy required in positioning the bow. Ideally, when playing harmonics, the finger touches the string at a node of the string's vibration and one bows at an antinode. The music here instructs the finger to be at the node closest to the nut. Cello harmonics are usually played in normal bowing position near the bridge. The ideal bowing position is as far from the bridge as half the distance from the finger to the nut. The higher the harmonic is, the more accurately one needs to position the bow and the closer it has to be to the bridge. I found that if one bowed the troublesome harmonic (3 octaves above the fundamental) at the next antinode along the string, near the upper corners of the body, the string was much less tempted to be indecisive or go for another harmonic than if one bowed at the antinode position near the bridge.

Most of what Praetorius wrote about the trumpet marine was quoted from Glareanus (1547). In that quote, it is claimed that experienced players can play, besides the harmonics, the intermediate tones and semitones, but that it is hard to hear them because of the rattling of the long string. As Crooks pointed out in his translation book, this can’t be done with harmonics. The instrument is bowed between the nut and the finger, and if the finger stopped the string in mid air instead of just touching it, these notes would resonate on the string between the finger and nut. The rest of the string can transmit some of this vibration to the bridge without resonating with it.

Stopping a string in mid-air rather than pressing it against a fingerboard is far from unknown. Violinists have always done it to play notes past the fingerboard. Modern violinists do it, and baroque violinists like Locatelli did it. Modern baroque fingerboards are longer than original octave-&-fifth baroque fingerboards because modern strings are thinner, and one needs to get closer to the bridge to get the thickness-to-length ratio to play easily while stopping without a fingerboard.

Praetorius wrote that violins were called ‘Polnische Geigen’ and could only speculate why Agricola used this name to describe fiddles that were played by fingering the strings without pressing them against the fingerboard. Violin stringing was always heavy before this century (except for Lullist France, when they were supposed to emulate viols). The North Indian sarangi is played by pressing the tip of the fingernail against the fingerboard, and rocking about that tip, pressing the nail against the string. Sarangi strings are very thick.

The sound from bowing thicker strings has fewer harmonics than from bowing thinner strings. Some of the energy in the missing harmonics in thicker strings is turned to heat by absorption.
of the gut, but most of it is taken away from the higher harmonics by phase cancellation due to inharmonicity and transferred to the remaining modes, mainly the fundamental. Enhancing the fundamental is the issue here. Until well into the 20th century, when composers and conductors didn't expect double basses to have the quickness of response of cellos, double-bass players used thick gut strings (without metal winding) to enhance the fundamental, the sound that the doubling cellists couldn't offer. This provided a more solid foundation for orchestral sound than there is in modern orchestras.

When bowing a string, it has a choice of which of the possible modes it can vibrate in, and generally picks the one (or the package of modes that work together) that can use the most energy. That is usually the fundamental with its harmonics thrown in, but when the string is stopped to be much shorter than the instrument is designed to resonate with, some harmonics on their own and various squeals become more competitive. Enhancing the fundamental there allows it to still dominate.

A harmonic may have a small fraction of the energy of the sound when bowing the whole string, but when it is chosen by the finger touching the string at its node, which stops vibration of lower harmonics and the fundamental, all of the bowing energy goes into that harmonic and its own higher harmonics. Then the same competitive situation as above occurs, and a thicker string which enhances the fundamental (which in this case is that particular harmonic and not its higher harmonics) makes it dominate and easier to play.

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Some earlyish cello string information

I’ve been sent a diagram of a string gauge for cello by Romberg (c.1840). I presume that it comes from an English edition of his famous Method of that date. The tapered slot goes from 0 to 1/8" (" means inches) in a length of 3", and 1/8" unit marks are along the slot between the 1st and 2nd inch, from 8 to 16 units from the apex. So each unit represents 1/24 times 1/8" or 0.13229 mm. There are markings for the strings at 10.9, 15.5, 9.4 and 12.5 units from the apex for the a, d, G and C strings respectively. The markings may represent how far the leading edge of the string goes in the slot, so the diameters would be measured half a diameter further along. The diameter then equals the units marked times a factor that is k/(1-k/2) where k is 0.13229. That factor is 0.14166. The diameters in mm then are respectively 1.54, 2.20, 1.33 and 1.77. If, on the other hand, the point of contact with the slot was the relevant point of measurement, the factor would be k, and the diameters would be 1.44, 2.05, 1.24 and 1.65 mm. We will calculate the tensions of the a and d strings. They are, in Kg (to the nearest 0.5 of a Kg), 22.5 and 20.5 in the former case and 19.5 and 17.5 in the latter one (a'=435 Hz. was assumed). These figures are about twice the tensions of modern cello strings (c 10 Kg), and three times the tensions of modern baroque cello strings (c. 7 Kg at a'=415 Hz.).

If we assume that the diameters of the G and C strings are total diameters of wound strings, to get string tensions comparable with the d string, the cores would have to be so thin to get the weight in the metal, that the cores would break. Thus the markings must be only for the diameters of the cores of the wound strings. To get the same tension as on the d string (the 3 lowest strings are usually in equal tension), the winding diameters on the G and C would have to be 0.29 and 0.50 mm in the former case and 0.32 and 0.55 mm in the latter case if the winding was of silver. If the winding was of silver-plated copper or just copper, the diameters would be 0.32 and 0.56 mm in the former case and 0.35 and 0.62 mm in the latter case.

Mimmo Peruffo tells me of an 18th century cello that Christopher Coin found in a castle in apparently original condition with original strings. The string measurements he gives, for a, d, G and C strings respectively in mm, are 1.2-1.25 (high twist), 1.8 (very high twist), 0.22 metal on 1.5 (high twist) and 0.36 metal on 1.8 (very high twist). This amounts to an equal-tension set at 14 Kg at modern pitch with copper or silver-plated copper (silver winding makes the equivalent diameters one semitone step higher). This set is very close to that specified by Savaress (1869). An unwound or open-wound G could be expected for the 18th century.
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