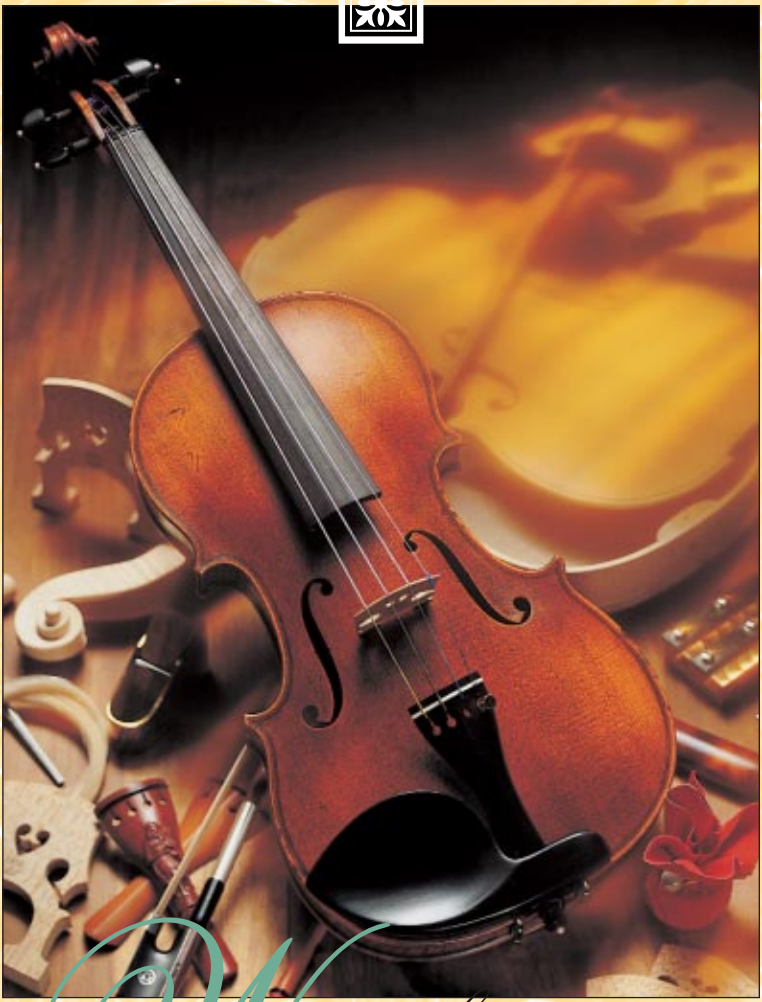
Knilling

STRING REFERENCE GUIDE



We speak your language

Introduction

This guide is dedicated to string educators, students, and enthusiasts, whose interest in, and love of the orchestral string instrument guarantees its continued position of importance in our lives, music, and culture.

Knilling String Instruments extends its deep gratitude and appreciation to all who contributed their time, expertise, and knowledge, to bring this opus to life.

PASSION HAS A VOICE

Rivaled by the human voice alone, the violin is the most expressive of instruments. It possesses amazing powers of communication. It exudes, articulates, challenges and soothes. Each player can find in this remarkable instrument the means to reveal, to bring forth a most personal force.

Its range of expression is phenomenal. Sometimes fiery, exploding with energy, igniting as the bow first touches the strings. Sometimes tender to the point of tears. Other times playful, tickling, giggling, as the bow dances from one string to another.

In the hands of a skilled and sensitive player, it is no mere tool. The violin truly gives passion a voice.

Over 80 years ago, this voice called to our founder, Bernard Kornblum, and out of his consuming passion for the violin, Knilling String Instruments was born. The voice continues to guide us today in our relationships with the violin makers and their families – relationships which now spans three generations. It expresses itself in every instrument we select, in every adjustment we perform, whether student or master, to give every instrument its amazing powers of communication.

So that new voices will continually be added to the old. Giving passion a voice for many generations to come.

Founded in 1922, Knilling proudly stands as the oldest violin company in North Amercia still owned and operated by its founding family.

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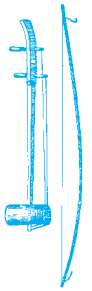
"The life of the arts, far from being an interruption, a distraction, in the life of a nation, is close to the center of the nation's purpose — and is a test of the quality of the nation's civilization."

— John F. Kennedy

A Brief History of the Violin

The study of sound and music can be said to have begun nearly 2,500 years ago, with the famous Greek scientist, Pythagoras, who made observations regarding the sounds of notes plucked on a simple lyre with strings at different lengths and tensions.

In ancient Greek or Roman times, stringed instruments, such as the lyre or harp, were plucked or strummed. It was not until 3000 B.C. that the first true stringed instrument played with a bow appeared — the *ravanastron*, an instrument still played in India today.



Ravanastron Drawing

Other early bowed instruments included the Indian-Arab *rebab*, which was brought into Europe in the thirteenth century, about the time of the Crusades, probably via Spain. (In France and other parts of Europe, it was called the *rebec*.) The *crwth* or *crwd*, was played in Brittany before the Moorish invasions. This stringed instrument actually had a tailpiece, and sound holes, and was held like a violin.

Rebab Drawing

In the nearly two thousand years that followed, the forerunners of the violin evolved rather slowly. Many of the earliest violins were structural amalgams of various stringed precursors, such as the rebec, lira da braccio, and Renaissance fiddle.

Drawing of a rebec being played

The full ancestry of the violin is unclear. In particular, it remains a mystery as to what individual or group brought forth the violin in its final form. It has even been conjectured that the great Florentine genius, Leonardo da Vinci (b.1451 — d.1519) may have contributed seminal concepts regarding its form and mathematical proportions. Suffice to say that by the early 1500's, a form of the violin emerged which, in its shape, basic dimensions, and final details, has remained fundamentally unchanged for nearly 400 years.

Prior to around 1600, the violin remained a rather minor instrument, used by what was regarded as a lower class, for their dance music. Archangelo Corelli (b.1653 —d.1713), a violinist as well as teacher and noted Baroque composer, may have been a significant early influence in popularizing the violin.

As the violin has inspired changes in music, changes in music have also led to certain alterations in the violin. Evolving performance requirements eventually imposed further changes on the violin; composers were writing music that increased technical demands on the performer in both range and power. The virtuosic compositions that were the hallmarks of nineteenth-century violin literature, would not have been possible on the original instruments made by Antonio Stradivari. Violin makers, such as Jean-Baptiste Vuillaume and firms like Hill, were called upon to literally disassemble and rebuild a majority of the pre-existing instruments. Adaptations included lengthening the neck and changing its angle, a longer bass bar, and new types of bridges and strings. These changes eventually resulted in the emergence of the modern violin, and contributed to its rise to prominence as "the king of instruments".

Three views of an inlaid violin by Antonio Stradivari, 1693

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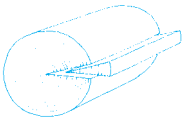
How a Violin is Made

The violin is a true marvel of balance and beauty. Its basic form has defied most well meaning attempts at improvement for nearly four centuries.

An understanding starts with the wood, primarily maple and spruce. The top plate of the violin is called the *soundboard* (also called the *top*, *table* or the *belly*). The soundboard must resonate easily, so a relatively light wood must be used. Because of its resonant qualities and light weight, the wood selected is almost exclusively spruce.

Arguably, the best wood for the soundboard features generally straight grain, and is free of knots. Ideally, it comes from trees grown where the onset of winter is quick, in a climate and soil which does not foster rapid growth. Under such conditions, a tree of suitable dimensions may easily be hundreds of years old. Even then, the wood is years, even decades from being used. It must be properly cut and stored to dry and cure naturally, to mature for its next life.

The best trees for making the soundboard are typically 200 to 250 years old, found at higher elevations in the Bavarian mountains. There, the climate and soil conditions promote slow growth. These trees are harvested only in the middle of winter when the sap has receded back into the roots.



Spruce cut on the quarter

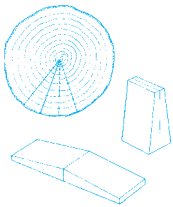
After the trunk is cut to appropriate lengths, it is split, typically like wedges of a pie. Spruce which has been split or cut in this fashion is said to be *cut on the quarter*.

The wood is then stored outdoors, in an area protected from precipitation. Here the wood is allowed to dry and cure for anywhere from 5 to 25 years, sometimes much longer. Properly seasoned wood is better for making a violin because it will not warp, and, better for playing, because it resonates more freely.

The drying of wood intended for student instruments is sometimes assisted by the use of a drying kiln,

which allows the moisture in the wood to be reduced more quickly under controlled conditions. However, there is no substitution for time.

Next, the wedges are split down the center. The two halves are then glued together like bookends. The grain of the wood, which comes from the annual growth rings, now runs evenly across both pieces.



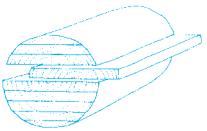
Wood cut on the quarter, split, and book matched

While spruce is used for the soundboard because of its tone-producing qualities and light weight, maple is used on the back, sides and neck because of its density, strength and beauty.

Because of its density, maple is ideal for the back plate, which can be either one piece, or, more commonly, two. Though thinly graduated (carved to desired thickness), the back must act more as a reflector than as a resonator, making rigidity very important.

Although other woods are sometimes used, traditionally, much of the violin's structural strength and beauty comes from maple, especially that found in certain areas of Eastern Europe. Suitable maple can be highly figured (*flamed*) or quite plain. Highly flamed maple is prized for its beauty by both maker and player alike. After all, the violin is intended to please the eye as well as the ear.

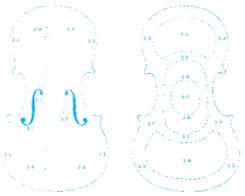
Sometimes, instead of being cut on the quarter, book-matched and glued, the maple for the back is cut or sawn longitudinally in straight lengths. Wood which has been split or cut in this fashion is said to be *cut on the slab*, and is often used to highlight the figure on one-piece backs.



Wood cut on the slab

Today's luthier still uses many hand tools quite similar to those employed by the old Italian masters. These include various rasps, clamps, knives, gouges, forms, templates and other specialized tools.

The thickness of the top and back plates is determined by time-tested patterns. The template is laid over the plates, and the pattern drawn on, leaving contour lines similar to those found on a topographical map. This helps the maker maintain the proper thickness or *graduation* for the top and back. The graduation



Graduation for front and back of the violin

will be different in different areas of the plates; the center and edges tend to be thicker, while the central areas above and below are much thinner. Using hand tools to carve away the excess wood, the violin maker adjusts the final shape and dimensions of the instrument based on the template.

For student violins, a few steps of the process can be accelerated with the help of specially designed machinery. However, much of the work must still be done by hand. For finer instruments, the maker painstakingly refines the graduation based on the character of the individual piece of wood, and based on exactly how she/he wants the instrument to look, feel and play.

Certain features of orchestral string instruments serve both ornamental and practical purposes. Two fine examples are the *f-holes* or *sound holes* and the *purfling*.

The f-holes, which lie on either side of the bridge, reduce the stiffness of the top, allowing it more freedom to respond. Once the soundboard has been contoured, the maker measures for the positioning of the f-holes. The size and precise placement of the f-holes have a distinct influence on the sound of the instrument. The exact area of the sound hole openings effects the way the instrument and the air inside can resonate. For the master violin maker, it also serves as an important artistic element, as individualized as a signature.

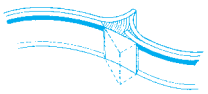
The *purfling*, which accentuates the graceful outlines of the body, is actually three fine strips of wood, delicately sandwiched into narrow channels on the top and back plates. Its practical benefit is to strengthen the plates, and prevent edge cracks from extending into the body of the instrument.

Using a special tool, the maker cuts a narrow channel around the edge of the top and back plates. A thin, flexible strip of purfling is then inlaid; this strip is actually three layers of wood: dark, light, and dark, laminated together. Like the f-hole, the purfling is more than decorative. It actually helps to protect the wood from splitting.

The *neck, pegbox*, and *scroll* (the curled shape at the top of the neck) are carved from a single block of seasoned maple. In practical terms, the fingerboard will be glued to the neck, and pegs to hold the strings will go into the pegbox. Yet this elegant part is also an example of the violin's unique blend of function and beauty.

The *sides*, or *ribs* of the violin, are fashioned from strips of maple. Since maple is strong, the ribs can be quite thin. The ribs are fitted around a mold and moistened. Then a heated bending iron is used to make them flexible enough to conform to the mold.

The internal architecture of the string instrument should enhance both its sound and soundness. Two important features which do this are the *blocks* and the *lining*.



Fitting the corner blocks

Once the mold is removed, the ribs are ready to be glued to the spruce *corner* and *end-blocks*. These blocks – there are actually six; two end blocks (top and bottom), and four corner blocks – are usually made of spruce or willow. The blocks hold the ribs and plates in position, and lend strength to the structure. In addition, the neck is mortised into the top block, while the bottom block holds the end pin.

The lining – twelve narrow strips of wood, generally willow or spruce, extend around the top and bottom of the ribs, between the blocks, carefully fitted and glued to both the ribs and the plates. This strengthens the sides, and adds surface area for attaching the top and back plates. Well fitted blocks and lining help provide essential support for the soundboard, allowing it to respond properly.

Normally hidden from view inside the instrument is a small but important piece of spruce, called the *bass bar*. Cut from a slender piece of spruce, the bass bar is glued lengthwise underneath the top plate, and extends along the underside of the soundboard. It adds structural strength, and also enhances the volume, range and projection of the lower tones.

Finally, the violin can be assembled and varnished. Over the centuries, an exotic array of substances have

been used to treat and color the wood. Despite modern scientific inquiry, mystery still surrounds the varnish used by the masters of Cremona. Intrigue still surrounds the formula and methods used by Stradivarius himself. Theories abound regarding the exact ingredients, their preparation, and their application. Just how much of the early formulas are still in use may never be known.

Today, the formulas and methods are still highly individualized. Master quality instruments are finished with spirit-, oil-based, or blended varnishes, in which some mixture of common and exotic compounds are dissolved or suspended. Layer after translucent layer is brushed on by hand, lending the instrument the particular color and luster the maker desires.

Oil and spirit varnish take the greatest amount of time and care to apply and dry, and are relatively soft, requiring rather delicate handling. For certain student instruments, more durable yet flexible finishes have recently been developed. Student (and some step-up) instruments frequently use a harder, more protective finish, called *nitrolac* (nitrocellulose lacquer). While attractive, they offer student instruments the combination of greater protection and ease of maintenance.

A varnished instrument is still incomplete, needing a fingerboard, nut, pegs, bridge, soundpost, tailpiece, saddle, endpin, and strings. The fingerboard, nut, saddle, tailpiece, tuning pegs and endpin are normally made of ebony or other types of dense hardwood. The strings are suspended by a bridge, made of seasoned maple.

The *bridge* transmits the vibrations of the strings to the soundboard itself. The quality of the maple blank can significantly effect the quality of response. This ornate, intricate little wedge of maple does far more than simply hold up the strings. It transmits the vibrations to the belly, which in turn starts the sound resonating throughout the body of the instrument. It works closely with the soundpost, which is located just beneath its treble foot. According to some theories, this leaves the other foot free to tap out its rapid rhythm, magnifying the vibrations of the strings.

The finest bridges are carved from "flecked" maple (called *speigel* in German), with fairly horizontal grain. Carving the bridge is as much an art as a science. A poorly cut bridge can impede performance of even the best instrument. Of great importance is that the feet are fitted exactly to the belly of the violin, without gaps. This facilitates the transfer of vibrations to the body.

Strings are made from a wide range of materials, from steel to gut to synthetic (perlon, synlon, PET, or nylon) cores. Each combination produces its own performance characteristics (*see Strings section*).

The French term for the soundpost is *l'âme*, the soul. This small dowel of spruce is fitted between the top and back plates, behind the foot of the bridge on the treble side. So critical is this seemingly innocuous piece of wood, that even slight changes in its position can change the tone of an instrument considerably, altering the way vibrations are transmitted to the top and back plates and to the bass bar. Although both soundpost and bass bar also help counter the downwards tension of the strings, so important is their combined effect on the sound, that they have been described as the "entire nervous system" of the instrument.

At this point, the violin is still far from being ready to play. In fact, the next stage of the violin's life is extremely important: the *adjustment*. Each of the above mentioned components must be hand–fitted and adjusted for each individual instrument. The quality of the adjustment can determine whether the instrument will perform to its potential and play with ease; it can even affect the condition and longevity of the instrument itself. (*See Knilling Custom Shop Adjustment).*

"Music, of all the liberal arts, has the greatest influence over the passions, and it is that to which the legislator ought to give the greatest encouragement."

— Napoleon Bonaparte

Famous Makers of the Violin Family

Throughout the centuries, hundreds of violin makers have risen to prominence as masters of their art. The selection presented here pays tribute to some of the most famous names, yet represents but a fraction of distinguished luthiers who have left their mark on the history of violin-making.

BRESCIAN SCHOOL

Gasparo da Salo (b. 1540 — d. 1609)
Originally a maker of viols and tenors, Gasparo da Salo's violins rose quickly to prominence, surpassing all his contemporaries, and he soon became the head of the Brescian school. Many of his instruments were made of pearwood and sycamore, especially his basses. The scroll particularly reflects the still primitive state of the instrument.

F-Hole by Gasparo da Salo

Giovanni Paolo Maggini
(b. 1520 — d. 1580)
Maggini was a pupil of Gasparo da Salo from age seven, where he remained until early adulthood. His patterns are rather large and broad in outline, but compact, with

Label used by Paolo Maggini

flattish arching sloping towards the purfling. The scrolls are still somewhat unrefined. His instruments are sometimes ornamented by elegant curls of purfling, typically laid in a double line.

CREMONESE SCHOOL

The Cremonese school was founded by Andreas Amati (b. 1525 — d. 1611), who started out as a maker of rebecs and viols. Some authorities have suggested that Andreas started the manufacture of violins contemporaneously with Gasparo da Salo. Noted makers of the Amati school include Joseph Guarnerius, Francesco Ruggieri, Jean Batiste Grancino, Francisco Grancino, Andreas Guarnerius, and Sanctus Seraphino.

Nicolaus Amati
(b.1596 — d. 1684) Nicolaus, the grandson of Andreas Amati, was considered the greatest maker of this illustrious family. Numerous masters of the first part of the

eighteenth century were his pupils. His most celebrated violins are those known as Grand Amati models. These were comparatively large instruments with long corners, bold scrolls and beautiful varnish, and although not powerful, were brilliant in tone. Instruments made by Nicolaus Amati are also notable for their arching, which tends to be rather high at the center.

Scroll by
Nicolaus Amati

Antonio Stradivari

(b.1644 — d.1737)

Purported to have been a pupil of Nicolaus Amati, Antonio Stradivari is considered by many to be the greatest violin-maker that ever lived. Stradivari served his apprenticeship with Amati, and stayed until 1670. During this period, he is not thought to have signed his work.

Label used by
Antonio Stradivari

Independently wealthy as a young man, Stradivari was free to pursue his quest and passion for perfection. His work can be divided into three periods:

Circa 1668 — 1686

The instruments made during the first period are known as "Amatesé Stradivari", which resemble Amati's "Grand" model, but with modified corners, and flatter arching. The wood used during this period, although acoustically sound, tends to be less figured than his later instruments. It has also been said that Stradivari spent this time procuring what he thought to be the best wood.

Circa 1686 — 1694

F-Hole by
Antonio Stradivari

The second period is characterized by graceful, larger instruments with even flatter arching, elegant f-holes, and beautiful golden or light red varnish. Towards the end of this period, Stradivari made instruments known as "Long Pattern", so-monikered for the narrowness between the f-holes, which gave the violins a lanky appearance.

Circa 1695 — 1725

Deep and brilliant in tone, the best Stradivarius violins were made during the third period, when Stradivari was in his 50's. The grace, beauty, and faultless perfection of instruments made during this period

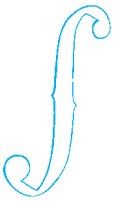
reflect the greatest violin maker's powers at his peak, reaching its zenith around 1714. Supple and elastic, the glorious translucent varnish applied by Stradivari continues to baffle experts. Over the centuries, masterful copies, perfect to the smallest detail, still fail to capture the soul that Strads from this era radiate. Only after 1725, does the work of this great master begin to show the effects of age.

Stradivari head showing oval shape

Stradivari was a very prolific and industrious maker, completing, on the average, twenty five violins or ten celli a year. In his sixty or seventy years of activity, he must have completed well over a thousand instruments. A surprising number have survived to this day. However, as the single most imitated maker, there is little doubt that some of the surviving "genuine" Strads may ultimately be revealed as masterful copies.

Scroll by Guarneri del Gesu

Bartolomeo Giuseppe Guarneri (b.1698 — d.1744) Bartolomeo Giuseppe Guarneri (also known as Joseph Guarneri del Gesu) was the greatest master of the celebrated Guarneri family of violin makers. He was the grandson of Andrea, and son of Giuseppe Giovanni Battista (who was known as Joseph Guarnerius filius Andreae). The term "del Gesu" comes from his labels which always incorporated the characters I.H.S. (Iesu Hominum Salvator) and a Roman cross.



F-Hole by Guarneri del Gesu

Although his work may be divided into four periods, instruments from the third period exhibit great originality and superb varnish. Instruments of this period are broader in the waist, with long but elegant inner bouts, long and perpendicular f-holes, perfect scrolls and lovely varnish, said to equal Stradivari's. Deep and powerful in tone, Guarneri instruments are said to rival those made by Stradivari.

During the latter part of his life, many of Joseph del Gesu's instruments exhibited a noticeably impetuous and personal character. Contemporary research has dispelled the apocrophyl tales claiming that many of these

instruments were “prison fiddles” or “drunken Josephs”, made in prison, using wood, tools and varnish smuggled in by sympathetic jailers. On the contrary, these later instruments show remarkably accurate workmanship and originality. The famed violin virtuoso Nicolo Paganini’s favorite instrument was a Guarneri del Gesu violin from this era (1743).

Francesco Ruggieri

(b.1620 — d.1695)
Thought to be Nicolo Amati’s first pupil, Francesco Ruggieri is increasingly becoming recognized as a great Cremonese maker in his own right.


Scroll by Francesco Ruggieri

Although he left Amati’s shop around 1641, Francesco Ruggieri continued to craft instruments in the Amati style, and often labeled them as such. Ruggieri also made a large number of celli, and experimented with the pattern, eventually developing a smaller, more manageable model than the typical large dimension standard of the 17th century.

Carlos Bergonzi

(b.1683 — d.1747)
Bergonzi is one of the greatest Cremonese makers, overshadowed only by Antonio Stradivari and Giuseppe Guarneri del Gesu. Carlos Bergonzi is thought to have learned the art of violin making from Giuseppe Guarneri filius Andreae, and Guarneri del Gesu, and established his own shop around 1720.

Bergonzi’s work is characterized by the delicacy of detail, especially his scrolls, which are cleanly carved and exceptionally symmetrical. His finest instruments date from 1730 to 1740, and are made from handsomely figured wood. Bergonzi apparently made neither violas nor celli.

NEAPOLITAN SCHOOL

Allessandro Gagliano

(b. 1640 — d. 1725)
Allessandro was the first of this long-lived family of violin makers from the region of Napoli, whose members span almost two centuries.


F-Hole by Allessandro Gagliano

Most of the Gagliano family made instruments based on the Stradivari model, except Allessandro.

Best known for his fine celli, his instruments exhibit great character and originality, and even his varnish was distinctive; rich, limpid and deep red in color.

Nicola and Gennaro Gagliano, sons of Allesandro were fine craftsmen, greatly influenced by Stradivari, and Amati. The brothers also made celli based on the Stradivari model, and developed a narrower model which was subsequently adopted by a majority of Neapolitan makers.

TYROLEAN SCHOOL

Jacobus Stainer (b.1620 —d.1683) The greatest maker of the German school of violin-making, Jacobus Stainer originally worked for Herz, the famous organ builder,

Label used by Jacobus Stainer

before settling on the profession for which he is now famous. Few makers have been more abundantly copied.

Said to have been a pupil of Nicolaus Amati, Stainer's violins were first offered for sale in the late 1630's. Pupils of note include Mattias Albani (1654), and members of the Klotz family (1670 — 1700).

Highly original, Stainer's instruments, although typically small in pattern, exhibit strong edges with purfling set rather near them, well-cut f-holes, and are far more highly arched than Cremonese instruments, especially between the upper bouts. The backs reflect more curvature than the bellies, with the summit of the arch almost as wide in dimension as the bridge. The scroll is often ornately finished with a carved lion's or animal's head, otherwise, they were left blunt and rather short.

Mattias Klotz (b.1656 — d.1743) Considered by many to be the founder of the violin industry in Mittenwald, Germany, a statue of Mattias Klotz erected in 1890 can still be seen there to this day.

Label used by Mattias Klotz

He received his first lessons from Jacobus Stainer, completing his education in Padua, Italy, under the aegis of Giovanni Railich, before returning to Mittenwald in 1678.

Although not always using the best woods, his work is excellent, and the tone of his instruments noteworthy. A good number of violins made by Mattias, and other members of the prolific Klotz family, are in existence.

FRENCH SCHOOL

Nicholas Lupot (b.1784 — d.1824)
Considered the best of the French school, Nicholas Lupot has been called the "French Stradivari".

Pupil of his father, François Lupot, Nicholas came with him to Orleans when he was eleven. In 1794, Lupot went to Paris to work with François-Louis Pique, before finally opening his own shop in 1798. His pupils include Bernardel and Gand.

Label used by Nicholas Lupot

Reaching his zenith by 1810, Lupot copied Strad almost exclusively, but his copies of other great masters are also excellent.

Jean-Baptiste Vuillaume
(b.1798 — d.1875)
Son and pupil of Claude Vuillaume V, Jean Baptiste Vuillaume is said to have been one of the most perfect imitators that ever lived. Vuillaume is also reputed to have been the only nineteenth century violin maker who was able to equal the varnish of the old Italians.

Enormously talented, he worked, at the age of nineteen, in the workshops of Lébé in Paris, and also with Francis Chanot.

Label used by Jean Baptiste Vuillaume

The influence of Lébé can be seen reflected in his work, and although he was taken in as a partner in 1825, Vuillaume left Lébé in 1828 to open his own shop.

Jean Baptiste Vuillaume was not only a meticulous maker, but as a dealer, handled many fine instruments, and was very successful at imitating other masters, especially Antonio Stradivari. Many instruments sold as genuine Stradivari, may in fact have been the work of Vuillaume. Vuillaume also engaged workmen to make bows and had pupils of his own as well. Out of his shop have come some of the most prominent French bow makers of the nineteenth century, including Eulry, Lenoble, Persois, Peccatte, and Voirin.

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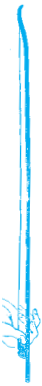
History of the Bow

Without the bow, the violin would be, for all practical purposes, mute. Therefore, an understanding of the origin of the bow is equally as important as an understanding of the origin of the violin.

The bow as a musical instrument, was well–known among primitive cultures around the world, and throughout Islam and the Byzantine Empire, but not introduced to Europe until around the 11th century.

Drawing of a bow for an Indian Ravanastron

Bows from this early period were quite rudimentary, subject to considerable variation. The curvature of the stick was also convex, much like a drawn archery bow, and the hair fastened directly to the stick without a device for adjusting the tension of the hair. Through the middle ages and following centuries, the development of the bow remained rather stagnant. Certain developments, such as rudimentary devices to spread the hair, can be seen in paintings from the fourteenth century, but it is not until the mid– and late–seventeenth century, well after the birth of the violin, that improvements such as frogs with dentated mechanisms (called *crémaillère* mechanisms) to adjust hair tension, and true button and screw mechanisms were developed.



Drawing of a Baroque Bow

The familiar pike-type Baroque bow head appeared in the mid-1700's, around the time of the death of Stradivari. Common woods used for making bows during this era were ironwood and snakewood; lighter woods were often fluted to give the bow additional strength and rigidity.

Up until the late eighteenth century, the curvature, or *camber* of the bow, remained convex. In the 1780's, the Italian violinist and composer Viotti came to Paris, where he became friends with the Tourte family.

Perhaps as a result of experimentation and artistic collaboration, the camber was changed from convex to concave, the fluted bow and pike's head abandoned, and the ferrule invented.

During this period, the evolution of the bow accelerated in response to important changes in performance practice, as music moved from the court and salon to larger venues and larger audiences. The new bow enabled greater sonority, power, and projection, sustained a wider range of dynamic levels, and articulated a greater variety of new bowing techniques.

The adoption of pernambuco as the wood of choice for string instrument bows is said to have been, in part, a consequence of expanding international trade. Ships plying South America trade routes would use pernambuco, which is extremely heavy and dense, as ballast on the return leg of their voyages (ships from North America used maple for similar purposes). Pernambuco also was an important source in dye manufacturing before the advent of synthetic aniline dyes. The ready availability of tremendous quantities of pernambuco wood eventually attracted the attention of François Xavier Tourte (b.1747 — d.1835), "the Stradivari of the bow".

With the work of the greatest member of the Tourte family, the bow was perfected. It was François Xavier Tourte who settled on pernambuco as having the ideal combination of strength and elasticity for making bows, and it was he who mathematically established the proper proportions of the bow, measurements which are still in use today.

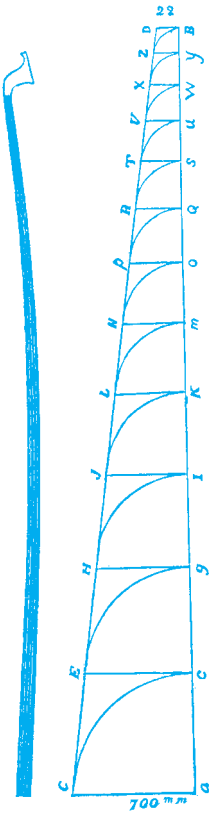


Chart for calculating bow proportions

Famous Bow Makers

Although there are scores of prominent names of renowned makers scattered throughout the history and evolution of the bow, there are two, in particular, whose impact on bow design and artistic achievement continue to influence makers to this day.

François Xavier Tourte

(b.1747 — d.1853)

The "Stradivari" of the art of bow making, François Xavier Tourte was originally a watchmaker, only joining his father and brother in making bows in the early 1700's after spending eight years at this trade. Although at first he used staves of old sugar barrels for his bows, which sold for a pittance, Tourte rapidly rose to prominence. At the height of his career, a single Tourte bow commanded princely sums.

Like Stradivari, Tourte experimented with design and wood, seeking to perfect his work, and is said to have destroyed that work which failed to meet his standards. During this period, Tourte settled on pernambuco as the ideal wood for bow making, and afterwards, worked ceaselessly to improve the design, ultimately giving the bow its final form, which we know today as the modern bow.

Dominique Pecatte

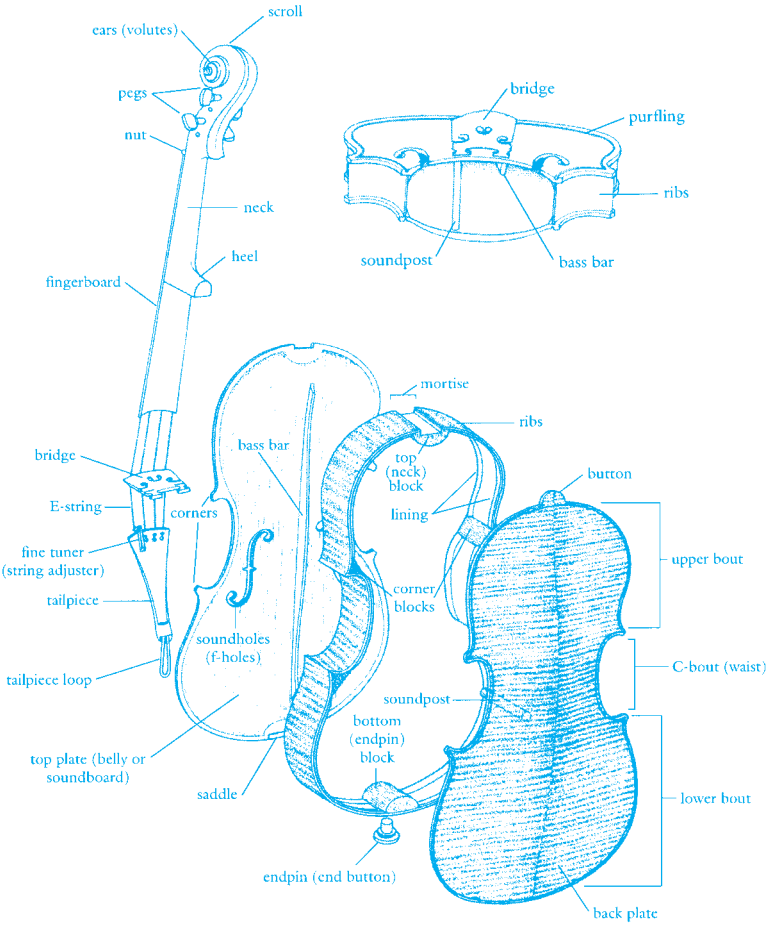
(b.1810 — d.1874)

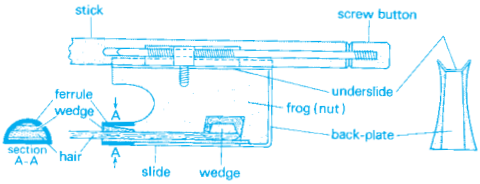
The most prominent member of an illustrious family of bow makers, Dominique Pecatte was an apprentice of J.B. Vuillaume from 1826 to 1837, whom he may have worked with, after which he took over the shop of François Lupot. Returning to Mirecourt in 1847, he remained there until his death.

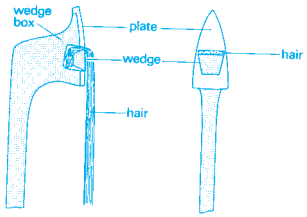
Known for the great beauty and elegance of his bows, Dominique Pecatte had a great influence on many of his contemporaries, such as Nicolas Maire, Guillaume Maline, and Joseph Henry, as well as many of today's bow makers.

F

Parts of the Violin and Bow







G

Measurements and Other Useful Information

MEASUREMENTS FOR GLASSER BOWS (in inches)

Size	Violin	Viola	Cello	Bass (French)	Bass(German/Butler)
4/4	29-1/8”	29-1/4”	28-1/8”		
3/4	27”	27”	26-5/8”	28-3/4”	29-1/2”
1/2	24-1/2”		25-3/8”	26-5/8”	27-7/8”
1/4	22-1/4”		23-5/8”	25-1/2”	26-3/4”
1/8	19-1/2”		20-1/2”		
1/10	19-1/2”		17-3/8”		
1/16	16-7/8”				

NOMINAL WEIGHTS FOR PERNAMBUCO BOWS

Violin	55 — 65 grams	Bass (French)	138 — 145 grams
Viola	68 — 74 grams	Bass (German)	128 — 140 grams
Cello	78 — 88 grams		

MENC STANDARDS FOR ADJUSTMENT (4/4 size)

The Music Educators National Conference (MENC) has established a standard for the adjustment of violins, violas, celli and basses. (All Knilling instruments are adjusted to meet or exceed MENC specifications.)

Instrument	Fingerboard height	Bridge thickness (top)	Soundpost diameter	Bridge height* between strings and fingerboard)	Stg spacing (at the top of the bridge)
Violin	19-1/2 — 20-1/2 mm	1/16”	1/4”	E — 1/8”; G — 3/16”	7/16”
Viola	24 — 25 mm	1/16”	1/4”	A — 3/16”; C — 1/4”	1/2”
Cello	62 — 65 mm	3/32”	7/16”	A — 1/4”; C — 5/16”	5/8”
Bass	9-1/2 — 11 cm	3/16”	11/16”	G — 7/16”; E — 11/16”	1-1/8”

* for steel strings

DETERMINING CORRECT INSTRUMENT SIZE

Violin/Viola

Support the instrument under the chin in playing position. The instrument is of proper size if the palm and fingers of the left hand can comfortably cup the scroll with the elbow relaxed.

Cello

Seat the student so that the knees are bent at a 90° angle. The instrument should rest such that the upper rim rests on the sternum (breast bone) and the left knee contacts the curve below the lower bout corner. The C-string peg should be near the left ear, with the neck a few inches from the shoulder. The left hand should be able to reach both ends of the fingerboard with ease, and the first and fourth fingers able to comfortably span a major third (E to G#) in first position on the D-string.

Bass

While standing behind the bass in playing position, the fingerboard nut should be opposite the forehead near eye level, and the right hand able to comfortably draw the bow from frog to tip. The first and fourth fingers of the left hand should be able to easily span a whole tone (E to F#) in the D-string in first position.

GENERAL AGE LEVEL GUIDE

Size	Violin	Viola	Cello	Bass
4/4	9 - adult	12 - adult	12 - adult	adult
3/4	9-11	11-13	10-13	11-adult
1/2	6-10	9-11	9-11	9-13
1/4	4-7			
1/8	3-5			
1/10	3-5			
1/16	3-5			

Age level guide subject to developmental variation among students of the same age.

AVERAGE BODY LENGTH IN INSTRUMENTS (in inches)

The following measurements are taken by measuring the length of the back, excluding the button. Measurements may vary from manufacturer to manufacturer, and from instrument to instrument.

Violin	Knilling MENC	Summit	Suzuki
4/4	14”	14-1/8”	14”
3/4	13-1/4”	13-1/4”	13”
1/2	12-1/2”	12-1/2”	12-1/4”
1/4	11”	11-1/8”	11-1/4”
1/8	10”	10-1/8”	10-3/8”
1/10	9”	9-1/8”	9-3/8”
1/16	8-1/2”	8-1/4”	8-3/8”

Viola*	Knilling MENC	Summit
4/4	15”, 15-1/2”, 16”, 16-1/2”	15-1/8”, 15-5/8”, 16-1/8”, 16-5/8”
3/4 (intermediate)	14”	14”
1/2 (junior)	13”	13-1/4”

* Fractional size violins are sometimes strung up as violas for 14”, 13” and even 12” sizes. It would be appropriate to note that all violas are a proportional compromise in comparison to the violin; a truly proportional viola would have to be in excess of 18” to accommodate its tonal range. Of more importance is that the instruments have an appropriately “dark” tone.

Cello	Knilling MENC	Summit	Engelhardt
4/4	29-5/8”	29-7/8”—30-1/8”	29-3/4”
3/4	27-5/16”	27-1/2”	27-1/4”
1/2	25-1/2”	25-5/8”—25-7/8”	24-3/4”
1/4	22-7/8”	21”	
1/8	20”	17-7/8”	
1/10		15-7/8”	

Bass	Knilling MENC	Summit	Engelhardt
3/4	43-1/4” — 44-1/2”	43”	42-1/2”
1/2	41-1/4”	39-3/4”	36” (Jr.)
1/4	37-1/2”	37”	
1/8	33-1/2”		

MAKING YOUR OWN SIZING STICK FOR VIOLIN AND VIOLA

To help determine the correct size instrument for a student, make your own sizing stick by taking an ordinary yardstick, and marking off the following measurements:

Violin		Viola	
4/4	23-5/8”	16-1/2”	27-1/4”
3/4	22-1/4”	16”	26-3/8”
1/2	20-3/8”	15-1/2”	25-5/8”
1/4	18-1/2”	15”	24-7/8”
1/8	16-7/8”	14”	23-1/4”
1/10	15-3/8”	13”	21-6/8”
1/16	14-1/4”	12”	20-3/8”

To use: place the stick under the chin, in playing position, and, with left arm extended, measure to the middle of the palm to determine the approximate correct size.

An Ounce of Prevention

This section offers advice that will help keep your instrument and bow in good playing condition.

It is generally unwise to attempt to adjust or repair an instrument or bow yourself. Periodically take the instrument and bow to an experienced repair person for a check-up. She/he can quickly look over your instrument or bow; a small repair or minor adjustment early on can often prevent costly major repairs and overhauls down the road.

GENERAL CARE

- Keep the instrument and bow clean and in good repair. A little preventive maintenance goes a long way. An annual or bi-annual check-up is well-advised.

- Protect the instrument and bow from prolonged sun, or sudden changes in temperature or humidity. Care should also be taken to keep them away from heaters, radiators, and air conditioning vents. Never leave any instrument or bow in a car for any length of time.

- Let an instrument or bow have some time to adjust to changes in temperature or humidity before the case is opened. The more extreme the temperature or humidity difference, the longer the time that should be allowed for the instrument and bow to adjust to the change.

- Avoid leaving instruments or bows unattended, on a chair, or hanging from a stand. Never horseplay with or around an instrument or bow.

- Don't use alcohol or hot water to clean either instrument or bow, as these liquids can easily dissolve the varnish and/or cause damage to the wood.

- Always remove the shoulder rest or pad from violins or violas before putting them back into the case.

- Don't cram music, folders, or other personal items in the case with the instrument, as they may damage the instrument. Fit small items into the accessory compartments provided.

INSTRUMENT CARE

- Handle violins or violas by the neck and chinrest to minimize varnish wear. Using a cloth or pad between the instrument and the player will also help protect the varnish from perspiration.

- Violinists and violists who perspire profusely can drape a small cloth or pad over the chinrest; cellists and bassists typically use a cloth, or a bib fastened around the neck of the instrument, and draped between the back of the instrument and player's sternum.

- Be aware of jacket or shirt buttons, dangling earrings, bracelets, watches and jewelry; they are often the cause of scratches, dings and dents.

- Always wipe the body, fingerboard, and strings clean after playing, to remove rosin dust and dirt. Pay particular attention to wiping hand moisture off strings and fingerboard, and removing rosin dust from underneath the strings.

- A 100% cotton cloth picks up dirt most effectively. However, whatever the material, make sure to launder the cloth frequently.

- Placing a small blanket or cloth over the top of the instrument will help protect it, especially if it doesn't fit snugly in the case.

- Periodically check to make sure that the feet of violin or viola shoulder rests have not worn through the protective rubber tubing. Replacing the tubing when necessary will help preserve the areas where the feet contact the instrument.

- Ideal humidity for string instruments is around 55%; anything below 40% may be cause for concern, although appropriate humidity levels may vary, depending on different areas of the country.

- In winter, when artificial heat drives down humidity levels, a humidifier is advisable in rooms where instruments are kept or stored, to prevent cracking. Individual instrument humidifiers can also be helpful, when properly and consistently used, during winter months when humidity levels are low. However, if an instrument humidifier is used, make sure to wipe any excess moisture off the humidifier before inserting it in the f-hole.Moisture dripping down the inside of the instrument can cause regrettable damage.

- In areas where the humidity levels are high, an arch protector can be made to help inhibit possible arch collapse. This small rectangular block is typically made of folded cardboard, faced on the exterior to avoid damage to the varnish. It is lightly wedged under the fingerboard about halfway between the end of the fingerboard and where the neck joins the body (where the arching is highest), when the instrument is not being played.

- Watch the edges on instruments, especially celli; rough areas or tiny splinters have a tendency to snag on clothing or carpet and compound any damage to the edges or corners.

- Occasionally check under the tailpiece to make sure that the string adjuster lever is not pressing against the belly of the instrument. Over extension of the lever can damage the varnish and wood.

- When tuning strings, gently twist the peg inwards as the peg is turned to ensure firm contact between peg and peg hole; this will minimize peg slippage. A good visual image is to twist the peg into the peg hole as one would twist a cork into a cork bottle, using gentle but firm pressure.

- Each time an instrument is tuned, the top of the bridge has a tendency to be pulled slightly forward (or backwards, when fine tuners are used). Check the instrument each time it is tuned, to make sure the back of the bridge is still perpendicular to the top of the instrument and the bridge feet flush against the belly.

- Should the soundpost fall, do not continue to play the instrument; the pressure of the strings could collapse the unsupported top. Immediately loosen the strings and take the instrument to a repair person at the earliest opportunity.

- Should a crack be discovered, or a corner get knocked off, make sure to keep the exposed edges clean, so any repairs can be as unobtrusive as possible. Do not attempt to glue an open seam or crack; take the instrument to a qualified repair person at the earliest opportunity to avoid further damage.

BOW CARE

- Always hold a bow by the frog, not by the tip or hair, and carry it with the tip raised, cradling the fragile head; if the bow is dropped, it is better that the bow falls on its frog than on the delicate tip.

- Avoid contact between fingers and bow hair; oils from the skin on the hair will make it more difficult to draw a clear, resonant tone.

- Always loosen the hair after playing. This keeps it from stretching unduly, preserves the camber (sweep or curvature of the bow) and helps keep the bow from warping.

- Keep the bow *clean* by wiping the stick with a soft, clean, cotton cloth after playing. Pay particular attention to the area underneath the shaft between hair and stick.

- Never tap or strike the head of the bow against the stand, or swish the bow through the air to remove excess rosin.

- Make sure the bow hair is even and full. When the ribbon of hair becomes uneven due to broken hairs, the bow becomes more susceptible to warpage and needs to be rehaired.

- Should the hair stretch to the point that tightening does not allow sufficient tension for the hair to clear the stick, or if the hair becomes so short that the stick is under constant tension even when the screw is fully loosened, the hair will need to be shortened, lengthened, or the bow rehaired.

- It is unnecessary to rosin the bow every time an instrument is played; too much rosin produces a gritty sound. Apply rosin sparingly and evenly, drawing the bow hair over the rosin in even strokes. Rotating the rosin cake will prevent deep grooves from forming in it.

- To avoid damage from mites and insects which can destroy bow hair, keep your case off the floor, especially carpeted areas or closets. Where this problem is severe, a cedar block placed in the accessory compartment of the case may help repel these pests. Mothballs (napthalene) can be used, placed only in the accessory compartment, *not* the instrument case cavity. *Caution:* mothballs may have an adverse effect on the varnish of the instrument.

- On any bow, there is a tendency towards wearing out the edge of the leather thumb grip near the frog, causing the thumb to erode the wood underneath (especially for cellists). The leather thumb grip should be replaced, or a protective leather patch put on, to prevent further damage. Some players use a length of surgical rubber over this area to protect the stick.

- Avoid playing on the side of the stick, which will damage octagonal facets, and wear the stick. Players may vary the tension of the hair to accommodate the type of piece being played; an aggressive, fortissimo passage may require a slightly more tensioned stick.

"Providing music education for our children is an essential part of developing cultural literacy in this country. When people are culturally literate, it means that they can think about things on many different levels, consider things thoroughly, and make choices based upon an understanding of things spoken and unspoken. It means that people can be articulate about their ideas and feelings. It means they can promote excellence in all areas. There is no place that develops these skills like the study of music. Music enhances the education of our children by helping them make connections and broadening the depth with which they think and feel. If we are to hope for a society of culturally literate people, music must be a vital part of our children's education."

— Yo-Yo Ma, cellist

Practice Tips

In learning to play an instrument, progress is a process of adding new skills to ones already mastered. The following are some suggestions for students which may help them practice and learn more effectively.

- Record daily practice times on a chart.
- Schedule a regular time each day and adhere to the schedule.
- Don't put off practicing until the end of the day.
- Make practice sessions a habit. Consistent practice hastens and maintains progress.
- Focus on progress and improvement. Listen. Be calm and patient; improvement comes a step at a time.
- Don't become discouraged; there will be days when everything suddenly comes together. Effort and persistence are the keys.
- Review each lesson and set objectives to work on before each new practice session.
- Attend as many concerts and performances as possible. Watch how the performers play and interact. Much can be learned from performances of all types, whether chamber music, orchestra, opera, theater, or solo performance.
- Records, video tapes and compact discs can be valuable learning aids. Listen or watch, and learn different techniques and interpretations.
- Music is like a language. The greater the mastery of its grammar and structure, the more effectively musical interpretations can be communicated.
- Play music with peers and learn from each other. Read music with friends; enjoy and use new skills.
- Be sure regular academic classwork is maintained, and assignments made up if a class is missed to take a lesson or play in a concert.

J Strings

This section contains information on some of the different types of string available, and the advantages and/or disadvantages of each type of material. String selection for an instrument can be a very personal decision, based not only on the tonal characteristics of the instrument, but also on individual player preference.

Which strings to use?

The four basic types of core materials commonly used are: solid steel, rope or cable core steel, synthetic, and gut. Each type of core material has distinctly different tonal and playing characteristics.

The outer wrapping can be made from a wide variety of materials, including nylon, aluminum, chrome, steel, stainless steel, tinned steel, tungsten, nickel-silver, silver, silver-plate, and gold. Each material provides its' own unique tonal and tactile characteristics, as well as varying degrees of resistance to wear and corrosion (primarily from contact with the player's fingers.)

The selection of string type should depend on the age, construction, and individual characteristics of each instrument, and the kind of response and tonal qualities required. Many musicians mix different types and gauges of strings to obtain the desired sound and response. Gauge itself does not determine weight or tension, as gut strings are thicker than steel strings, and silver wound strings are thinner than aluminum wound strings.

Listed here are some of the characteristics of various popular types of strings.

Steel core

Generally used on new instruments because they are economical, and produce a large, bright volume of sound with a minimal break-in period. These strings have a solid steel core with an outer wrapping of stainless steel, chrome, steel, nickel–silver, or aluminum.

The advantages are:

1. Longer lasting than gut or synthetic core strings.
2. Unaffected by changes in temperature and humidity, which affect not only pitch retention, but also string life.
3. Bright, loud response with a minimum of effort.

Rope or spiral core

Rope core, spiral (or cable) core strings combine many of the virtues of gut with the durability and volume of steel core strings. The central core of the string consists of strands of fine wire twisted into a cable. The wire unit is then overlaid with a flatwrap of chrome steel, nickel–silver, silver, or tungsten.

The advantages are:

1. Exhibit much greater durability than gut core strings.
2. Unaffected by fluctuations in humidity or temperature.
3. More flexible in response and range than steel core strings.

Synthetic core

Synthetic cores strings typically have a nylon composition core, sometimes referred to as perlon, synlon, PET synthetic, or nylon core. In addition to a generally brighter and more focused response, synthetic core strings exhibit many of the characteristics of gut core strings in terms of subtlety and warmth, without gut's inherent sensitivity to external factors. Natural gut reacts to changes in humidity and temperature by shrinking or swelling, which not only causes the winding to eventually loosen, but affects the pitch and longevity of the string itself. The synthetic core, being inert, is practically unaffected by environmental factors, thereby greatly increasing the playing life of the string. The outer wrap of the string is typically flat wrapped with aluminum, silver plate, nickel–silver, or silver.

The advantages are:

1. Much more durable than gut.
2. Unaffected by changes in temperature and humidity.
3. Response and performance more similar to gut than either rope core or steel core strings.

Gut

Gut core strings are associated historically with the oldest type of strings found on musical instruments (and were used on the original Amati, Stradivari and Guarneri instruments).

Strings made from sheep gut are mentioned early in the history of string instruments. Although other materials such as tendons and horsehair were used, the discovery of an Egyptian lute dating from circa 1500 B.C. indicates that the Egyptians were well acquainted with the technique of manufacturing gut strings.

In the following centuries, twisted gut strings were probably the most common type of strings used. It was during the middle of the 17th century – at the time of Stradivari – that metal (initially copper) wound strings started gaining prominence. Eventually, these strings evolved into the modern metal wound strings in use today.

Many professional musicians, especially violinists, still prefer gut core strings on all but the E-string (which normally uses a plain or wound solid steel core string), however, perlon strings have become increasingly popular.

Players adhering to period performance practice also continue to use gut core strings to achieve the correct sound for Baroque and Classical performances.

The advantages are:

1. Excellent flexibility and feel.
2. Warm, brilliant tone without harshness.
3. Sensitive response and subtlety.

Miscellaneous notes on strings:

- For any given tuning, the thicker the string, the higher the tension; the higher the tension, the louder the string tends to play. However, increased tension can also adversely affect the tone.
- The string diameter of silver wound strings are thinner than corresponding aluminum wound strings, thus it is quite possible for a silver violin G-string to actually be thinner than an aluminum wound violin D-string.
- All 3/4 instruments can be equipped with 4/4 size strings, although strings made specifically for 3/4 size will, in general, be slightly thinner in diameter. Fractional size strings of one size can be utilized for the next smaller size, i.e. 3/4 can be used for both 3/4 and 1/2; 1/4 can be used for both 1/4 and 1/8, etc.
- The large size 4/4 viola tailpiece with built-in tuners can be used for 1/10 size cello, provided that the strings have small ball ends.
- Solo bass strings can be substituted for orchestra bass strings when thin gauge is desired.

Tips, Tricks and Trouble Shooting

This section addresses some of the more common problems players may encounter, and suggests some remedies.

My pegs are sticking (or slipping). What can I do?

Normal usage will eventually cause both the peg and the peg hole to wear, which may result in the pegs slipping or sticking, making tuning difficult. Ordinary chalk, applied to the areas of contact between the peg and peg box (which show up as shiny areas on the peg shaft), can help provide more grip. The operation of pegs that stick or are difficult to rotate may be improved by the use of peg dope or lead from a soft graphite pencil applied to the contact areas. Eventually, pegs may wear to the extent that replacement pegs will need to be fitted by a qualified repair person.

How can I tell if the bridge is on straight?

The feet of a properly cut bridge should follow the contour of the top perfectly, with no gaps. The fit of the bridge feet is critical because they serve as the conduit for transmitting vibrations between the strings and the rest of the instrument. If a bridge is tipped, the feet of the bridge will no longer be flush and in full contact with the top.

The bridge should be positioned so that the back side of the bridge (the side facing the tailpiece) is perpendicular to the top or belly of the instrument. The slightly beveled and breasted contour of the side facing the tailpiece can impart the illusion of the bridge being slightly tipped backwards; however, the back of the bridge should still be perfectly straight.

How can I tell if my bridge is in the right place?

While there are more precise methods of determining proper bridge location, an approximate placement can be achieved by aligning the feet of the bridge between the inner notches of the f-holes. If the bridge has been knocked off, the instrument, do not attempt to

replace the bridge before first checking to see that the instrument is undamaged and that the soundpost has not fallen. When in doubt, have the instrument checked by a qualified repair person. *Never* glue the bridge to the instrument.

How do I straighten my bridge?

A relatively safe technique for straightening a bridge is to carefully pinch the string right next to the bridge between thumb and forefinger. By squeezing the fingers together and rolling them against the bridge, lateral pressure is applied against the top face of the bridge, pushing it slightly backwards (or forwards, depending on which side the pressure needs to be applied). Repeat with each string, in turn, until the bridge is once again perpendicular. If the bridge is significantly warped, have the instrument serviced promptly, before the bridge collapses or breaks.

Better to have avoided this situation in the first place, by having checked that the bridge was perpendicular after each tuning; it is easier (and less traumatic) to correct a slight bridge lean, than have to address a situation where the bridge is substantially tilted and the feet are no longer in full contact with the top.

When do I need to change strings?

Strings will eventually lose their original responsiveness. Replace aging strings at regular intervals, commensurate with use. For some players, it may be a few months; for others, a few years. A general rule of thumb is to change strings every six months or so.

How do I change the strings on my instrument?

Replace strings one at a time, to prevent the soundpost from falling, and reduce stress on the instrument itself. Before removing the old strings, inspect the area around the nut and bridge; if the strings are being pinched, or have cut deeply into the grooves (they may even be flush with the top of the nut or bridge!), take the instrument to a qualified repair person for service. The strings should rest roughly a third of the way into the grooves.

After removing the old string, check the grooves in the nut and bridge for wear or sharp edges. A bit of soft pencil lead applied in the grooves

will reduce friction and help the string slide smoothly over the bridge or nut.

When string adjusters are not being used, pass replacement strings through the tailpiece holes from underneath the tailpiece. The string should then extend straight from the tailpiece hole, over the saddle or fret, to the bridge — do not thread the string back through the ball or loop at the end of the string. Wind the string on the pegs so that the string passes over the peg and not under it, and progresses from the peg hole towards the peg box walls. Make sure that the string does not overlap or cross over itself, nor contact the peg box wall.

Whether steel, nylon, or gut, take the time to gradually bring the string up to pitch. Avoid over-tuning, which may damage the strings, and guard against the top of the bridge being pulled forwards as new strings are being brought up to pitch.

Do I need to use string adjusters?

String adjusters, or fine tuners, need only be used when steel core strings are installed on an instrument. The relative elasticity of gut and synthetic core strings obviates the need for fine tuners with these more pliant core materials. E-strings in synthetic or gut core violin sets typically have a metal core, and E-string adjusters should always be installed with these strings.

For ease of tuning, many educators do request four fine tuners regardless of the type of string being used. Special wide slot string adjusters are commonly available for synthetic and gut core strings. Alternatively, the slot on a standard string adjuster may be carefully spread to accommodate the slightly thicker synthetic or gut core strings.

My string adjusters are stuck!

Often, when a string adjuster screw will no longer turn, it is because the arm of the adjuster has been fully extended. Care must be taken that the arm of the adjuster below the tailpiece is not pressing against the top of the instrument itself.

To remedy the situation, turn the adjustment screw counter-clockwise, and then raise the string back to pitch by using the peg. Usage of string adjusters which have protective sleeves (Buschmann tuners), will help prevent damage from the string adjuster.

Another possibility is that the adjuster simply needs to be lubricated. The screw threads could also be cross-threaded, or the screw shaft may be bent; if so, the string adjuster should be replaced.

When does my fingerboard need to be replaced?

Fingerboards can eventually wear out or become warped, and need to be replaned, scraped or replaced. Signs of wear include pits from fingers, longitudinal grooves from string wear, or overall warpage. The instrument may then buzz, or intonation problems may be experienced.

There's a buzz in my instrument.

Chances are, a buzz or rattling sound in the instrument is not caused by a loose bass bar, but something much more prosaic. Likely culprits include: loose sliding (Si-Hon-style) mute or loose string adjusters (don't forget to check the lock nuts, too), loose string winding, loose purfling or decorative fittings, loose or badly worn fingerboards (these often open at the base of the neck), and open seams or cracks.

By holding the instrument by the neck and gently rapping all around the top and back, an open seam can often be located by the slight rattle it will emit.

On celli, if too much of the endpin is retracted in the body, the pin may buzz when the instrument is played.

When new violins are varnished, sometimes a bit of varnish dries in the narrow opening of the f-hole, and when the instrument is played, the dried varnish buzzes.

What is a wolf tone?

Wolf tones occur when strong sympathetic vibrations from the instrument itself interfere with string vibration. The sensation may manifest itself in pulsation, throbbing, roughness, jump in frequency, or difficulty in drawing the tone from the instrument.

To a greater or lesser degree, wolf tones are present on all instruments, even the finest Stradivari, caused by excess tension, or an anomaly in design or graduation. Typically, wolf tones can be heard (and felt) when playing B or B flat on the violin, B flat or C on the viola, and E to F sharp on the cello (especially in fourth position on the G-string,).

Most good players learn to compensate for the wolf tone; proper vibrato can often make the wolf disappear; cellists often simply squeeze the lower bout with a knee when playing in areas where the wolf lurks.

What can I do if my instrument has a bad wolf tone?

Adjusting or refitting the soundpost or bridge, installing a thicker soundpost, or fitting an internal wolf resonator can help tame the wolf, but, before taking drastic steps, try the following options:

First, make sure that the instrument has no open seams or areas that have come unglued. A loose soundpost can often be the culprit, and may be caused by a loose bottom seam on the treble side, or even too much humidity, which causes the instrument to swell.

If the instrument is sound, try:

1. Changing the offending string to a thinner gauge string.

2. Using a Si-Hon style mute, which dampens the area around the tailpiece, or twisting a Tourte-style so it wedges between the strings.

3. Fitting a wolf-tone eliminator on the string behind the bridge. Moving the eliminator closer or further from the bridge can alter the pitch, and by placing it on a quarter tone or less vital note, reduce the frequency of the wolf to some degree. Once the optimum location is identified, the eliminator can then be locked in position by tightening the adjustment screw.

4. Altering the sympathetic vibration of the strings. One way is to fractionally lengthen the tailpiece loop (which will slightly shorten the overall string length).

5. Using a heavier tailpiece. Often, switching from a synthetic tailpiece to an ebony or metal tailpiece will noticeably reduce a wolf tone.

Can harmonics help tune my instrument?

Bowing while lightly touching a string at 1/2 its length, sounds a pitch an octave higher; 1/3 its length, an octave and a fifth; 1/4 its length, a double octave; 1/5 its length, two octaves and a third; and 1/6 its length, two octaves and a fifth. Familiarity with harmonics often facilitates tuning, especially for bass. Touching the D-string at 1/3 its length sounds the same pitch as touching the A-string

at 1/4 its length. This also applies to the other adjacent strings.

When should the bow be re-haired?

Generally, when the ribbon of hair is so thin that there are not enough to perform their function properly, or when the ribbon has become uneven, the bow should be rehaired. Playing on a bow that has had too many hairs broken on one side can actually cause the stick to warp. Caked or dirty hair can be cleaned occasionally with mild liquid detergent, but should only be done with utmost care taken not to get the bow wet — beware especially of capillary action wicking moisture into the mortises.

In winter, bow hair may shrink due to lack of humidity, preventing the bow from being properly loosened. Likewise, summer humidity may cause the hair to stretch to such an extent that the bow can no longer be tightened. Either scenario is reason enough to take the bow to a qualified repair person to shorten, lengthen, or even rehair the bow.

"Which of us, I wonder, has not pondered the great debt we owe to those strong individuals who taught us and the educational environment of our formative years that allowed and encouraged our minds and sensibilities to develop.

I fear for the generations to come in this increasingly materialistic society if they are to be further deprived of those aspects of our culture that can enrich our lives and provide a background for enlightened judgment in their later positions of responsibility.

All is not lost, but we must, all of us, exert ourselves to make sure that it is not. The Philistines are among us and would have us believe that the arts do not matter; that vocational training is all that education is about.

They are damnably wrong."

— Raymond Leppard, music director, Indianapolis Symphony Orchestra

Knilling Custom Shop Adjustment

Located in St. Louis, Missouri, the Knilling Custom Shop is staffed by dedicated men and women, experienced and skilled craftspeople committed to bringing out the best each instrument has to offer. Knilling standards of adjustment meet or exceed those established by the Music Educators National Conference (MENC). When you receive an instrument from us, you know it has received precise, painstaking attention to detail by craftspeople who take pride in their work. You are getting an instrument that lives up to the Knilling reputation.

BASIC ADJUSTMENT

Bridge

Each bridge on a Knilling instrument is hand carved for precise fit, proper string height and spacing. The soles of the bridge feet should fit flush to the top; the better the contact, the better the sound transmission. Each bridge has to be individually fit, because no two tops are alike.

Each bridge is also beveled or "breasted" on the side facing the fingerboard (the back of the bridge should always be straight, and perpendicular to the top), and the bridge thickness precisely tapered towards the top; properly removing the excess wood allows the bridge to vibrate more freely and improves the sound without weakening the bridge structurally.

String height and spacing is also important for proper playability; Knilling instruments are all adjusted to meet or exceed specifications established by MENC, the Music Educators National

Conference. Even the depths of the string grooves in the bridge are carefully maintained and lubricated for easy string passage.

Not only is the cut of the bridge important, but the quality of the basic blank itself is an important factor in any instrument's performance. A cheap bridge blank not only does not transmit vibrations well, but quickly warps and wears, necessitating costly premature replacement.

Pegs

Not only is every peg hand–fitted and lubricated for smooth and easy tuning, but the pegs ends are rounded, and fit flush for a professional finish. A superior grade of ebony is used for greater durability, and a special process employed when fitting the pegs to ensure that they don't shrink in the peg holes. String holes are drilled after the peg is fitted, and, care is taken that each string is wound on the pegs properly; over the peg and towards the peg box wall.

Buschmann tuners

On student violins, violas, and celli, when steel core strings are employed, Knilling installs four Buschmann string adjusters. A patented exclusive, the caps on the Buschmann tuners protect the instrument from tuner damage should the bridge get knocked out of place and the tailpiece collapse. Only quality German-made string hardware is used, to ensure long–term reliability and smooth performance.

Strings

While quality steel core strings are standard on most Knilling student instruments, substitutions are welcome. Therefore, if other types or brands of strings are desired, these requests can be accommodated without difficulty.

Fingerboards and nuts

In order to ensure that the strings will maintain proper clearance when played, the fingerboard of a string instrument must be precisely planed and dressed for correct curvature, and then refinished to produce a smooth playing surface. Look for a slight dish near the middle of the fingerboard; that is what allows the strings to be played in the upper positions without buzzing. In addition, each nut is carefully shaped, grooved, radiused, and lubricated so that the string passes smoothly over the nut. Each groove is spaced correctly and precisely

cut so that the string rests at the proper depth; one–third the diameter of the string.

The quality of ebony used is also important when you consider that instruments in a rental pool may be in service for many decades. We specify only superior quality ebony for the pegs, nut, fingerboard and tailpiece.

Soundpost

If you look through the f-holes of a violin, you will see the soundpost, a slender dowel of wood, positioned just under the treble foot of the bridge. It is held in position only by friction and string tension. Often referred to as the soul of the instrument, the fitting and placement of this innocuous-looking piece of spruce is critical to an instrument's performance. The soundpost for each Knilling instrument is individually cut, then custom fitted and positioned for proper voicing.

Synthetic tailpiece loop

More durable than gut, we only use proven quality synthetic tailpiece loops which are individually adjusted to the correct length, trimmed and then secured.

Chinrest

An ebonite Dresden model chinrest comes standard with most violins and violas. The smooth, shallow cup provides a comfortable contact surface.

Finally...

Before any Knilling instrument is shipped, it goes through a final inspection at a separate station outside the violin shop, where it is examined and polished before being outfitted with case and bow.

"Bach gave us God's World; Mozart gave us God's laughter; Beethoven gave us God's Fire; God gave us music that we may pray without words"

— From the facade of a German opera house

MASTER ADJUSTMENT

A step-up or master instrument will show a much higher degree of refinement in construction and selection of woods than a student instrument. However, even the best instrument will not play well unless it is set up well.

Whether adjusting an instrument that costs $500, $5,000, or $50,000, certain basic requirements remain the same: pegs must be properly fitted and finished; the fingerboard and nut correctly planed and dressed; the bridge must fit precisely, with correct height and string spacing; the soundpost accurately cut and positioned.

Many of the steps that are required to adjust a student instrument are shared by step-up or master instruments. However, here are a few aspects of a step-up adjustment which differentiates a Knilling Master Adjustment from a Basic Adjustment.

Bridge

One of the first things you are likely to notice, when you look at a master level Knilling instrument, is the bridge.

The Knilling Custom Shop uses only genuine French Jeandel Aubert bridge blanks on our step-up and master instruments. Their Aubert à Mirecourt Deluxe model bridge, which we use on our fine master violins, is the same model that can be found on many of the rare instruments played by soloists and symphony musicians around the world.

The carving of each bridge reflects professional refinement, designed to not only enhance the performance of the instrument, but also add an aesthetic appeal. Things to note include the elegant opening of the eyes and heart, the way the feet are trimmed to perfectly fit the contour of the top, the graceful curves and beveled edges of the sides, the slim taper and subtle breasting of the bridge face, decorative cuts above the feet and around the heart, a protective circle of parchment for the E-string, and burnishing of the bridge.

While all these distinctive touches take time and a high degree of skill (and talent), this devotion to detail and perfection is part of what marks Knilling as a genuine specialist in string instruments.

Strings

All Knilling step-up and master violins and violas come standard with premium perlon core strings.

Because synthetic core strings have much greater elasticity than steel core strings, string adjusters are not typically used; only an E-string adjuster is necessary. However, for those who so desire, our Knilling Custom Shop can install additional string adjusters and, should particular strings be preferred, we can accommodate almost any request.

Celli and basses come with premium chrome steel strings. Because the standard strings do have steel cores, all master celli come with four patented Buschmann fine tuners. Special requests for strings are welcome; for example, a popular substitution for celli are Jargar A and D strings.

Pegs

Step-up and master instruments present an opportunity to complement the premium tonewoods and refined craftsmanship with tastefully ornamented pegs, tailpiece, chinrest and endpin, which add both visual and aesthetic appeal. Hill-style, Parisian eye, brass diamond inlay ebony, rosewood, boxwood or tintul wood components are a few of the many options available.

*Specifications subject to change without notice.

"The credit in life goes not to the critic who stands on the sidelines and points out where the strong stumble. But rather the real credit in life goes to the person who's actually in the arena, whose face is marred with sweat and dust, who knows great enthusiasm and devotion for life and learns to spend himself at a worthy cause. If he wins, he knows the thrill of great achievement, and if he loses, at least he loses while daring greatly so that his place in life will never be with those cold and timid souls who know neither victory nor defeat."

— Theodore Roosevelt

Knilling Support Materials

Year–in and year–out, we present the breadth of the Knilling product line and educator support materials to string teachers who attend state, regional and national MENC conventions throughout the United States.

Since we are string specialists, the Knilling display is devoted exclusively to student and step-up string instruments, and to our excellent string support materials.

Knilling Educator and Training Aids

No company in the world offers as broad a range of quality recruiting and educational materials targeted to the string student as is offered by Knilling. String educators deeply appreciate the fact that their instruments are given the attention and focus they deserve. As a result, the Knilling name is recognized by string educators everywhere as representing strings and strings alone.

Knilling Custom Folios

Gorgeous, four color exterior with imprint space at the top. Interior contains a glossary of musical terms, plus care of instrument and bow and practice tips imprinted on the flaps.

No.KNOF87 - Large, full size (11-3/4" x 14") concert folio features elegant string instrument scrolls set against a matte black background.

No.KNOFLT - Smaller, compact (9-1/2" x 12-1/2") lite folio fits in any backpack. Exterior graphic features a violin and bow set against a cascade of sports paraphernalia.

Knilling Clinics

Available from Knilling, through authorized dealers, are clinics and workshops for students and educators, designed to open up the world of string instruments, ignite student interest, and motivate them to learn in refreshing new ways.

Knilling Videos

Knilling offers a number of exceptional videos, equally suitable for dealer, educator or classroom use.

"Violin Revealed" Video
What every educator wants every parent to know, this 13 minutevideo wascreated to help families and students understand the differences between a genuinely suitable instru ment and a "problem-prone" look-alike.
No.KNVRVHS - VHS format
No.VRDVD - DVD format

"Perfection Pegs Revealed" Video
Explore one of the most revolutionary innovations ever developed for the violin, viola and cello, the planetary geared Perfection Peg. This 12 miniute video also includes commentary from music educators.
No. VHS - PRVHS format
No. DVD - PRDVD format

"Music fosters learning, creative and critical thinking, and self-expression from early childhood through adulthood. I believe the full range of arts disciplines — music, visual art, dance, and theater — should be part of the core curriculum in public institutions and the institutions of higher learning and culture, e.g. colleges, museums, and libraries, should be arts education centers. The result will be increased awareness and sensitivity to the world around us and how to enhance our lives and environment through the arts.

In addition, stronger participation in arts education will lead to world-class competitiveness on the part of our citizenry at large, and in the academic, business, and professional communities in particular. Through the knowledge and practice of the arts comes an appreciation of multiple interpretations and an understanding of standards of excellence. Inventiveness has been the hallmark of American character; I believe comprehensive and sequential instruction on music and the other arts will enable our children to cooperate and compete more effectively with the other nations of the world."

— Richard S. Gurin,
President and CEO, Binney & Smith

Abridged Dictionary of Musical Terms

Dynamics

Pianissimo (pp) — *very soft*

Piano (p) — *soft*

Mezzo piano (mp) — *medium soft*

Mezzo forte (mf) — *medium loud*

Forte (mf) — *loud*

Fortissimo (ff/fff) — *very loud*

Dynamic Modifiers

Calando — *with decreasing volume*

Crescendo (Cres., <) — *gradually louder*

Decrescendo (Decres., Diminuendo, >) — *gradually softer*

Morendo — *dying away*

Peine entendu — *barely audible*

Piu — *more*

Rinforzando (Sforzando, rfz, sfz) — *sudden sharp accent*

Stinguendo — *fading away*

Tempi (from slow to fast)

Grave — *with gravity; solemn; very slow*

Largo — *broadly; very slow*

Larghetto — *very slow, but a little faster than Largo*

Lento — *slow*

Adagio — *literally means at ease; slowly*

Andante — *literally means at a walking tempo; moderately*

Andantino — *a little faster than Andante*

Moderato — *moderately*

Allegro — *literally means cheerful; fast*

Allegretto — *a tempo in between Allegro and Andante*

Presto — *very fast*

Prestissimo — *as fast as possible*

Tempo Modifiers

A tempo — *return to normal tempo*

Accelerando — *accelerate; play faster*

Allargando — *slowing down and becoming broader*

Appoggiando — *drawing out, lengthening*

Assai — *much, as in Allegro Assai; much faster*

Cedez — *slow down*

Con moto — *with motion*

Dopplo movimento (Doppelt so schnell) — *double speed*

L'Itesso — *the same*

Meno — *less*

Molto — *very*

Non troppo — *not too much*

Piu — *more*

Rallentando (Zuruckhalten, rallentir, ritardando) — *slowing down*

Rasch — *quick*

Ritenuto — *suddenly slower*

Rubato — *elastic, flexible tempo*

Schnell — *faster*

Sostenuto — *sustained*

Stringendo — *quickening; with growing excitement*

Tempo primo — *resume the original or first tempo*

Vivace — *lively*

Vivasissimo — *very quick*

Expressive Markings

Affabile — *sweetly and gently*

Affetuoso — *affectionate, tender*

Affretando — *hurrying*

Agitato — *agitated*

Animato — *lively*

Arioso — *lyric and expressive*

Attaca — *attack*

Aufgeregt — *excited*

Ausdrucksvoll — *expressively*

Bewegt — *animated, with motion*

Bravura — *dash, brilliancy*

Cantabile — *singing*

Capriccioso — *whimsical*

Comodo — *easy, comfortable*

Con brio — *with vigor*

Con calore — *with warmth*

Con fuoco — *with fire*

Deutlich — *clear, distinct*

Dolce — *sweet*

Doucement — *gently*

Doulereux — *sorrowful*

Duramanente — *harsh*

Eclatante — *brilliant, sparkling*

Empfindung, mit — *with emotion, with feeling*

En dehors — *emphasized*

Entscheiden (Entschlossen) — *resolute, determined*

Expressivo — *expressively*

Fastoso — *pompous*

Fierlich — *solemn*

Fiero — *high spirited; bold*

Fleissend (Fleissender) — *flowing, more flowing*

Frei — *free, with freedom*

Frolich — *joyful*

Garbato (con garbo) — *graceful, elegant*

Gelassen — *quiet, calm*

Gemachlich — *comfortable, leisurely*

Gemendo — *lamenting*

Gesangvoll — *songlike, cantabile*

Gescgwing — *quick, nimble*

Giocoso — *merry*

Giusto — *just right, as in Tempo Giusto; strict or fitting tempo*

Grazioso — *graceful*

Gusto — *with zest*

Hastig — *with haste, hurrying*

Heftig — *violent*

Innig — *heartfelt, tender*

Kraftig — *strong, vigorous*

Lacrimoso — *mournful*

Langsam — *slow*

Lebhaft (Lebendig) — *lively*

Leidenschaftig — *passionate*

Legato — *smooth*

Leggiero — *lightly*

Liscio — *smooth*

Lourd — *heavy*

Lusingando — *caressing*

Lustig — *merry, cheerful*

Lutuoso — *mourning*

Maestoso — *majestic*

Marcato — *stressed; with emphasis*

Markiert — *marked, stressed*

Markig — *vigorous*

Mesto — *sad*

Mezzo — *medium*

Morendo — *dying away*

Munter — *cheerful*

Nachdrucklich — *emphatic, expressive*

Patetico — *with great passion*

Pesante — *heavy, emphatic*

Piacevole — *pleasing, agreeable*

Pianamente — *smoothly, softly*

Placido — *tranquil; calm*

Precipitando — *rushing, impetuous*

Ruhig — *quiet*

Scherzando — *humorous*

Scherzhaft — *playful*

Schwungvoll — *animated, with spirit*

Semplice — *simple; unaffected*

Sempre — *always; still, as in Sempre Forte; still loud*

Sfoggiando — *ostentatious*

Slancio, con — *with dash*

Snello — *agile, nimble*

Soave — *gentle, sweet*

Sospirando — *sighing, plaintive*

Staccato — *detached, short*

Straziante — *anguished*

Strepitoso — *boisterous*

Tenuto — *held*

Traumerisch — *dreamy*

Treibend — *hurrying*

Unruhig— *restless*

Voile — *veiled*

Volante — *flying, rushing*

Zart — *tender, soft*

Bowings

Abstreich (tierez, tierer, tiere) — *down bow*

Aufstrich (poussez) — *up bow*

Am Steg — *near the bridge*

Am Frosch — *near the frog*

Am Griffbrett (sul tasto) — *near or over the fingerboard*

Arco — *with the bow*

Arpeggio — *arpeggiated, so that the notes of the chord are played one after the other instead of simultaneously*

Arrache — *forceful pizzicato*

Au chevalet — *close to the bridge*

Brise — *short detached strokes of the bow*

Col legno — *with the wood of the bow*

Col arco — *with the bow*

Detache — *detached single bowing, with slight articulation on each note*

Flautando (flautato) — *bowing lightly over the fingerboard to produce a flutelike effect*

Glissando (strisciando) — *sliding from one pitch to the other*

Jete (ricochet) — *"throwing" the upper part of the bow on the string so that it will bounce a series of rapid notes on the down bow*

Loure — *slight seperation of notes taken in a slur*

Martele — *"hammered" bowing, with a forceful, sudden release*

Pizzicato — *plucked*

Saltando (sautille) — *light, bouncing strokes taken in the middle of the bow*

Staccato — *short, detached strokes*

Sul — *on; as in Sul G; play on the G string*

Sul ponticello — *close to the bridge*

Sul tasto (sur la touche) — *near or over the fingerboard*

Talon — *at the frog*

Tremolo — *short, rapidly repeated strokes on one note*

Tenuto — *sustained*

Miscellaneous terms

A piacere — *at the performers discretion*

Al fine — *to the end*

Al segno (a.s.) — *to the sign*

Alta — *higher, as in 8va Alta; play one octave higher*

Ancora — *again, repeat (more), as in Ancora Piu Forte; still louder*

Anfang — *from the beginning*

Attaca — *attack; go to the next section or movement without a break*

Aufstrich — *up bow*

Bassa — *lower, as in 8va Bassa; play one octave lower*

Begleitung — *accompaniment*

Bis — *repeat*

Cadenza — *extended section, usually for a solo in a free, improvisatory style*

Coda — *closing section of a movement*

Come prima — *as at first*

Con — *with, as in con brio; with spirit*

Da capo — *from the beginning*

Dal segno — *from the sign*

Dampfer — *mute*

Divisi (div.) — *divided*

Fine — *end*

GP — *general pause*

Luftpause — *breathing rest*

Oberstimme — *upper part*

Ossia — *alternate passage, usually easier*

Ottava (8va) — *octave*

Pocco — *a little*

Senza — *without, as in Senza Sordino; play without the mute*

Simile — *continue in the same manner*

Sordino — *mute*

Subito — *suddenly*

Sul — *on, as in Sul G; play on the G string*

Tacet — *silent*

Tutti — *all*

Volti — *turn; as in Volti Subito; turn (the page) quickly*

0 Weights and Measures

Customary U.S. Weights and Measures

Linear Measure

12 inches (in.) = 1 foot (ft.)

3 feet = 1 yard (yd.)

5 1/2 yards = 1 rod (rd.), pole or perch (16-1/2 ft.)

40 rods = 1 furlong (fur.) = 220 yards = 660 feet

8 furlongs = 1 statute mile (mi.) = 1,760 yds = 5,280 ft.

3 land miles = 1 league

5,280 feet = 1 statute or land mile

6,076.11549 feet = 1 international nautical mile

Area Measure

144 square inches = 1 sq. ft.

9 square feet = 1 sq. yd.= 1,296 sq. in.

30-1/4 sq yds = 1 sq. rd. = 272 1/4 sq. ft.

160 square rods = 1 acre = 4,840 sq. yds. = 43,560 sq. ft.

640 acres = 1 sq. mile

1 mile square = 1 section (of land)

6 mile square = 1 township = 36 sections = 36 sq. mi.

Cubic Measurement

1,728 cubic inches = 1 cu. ft.

27 cubic feet = 1 cu. yd.

Liquid Measure

When necessary to distinguish the liquid pint or quart from the dry pint or quart, the word "liquid" or the abbreviation "liq" should be used in combination with the name or abbreviation of the liquid unit.

4 gills (gi.) = 1 pint (pt.) (= 28.875 cu. in.)

2 pints = 1 quart (qt.) (= 57.75 cu. in.)

4 quarts = 1 gallon (gal.) (231 cu. in.) = 8 pts. = 32 gills

Apothecaries Fluid Measure

60 minims (min.) = 1 fluid dram (fl. dr.) (= 0.2256 cu. in.)

8 fluid drams = 1 fluid oz. (fl. oz.) (= 1.8047 cu. in.)

16 fluid ounces = 1 pt. (= 28.785 cu. in.) = 128 fl. drs.

2 pints = 1 qt (= 57.75 cu. in.) = 32 fl. oz. = 256 fl. drs.

4 quarts = 1 gal (= 231 cu. in.) = 8 pts = 1,024 fl. drs.

Dry Measure

When necessary to distinguish the dry pint or quart from the liquid pint or quart, the word "dry" should be used in combination with the name or abbreviation of the dry unit.

2 pints = 1 quart (qt.) (= 64.2006 cu. in.)

8 quarts = 1 peck (pk.) (= 537.605 cu. in.) = 16 pts

4 pecks = 1 bushel (bu.) (= 2,150.42 cu. in.) = 32 qts

Avoirdupois Weight

When necessary to distinguish the avoirdupois dram from the apothecaries dram, or distinguish the avoirdupois dram or ounce from the fluid dram or ounce, or to distinguish the avoirdupois ounce or pound from the troy or apothecaries ounce or pound, the word "avoirdupois" or the abbreviation "avdp." should be used in combination with the name or abbreviation of the avoirdupois unit. (The "grain" is the same in avoirdupois, troy and apothecaries weights)

27 11/32 grains = 1 dram (dr)

16 drams = 1 oz = 437 1/2 grains

16 ounces = 1 pound (lb) = 256 drams = 7,000 grains

100 pounds = 1 hundred weight (cwt)*

20 hundredweights = 1 ton (tn) = 2,000 lbs.*

In "gross" or "long" measure, the following values are recognized:

112 pounds = 1 gross or long cwt*

20 gross or long hundredweights = 1 gross or long ton = 2,240 lbs.

* When the terms "hundredweight" and "ton" are used unmodified, they are commonly understood to mean the 100-pound hundredweight and the 2,000-pound ton, respectively; these units may be designated "net" or "short" when necessary to distinguish them from the corresponding units in gross or long measure.

Circular Measure

Second (“) = 1/60 minute

Minute (‘) = 60 seconds

Degree (°) = 60 minutes

Right angle = 90 degrees

Straight angle = 180 degrees

Circle = 360 degrees

Troy Weight

24 grains = 1 pennyweight (dwt)

20 pennyweights = 1 ounce troy (oz t) = 480 grains

12 ounces troy = 1 pound troy (lb t) = 240 pennyweights = 5,760 grains

Apothecaries Weights

20 grains = 1 scruple (s ap)

3 scruples = 1 dram apothecaries (dr ap) = 60 grains

8 drams apothecaries = 1 ounce apothecaries (oz ap) = 24 scruples = 480 grains

12 ounces apothecaries = 1 pound apothecaries (lb ap) = 96 drams apothecaries = 288 scruples = 5, 760 grains

Customary Metric Conversions (approximate)

Customary

Inches (in) x 25.4 = millimeters

Feet (ft) x .3 = meter

Yards (yd) x .9 = meters

Miles (mi) x 1.6 = kilometers

Square inches (in^2) x 6.5 = sq centimeters

Spuare Feet (ft^2) x .1 = sq meter

Square yards (yd^2) x .8 = sq meter

Acres x .4 = hectare

Cubic Feet (ft^3) x .03 = cu meter

Cord (cd) x 3.6 = cu mete

Quarts (lq) (qt) x .9 = liter

Gallons (gal) x .004 = cu meters

Ounces (oz) (avdp) x 28.4 = grams

Pounds (lb) (avdp) x .5 = kilogram

Horsepower (hp) x .7 = kilowatt

Degrees Fahrenheit (-32) x 5/9 = degrees Celsius

Metric

Millimeters (mm) x .04 = inch

Meters x 3.3 = feet

Meters (m) x 1.1 = yards

Kilometers x .6 = mile

Sq centimeters (cm^2) x .2 = sq inch

Sq meter (m^2) x 10.8 = sq feet

Sq meter (m^2) x 1.2 = sq yards

Hectare (ha) x 2.5 = acres

Cu meters (m^3) x 35.3 = cu feet

Liters (l) x 1.1 = quarts (lq)

Cu meters (m^3) x 284.2 = gallons

Grams (g) x .04 = ounce (avdp)

Kilograms (kg) x 2.2 lbs (avdp)

Kilowatts (kW) x 1.3 = horsepower

Degrees Celsius x 9/5 + 32 = degrees Fahrenheit

Units of Length and Area

Customary	Metric
Inch (in)	= 25.4 millimeters
Foot (ft)	= 12 in - .305 meter
Yard (yd)	= 36 in or 3 ft = .914 meter
Mile (mi)	= 5,280 ft = 1.609 kilometer
In^2 (sq in)	= 6.453 cm^2
Ft^2 (sq ft)	= 144 sq in = .093 m^2
Yd^2 (sq yd)	= 1,296 sq in = .836 m^2 = 9 sq ft
Acre	= 43,560 sq ft = .405 ha
$Mile^2$ (sq mi)	= 640 acres = 2.59 km^2

Metric	Customary
Millimeter (mm)	= .001 meter = .039 inch
Centimeter (cm)	= .01 meter = .394 inch
Decimeter (dm)	= .1 meter = 3.937 inch
Meter (m)	= 3.281 feet
Kilometer (km)	= 1,000 meters = .621 mile
Sq millimeter (mm^2)	= .000001 m^2 = .002 sq in
Sq centimeter (cm^2)	= .0001 m^2 = .155 sq in
Sq decimeter (dm^2)	= .01 m^2 = 15.5 sq in
Sq meter (m^2)	= 10.764 sq ft
Hectare (ha)	= 10,000 m^2 = 2.471 acres
Sq kilometer $(km)^2$	= 1,000,000 m^2 = .386 sq miles

Metric Weights and Measures

	Approximate U.S. Equivalent
10 millimeters (mm) = 1 centimeter (cm)	0.59 in
10 centimeters = 1 decimeter (dm) = 100 millimeters	3.94 in
10 decimeters = 1 meter (m) = 1,000 millimeters	39.37 in
10 meters = 1 dekameter (dam)	32.81 ft
10 dekameters = hectometer (hm) = 100 meters	109.36 yds
10 hectometers = 1 kilometer (km) = 1,000 meters	.62 mi
10 kilometers = 1 myriameter (mym) = 10,000 meters	6.2 mi

Area Measure

	Approximate U.S. Equivalent
100 square millimeters (mm^2) = 1 sq centimeter (cm^2)	0.155 sq in
10,000 square centimeters = 1 sq meter (m^2) = 1,000,000 sq millimeters	10.76 sq ft
100 square meters = 1 are (a)	119.60 sq yds
100 ares = 1 hectare (ha) = 10,000 sq meters	2.47 acres
100 hectares = 1 sq kilometer (km^2) = 1,000,000 sq meters	0.3861 sq mi.

Volume Measure

	Approximate U.S. Equivalent		
	cubic	dry	liquid
10 milliliters = 1 centiliter (cl)	0.6 cu in		0.338 fl oz
10 centiliters = 1 deciliter (dl) = 100 milliliters	6.1 cu in	0.18 pt	0.21 pt
10 deciliters = 1 liter (l) = 1,000 milliliters	61.02 cu in	0.908 qt	1.057 qts
10 liters = 1 dekaliter (dal)	0.35 cu ft	1.14 pk	2.64 gal
10 dekaliters = 1 hectoliter (hl) = 100 liters	3.5 cu ft	2.84 bu	
10 hectoliters = 1 kiloliter (kl) = 1,000 liters	1.31 cu yds		

Cubic Measure

1,000 cubic millimeters (mm^3) = 1 cu centimeter (cm^3 or cc)	0.061 cu in
1,000 cubic centimeters = 1 cu decimeter (dm^3) = 1,000,000 cu millimeters	35.35 cu ft
1,000 cubic decimeters = 1 cu meter (m^3) = 1 stere = 1,000,000 cu centimeters = 1,000,000,000 cu millimeters	1.31 cu yds

Weight

10 milligrams = 1 centigram (cg)	0.154 gr
10 centigrams = 1 decigram (dc) = 100 milligrams	1.543 gr
10 decigrams = 1 gram (g) = 1,000 milligrams	0.035 oz
10 grams = 1 dekagram (dag)	0.353 oz
10 dekagrams = 1 hectogram (hg) = 100 grams	3.527 oz
10 hectograms = 1 kilogram (kg) = 1,000 grams	2.2046 lbs
100 kilograms = 1 quintal = 100,000 grams	220.46 lbs
1,000 kilograms = 1 metric ton (t)	1.1 tn

Gunter's or Surveyor's Chain Measure

7.92 inches =1 link (li)

100 links = 1 chain (ch) = 4 rods = 66 feet

80 chains = 1 statute mile = 320 rods = 5.280 feet

Units of Weight (or Mass)

Customary

Avoirdupois[1]

Grain = .065 gram

Ounce (oz avdp) = 437.5 grains = 28.350 grams = 16 drams

Pound (lb avdp) = 7,000 grains = .454 kilograms = 16 ounces

Hundredweight (cwt) = 100 pounds = 45.359 kg

Ton, short (tn) = 2,000 pounds = .907 metric tons

Ton, long or gross = 2,240 pounds = 1.016 metric tons

Ounce (oz troy)[3] = 480 grains = 31.104 grams

Pound (lb troy) = 5,760 grains = .373 kilogram = 12 ounces

Metric

Gram(g) = .035 oz avdp = 0.32 oz troy

Dekagram (dag) = 10 g = .353 oz avdp = .322 oz troy

Hectogram (hg) = 10 g = 3.527 oz avdp = 3.215oz troy

Kilogram (kg) = 1,000 g = 2.205 lb avdp = 2.679 lb troy

Metric ton = 1,000 kg = 1.102 short tons = .984 long ton

[1] For weighing ordinary commodities
[2] For weighing precious metals, jewels, etc.
[3] Also known as fine ounces

Units of Capacity

Liquid

Fluid ounce (fl oz) = 29.573 ml

Pint (pt) = 16 fl oz = .473 liter

Quart (qt) = 32 fl oz = 2 pt = .946 liter

Gallon (gal) = 8 pt = 4 qt = 3.785 liters

Dry

Pint (pt) = .551 dm^3

Quart (qt) = 2 pints - 1.101 dm^3

Peck (pk) = 8 quarts = 8.810 dm^3

Bushel (bu) = 32 quarts = 35.238 dm^3

Metric

Milliliter (ml) = .001 liter

Liter (l)

Hectoliter (hl) = 100 liters

Customary

= .034 fl oz (liquid) = .002 pt (dry)

= 1.057 qt (liquid) = .908 qt (dry)

= 26.418 gal (liquid) = 2.838 qt (dry)

Customary/Metric Equivalents

Length

1 angstrom (light wave measurement)[1]	0.1 millimicron = 0.0001 micron = 0.000 000 1 millimeter = 0.000 000 004 inch
1 cable length	120 fathoms = 720 feet = 219.456 meters
1 centimeter	0.3937 inch
1 chain (Gunter's or surveyor's)	66 feet = 20.1168 meters
1 decimeter	3.937 inches
1 dekameter	32.808 feet
1 fathom	6 feet = 1.8288 meters
1 foot	0.3048 meters
1 furlong	10 chains (surveyor's) = 660 feet = 200 yards = 1/8 statute miles = 201.168 meters
1 inch	2.43 centimeters
1 kilometers	0.621 mile
1 league (land)	3 statute miles = 4.828 kilometers
1 link (Gunter's or surveyor's)	7.92 inches = 0.201 168 meter
1 meter	39.37 inches = 1.094 yards

1 mil	0.001 inch = 0.025 4 millimeter
1 mile (statute or land)	5,280 feet = 1.609 kilometers
1 mile (nautical international)	1.852 kilometers = 0.999 U.S. nautical miles
1 millimeter	0.03937 inch
1 millimicron (mμ)	0.001 micron = 0.000 000 03937 inch
1 nanometer	0.001 micrometer = 0.000 000 039 37 inch
1 point (typography)	0.013 837 inch = 1/72 inch(approximately) = 0.351 millimeter
1 rod, pole or perch	16-1/2 feet = 5.0292 meters
1 yard	0.9144 meter

Capacities or Volumes

1 barrel, liquid	31 to 42 gallons[2]
1 barrel, standard for fruit, vegetables and other dry commodities except cranberries	7,056 cubic inches = 105 dry quarts = 3.281 bushels, struck measure
1 barrel, standard, cranberry	5.286 cubic inches = 86 45/64 dry quarts = 2.709 bushels, struck measure
1 bushel (U.S.), struck measure	2,150.42 cubic inches = 35.238 liters
1 bushel (U.S.), heaped	2,747.715 cubic inches = 1.278 bushels, struck measure[3]
1 cord (firewood)	128 cubic feet
1 cubic centimeter	0.061 cubic inches
1 cubic decimeter	61.024 cubic inches
1 cubic foot	7.481 gallons = 28.316 cubic decimeters
1 cubic inch	0.554 fluid ounces = 4.433 fluid drams = 16.387 cubic centimeters
1 cubic meter	1.308 cubic yards
1 cubic yard	0.765 cubic meters
1 cup, measuring	8 fluid ounces = 1/2 liquid pint
1 dram, fluid or liquid (U.S.)	1/8 fluid ounces = 0.226 cubic inch = 3.697 milliliters = 1.041 British fluid drachms
1 dekaliter	2.642 gallons = 1.135 pecks
1 gallon (U.S.)	231 cubic inches = 3.785 liters = 0.833 British gallon = 128 US fluid ounces
1 gallon (British Imperial)	277.42 cubic inches =1.201 US gallons = 4.546 liters = 160 British fluid ounces
1 gill	7.219 cubic inches = 4 fluid ounces = 0.118 liter
1 hectoliter	26.418 gallons = 2.838 bushels
1 liter	1.057 liquid quarts = 0.908 dry quarts = 61.024 cubic inches
1 milliliter	0.271 fluid drams = 16.231 minims = 0.061 cubic inches
1 ounce, fluid or dry (U.S.)	1.805 cubic inches = 29.574 milliliters = 1.041 British fluid ounces
1 peck	8.810 liters
1 pint, dry	33.600 cubic inches = 0.551 liters
1 pint, liquid	28.875 cubic inches = 0.473 liter
1 quart, dry (U.S.)	67.201 cubic inches = 1.101 liters = 0.969 British quart
1 quart, liquid (U.S.)	57.75 cubic inches = 0.946 liters = 0.833 British quart
1 quart (British)	69.354 cubic inches = 1.032 U.S. dry quarts = 1.201 U.S. liquid quarts

1 tablespoon, measuring	3 teaspoons = 4 fluid drams = 1/2 fluid ounce
1 teaspoon, measuring	1/3 tablespoon = 1 1/3 fluid drams
1 assay ton[4]	29.167 grams
1 carat	200 milligrams = 3.086 grains
1 dram, apothecaries	60 grains = 3.888 grams
1 dram, avoirdupois	22 11/32 (= 27.344) grains = 1.772 grams
1 grain	64.798 91 milligrams
1 gram	15.432 grains = 0.035 ounce, avoirdupois
1 hundredweight, gross or long[5]	112 pounds = 50.802 kilograms
1 hundredweight, net or short	100 pounds = 45.359 kilograms
1 kilogram	2.205 pounds
1 microgram [µg (the Greek letter mu in combination with the letter g)]	0.000 001 gram
1 milligram	0.015 grain
1 ounce, avoirdupois	437.5 grains = 0.911 troy or apothecaries ounces = 28.350 grams
1 ounce, troy or apothecaries	480 grains = 1.097 avoirdupois ounces = 31.103 grams
1 pennyweight	1.555 grams
1 point	0.01 carat = 2 milligrams
1 pound, avoirdupois	7,000 grains = 1.215 troy or apothecaries pound = 453.592 37 grams
1 pound, troy or apothecaries	5,760 grains = 0.823 avoirdupois pound = 373.242 grams
1 ton, gross or long	2,240 pounds = 1.12 net tons = 1.016 metric tons
1 ton, metric	2,204.623 pounds = 0.984 gross tons = 1.102 net tons
1 ton, net or short	2,000 ponds = 0.893 gross ton = 0.907 metric ton

Areas of Surfaces

1 acre	43,560 square feet = 4,850 square yards = 0.405 hectare
1 are	119.599 square yards = 0.025 acre
1 hectare	2.471 acre
1 square centimeter	0.155 square inch
1 square decimeter	15.5 square inches
1 square foot	929.030 square centimeters
1 square inch	6.4516 square centimeters
1 square kilometer	0.386 square mile = 247.105 acres
1 square meter	1.196 square yards = 10.764 square feet
1 square mile	258.999 hectares
1 square millimeter	0.002 square inch
1 square rod (sq pole or sq perch)	25.293 square meters
1 square rod (sq pole or sq perch)	0.836 square meters

[1] The angstrom is basically defined as 10^{10} meter

[2] There are a variety of "barrels" established by law or usage. For example, federal taxes on fermented liquors are based on a barrel of 31 gallons; many state laws fix the "barrel for liquids" at 31 1/2 gallons; one state fixes a 36-gallon barrel for cistern measurements; federal law recognizes a 40-gallon barrel for "proof spirits"; by custom, 42 gallons comprise a barrel of crude oil or petroleum products for statistical purposes, and this equivalent is recognized "for liquids" by four states.

[3] Frequently recognized as 1 1/4 bushels, struck measure.

[4] Used in assaying. The assay ton bears the same relation to the milligram that a ton of 2,000 pounds avoirdupois bears to the troy ounce; hence the weight of in milligrams of precious metal obtained from one assay ton of ore gives directly the number of troy ounces to the net ton.

[5] The gross or long ton and hundredweight are used commercially in the Untied States to only a limited extent, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight".

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