

# Musical Instruments

This year, two students investigated the science behind musical instrument construction. Specifically, they looked at construction techniques, materials selection, and the history of violins and guitars.

The Violin

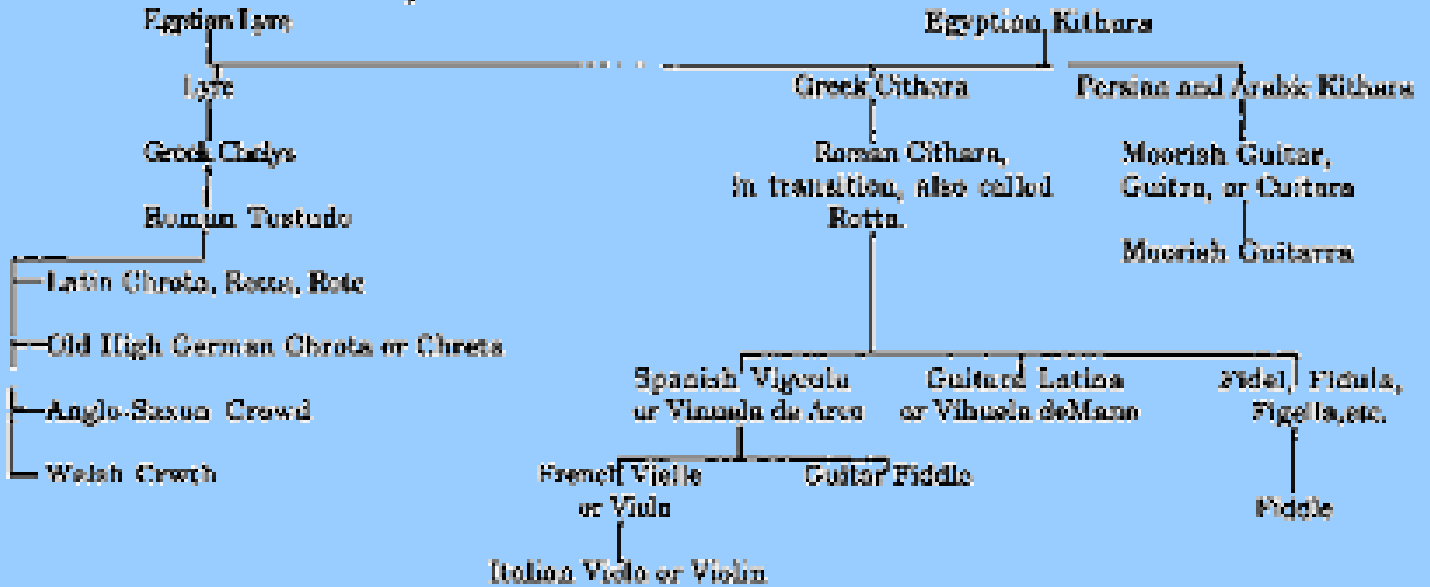
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The Guitar

Coming Soon!

# History of the Violin

## • Outline: Precursors of the Violin

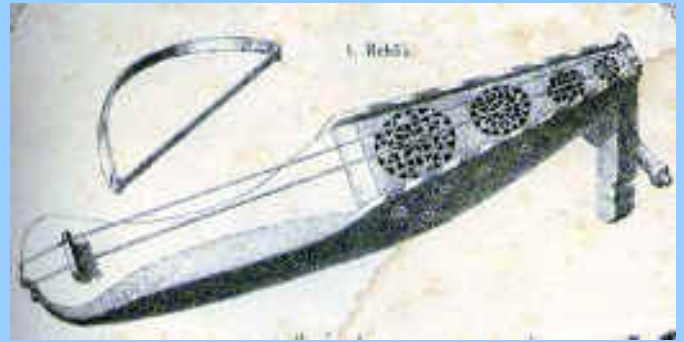


The violin wasn't invented by one person; rather, it evolved from several earlier stringed instruments. The major ancestors of the violin were the Arabic rabab, the medieval rebec, the Renaissance fiddle, and the lira di braccio. The pear-shaped rebec (influenced by the rabab) had strings that were tuned in fifths, and this system was adopted for the violin. However, the shape of the violin was taken from the fiddle and the lira di braccio, as these larger instruments produced a bigger sound and the hourglass shape made bowing easier. The creation of the violin was an ongoing process, so it is difficult to say when the instrument that most resembles a modern violin first appeared; one theory is that violins as we know them were first invented around 1520 A.D. in northern Italy. This date is chosen because this was when the first painting including a violin was made—the Madonna of the Orange Trees by Gaudenzio Ferrari.

The Arabic Rabab, or Rababah, is the earliest known bowed instrument and the parent of the medieval European rebec. The rabab has a membrane belly made of animal skin or wood and one to three strings. There is normally no fingerboard, and body shapes vary. Pear- and boat-shaped rababs were particularly common and influenced the rebec.



- First mentioned in the 10th century
- Has one to three strings
- No fingerboard
- Typically played across the lap, like a guitar
- Bowed
- Sometimes made of animal skin
- Has many shapes—pear and boat shapes most popular



The Rebec provided for the uniform fifth tuning system which contributed to a more consistent fingering technique and had the lateral tuning pegs which make for easier tuning. It did, however, have fewer strings than the modern violin, typically around three.

- Dates back to the thirteenth century
- Contains soprano, alto, bass members in family
- Has three strings, tuned in 5ths
- Pegs are laterally inserted into peg box
- No frets
- Pear-shaped body; neck and peg box integral parts of body
- Playing position at the breast or neck
- Bowed, held overhand
- No sound post



**The Renaissance Fiddle** provided a greater sonority of sound due to its sound post and flat sound box. It also had a separate neck and fingerboard, and was a more efficient, easier-playing instrument.

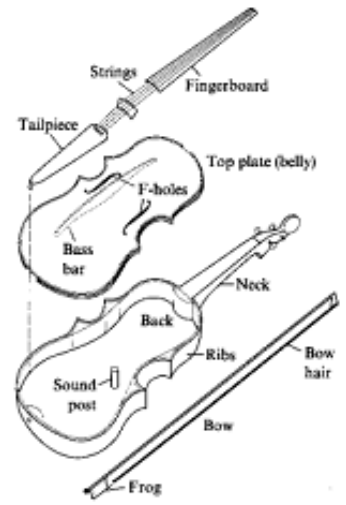
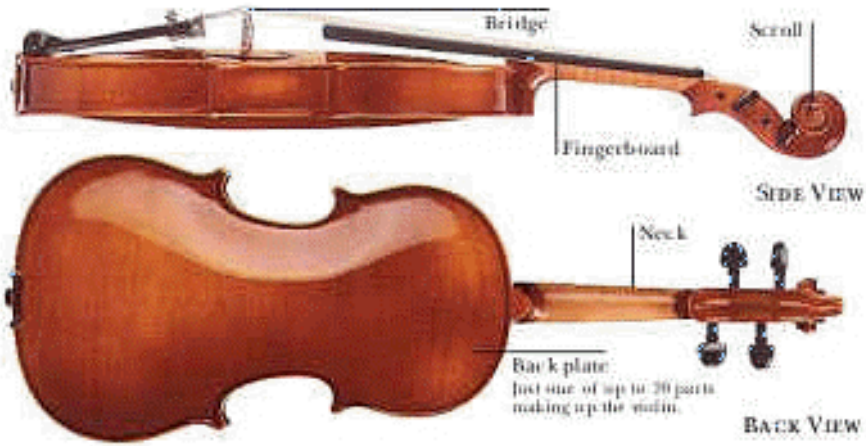
- Has five strings, one of which may be a drone Soprano register
- Constructed of a top and back with connecting ribs
- Has separate neck, peg box, fingerboard
- Has frets
- Front pegs, heart or leaf-shaped peg box
- Oval or indented shape

**The lira di braccio, or lira da braccio**, (a species of fiddle from the 15<sup>th</sup> century) had the typical violin outline, including the upper, lower and middle ("waist") bouts, an arched top and back, and connecting ribs and overhanging edges. The sound holes, now called f-holes, were indeed f- (or C-) shaped. These instruments occasionally had frets, and always had turning pegs set horizontally in a heart-shaped peg box.

- Close body outline, size varying from small to large
- Arched top and back, overhanging edges, ribs
- Sound post
- Seven strings, two of which were drones and ran off the fingerboard.
- Occasionally had frets
- Tuning pegs set horizontally in heart or leaf shaped peg box
- f or C-shaped sound holes



# VIEWS



Continued on next page.

# Construction of a Modern Violin



First the wood is cut out according to a pattern. (left)

Then wood blocks are added and the side is wrapped around. (right)



The back can be made from a single sheet of wood, or two pieces joined together, while the front is made from only a single sheet.

The picture on the left is of two pieces being joined for the back, and the picture on the right is of the back being cut into the proper shape. The front would also be cut this way.



The front and back are planed and sanded smooth



The inlay, or purfling, is made of three separate strips of wood. It protects the edges of the face and back.



This is the finished top with "f" holes and bass bar. The bass bar broadens the resonating field of the lower strings.



The scroll is carved from a solid piece of wood.





## Which Wood?

Wood in and of itself has very poor acoustical qualities. It is stiff, knotted, and full of dried sap. Before it can be used for violins, it must be seasoned and treated so that it has good resonance and tone. There is no exact science to finding the perfect wood. All a craftsman can do is follow general guidelines, and go by feel. Some details, however, are common knowledge.

- A violin is never made from just one type of wood—usually the back, ribs, and neck of a violin are made from sycamore or maple, while spruce is generally used for the belly. Even within the maple and spruce families, violin makers prefer specific varieties—for maple, acer pseudoplatanus or acer platanoides, while for spruce craftsmen prefer picea abies or picea excelsa. These woods give the best resonance.
- The wood must be carefully selected—for example, the spruce must have a compact, even, and fine grain.
- Wood must be seasoned, typically for eight to ten years, before it can be used. If fresh wood is used it will distort, check, and split.

Violin makers today often try to reproduce the tone of violins made in Cremona, Italy, during the mid sixteenth and seventeenth centuries, because violins from this period are thought to have a purer tone quality. Unfortunately, violin makers such as Amati, Guarneri, and Stradivari didn't document their techniques, preferring to keep them trade secrets. For this reason, craftsmen today try a variety of remedies to find the perfect wood.

- Some violin makers treat their wood with chemicals, while others boil it or smoke it over manure.
- One belief is that wood grown at high altitudes, which has suffered harsh conditions such as poor soil and cold weather, has better sound qualities. This might sound like folk lore, but it is true that wood grown too quickly in lush environments and rich soil generally tends to be less resonant and less able to withstand the stresses it is subjected to in the finished state.
- Another technique is to air-dry wood instead of kiln-drying it. This allows the wood to better withstand the tension of the strings.
- Some violin makers store the trunk upright for some weeks in an attempt to let the sap settle.



- Common techniques to test wood include biting the wood to test its strength and letting the wood fall and listening to its "ring."
- After a tree is felled, it is very important is to debark the wood as soon as possible to prevent insect and fungus growth between the bark and the cambrium.

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## Craftsmen of the Cremona

**Andrea Amati**, born in 1511, was one of the earliest violin makers. He started the Amati Legacy of making violins. Amati always made violins in matched pairs, the most famous of which was a pair of instruments made during the 1560's and 1570's for the court of Charles IV of France. Very few of his violins remain, but there are some that can be viewed in museums across the world.

**Nicolo Amati** (1596-1684) was one of the greatest makers in the Amati Dynasty. He taught students such as Antonio Stradivari and Giuseppe Antonio Guarneri how to make violins.

**Giuseppe Guarneri** (1698-1744) was one of the finest violin-makers of all-time. Guarneri is commonly referred to as "del Gesu" because of the initials I. H. S. and since he signed all his violins with a cross. He deviated widely from family tradition, developing instruments uniquely his own. There are very few of his instruments left today.

**Antonio Stradivari** (1644-1737) is probably the most famous violin maker. When he was a child he served as an apprentice to Nicolo Amati before he began making violins at the age of eleven. Stradivari labeled his instruments with the Latin name Stradivarius. His "Golden Period," when he created his finest instruments, was from 1714 to 1720. These pieces of art had an amber color, a flamed maple back, fabulous tone, and an excellent ease of response. Some of the violins he made in this period were the Betts, Alard, and the Messiah. Throughout his lifetime, he made 1,116 instruments including twenty-five violas, one hundred cellos, two guitars, and six-hundred violins. Today, 450 violins, 60 cellos, and 13 violas remain.

The violin "Soil" made in 1714 by Antonio Stradivari (front and back view). Currently, Soil is owned by the world famous violinist Itzhak Perlman. Soil has an estimated market value of \$6 million dollars.



## Science and the Stradivari

**Joseph Nagyvary** is a biochemist at Texas A&M University who has done numerous studies on Stradivarius violins to find exactly what Stradivari and the other craftsmen of Cremona, Italy, did to create such beautiful pieces of art.



As a biochemist, Nagyvary was very interested in the chemical makeup of the wood used for the violins. Before he proceeded with the material properties however, he researched the history of the craft process. He found that the trees which the Italian craftsmen used were cut in the Alps and floated down rivers until they reached the Bay of Venice, where they were often kept for an extended period of time. Indeed, Nagyvary found that the salt concentration in the classic violins is ten to fifty times higher than the salt concentration of wood not soaked in sea water. Also, soaking wood makes it lighter and improves its resonance.

Nagyvary also examined slivers of classic violins under a scanning electron microscope. He discovered that soaking in water encouraged the growth of microorganisms, which caused holes in the wood's cell walls. The wood was fifty times more permeable, but just as strong as before. The air pockets created by the bacteria increased the wood's resonance.

Once the wood finished its sea journey however, the Italian craftsmen used an unknown preservative on the wood in order to protect against insects. Nagyvary experimented with all types of chemicals, including borax. Borax is a likely choice because it was known as an insecticide long before the 18th century. In addition to killing bugs, borax acts as a chemical "cross linker." This means that borax binds different molecules together and fills in pores in the wood. Borax not only preserves the wood but it makes it harder and stronger.