Southern California Association of Violin Makers

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MEETING NOTICE

DATE AND TIME: Sunday December 2; 6:00 PM

Presentation on the G. Lucchi Wood Elasticity Tester

Lorenzo Brullo, back from his recent trip to Cremona and other places in Italy, reported on the article on the G. Lucchi Wood Elasticity Tester which appears in translation elsewhere in this issue of the Bulletin. Larry also met Mr. Lucchi while on his trip and discussed this instrument with him.

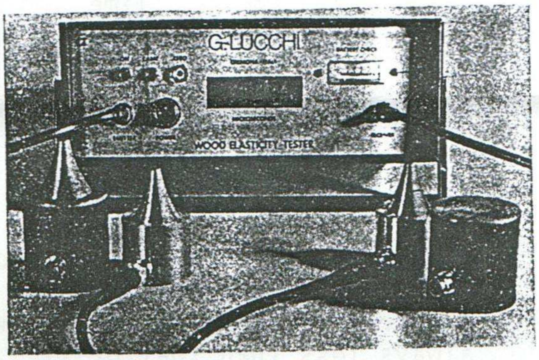
The following article, translated from the Italian periodical Liuteria, earns Larry Brullo the Association's new certificate admitting him to the Order of the Quill and Scroll.

Electronics for the Luthier:

A MEANS FOR VALUATION, RESEARCH, VERIFICATION

by Giovanni Lucchi and G. Piero Seghetti

Translated by Lawrence R. Brullo from Liuteria no. 10



We have examined the 1948 research paper "Misura dell'Attrito Interno e delle Constanti del Legno" (Measurements of the Internal Friction and the Constants of Wood) by G. Pasqualini and I. Barducci. And we have been able to experiment with some of the more representative findings in a simple method which displays the readings immediately and directly on a digital readout.

We are particularly concerned with the velocity of sound propagation through materials -- (longitudinal, in the direction of the fibres). We will call this V_1. This may be described as meters divided by seconds (m/s).

In the olden days the masters used other systems which provided empirical information. For example, when the tree trunks descended down the gullies, hitting the sides and obstacles, they emitted sounds. If the trunks were of good material it was said, "they sang." In effect the noise gave forth harmonic notes of a musical quality.

Another example is when the trunk was cut. When placed with its balance point on a support and hit with a hammer at one extreme it vibrated with a particular tone (full, shrill, round, etc.) so that to expert ears the better wood could be discerned. Therefore, the knowledgeable violin maker was able by thumping, knocking, tapping, and hitting to determine the quality of the wood, proper measurements, etc. Of course, notwithstanding much experience, the final judgement could only be arrived at when the instrument was finished.

Today, the evaluation may be obtained by measuring V_1 with an electronic instrument we hereby present.

From V_1 and from the density of the wood may be determined the module of elasticity of the wood "E," which, for the luthier, is the most important char-

NOTE:

1). GIOVANNI LUCCHI, member of our editorial staff (Liuteria) and Master bow maker, teacher at the Corso Archetti in Cremona at the Centro Professionale della Regione Lombardia.
G. PIERO SEGHETTI, engineer, with expertise in "Controls not destructive" at the Centrali Nucleari dell'ENEL.

2). I.BARDUCCI and G. PASQUALINI, Measurements of Internal friction and of the Elasticity Constants of Wood, in "Nuovo Cimento" no. 5, 416 (1948).

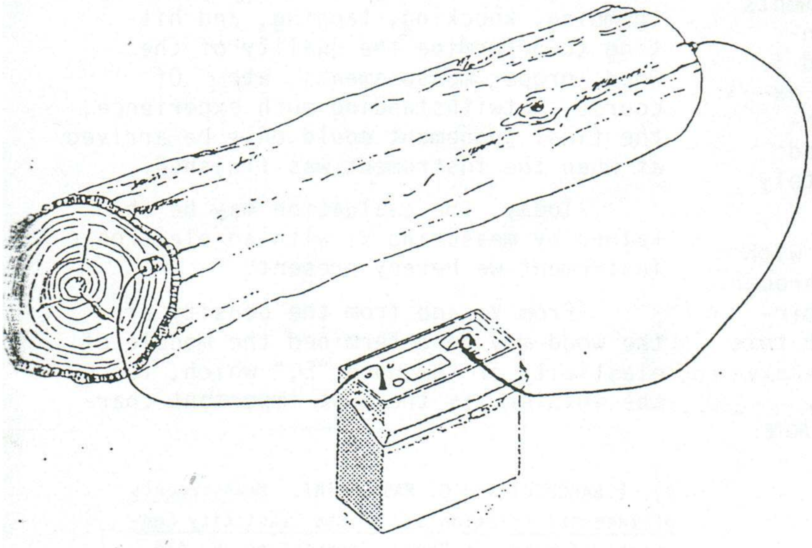
acteristic of materials. In fact, from the value of "E" depends the dimensions in thicknesses for the top plate or the back plate, the diameter of a bow stick, etc.

The greater the value of V_l, the greater will be "E" and the smaller need be the thicknesses, the greater will be the amplitude of vibrations, the greater will be the power of sound -- therefore permitting one to work within the zone of high elasticity without danger of causing permanent weakness.

The WOOD ELASICITY TESTER, which measures V_l, is a simple apparatus which applies to the luthier woods a well known tecnique, already tested and applied to other industry and research fields for Non Destructive testing of the quality of different materials.

Characteristics and Function

The apparatus consists of a generator that transmits impulses at regular intervals through a probe consisting of a quartz transmitter (transducer). A second quartz probe of the same dimension and resonating frequency receives the impulses. The transmitting probe is placed on one end of the violin plate or tree trunk, while the receiving probe is placed on the opposite end.



The wood vibrates, and the vibration arrives at the opposite end in a "T" time.

The receiving probe starts vibrating and transforms thase mechanical vibrations into an electrical signal recorded by the testing instrument.

The apparatus internally contains a counter which measures the time "t" that the vibrations take to travel through the wood. The major considerations are the length of the wood and the time necessary for the vibrations to travel the distance. Speed of travel is displayed in microseconds on a digital readout.

Knowing the length and the time of travel will reveal the velocity.

$$\text{Velocity} = \frac{\text{Length}}{\text{Time}}$$

$$\text{Velocity (km per second)} = \frac{\text{length (mm)}}{\text{time (microseconds}}$$

If one measures the wood transversely across the fibres one receives the transverse velocity "V_t" which is always less than that of V_l.

Luthier applications

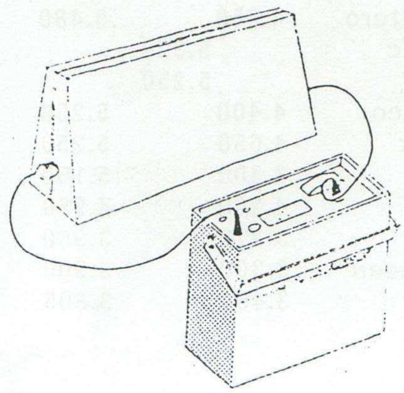
As was previously stated, the apparatus does not destroy or alter the material during testing. It measures real time quickly without complicated mathematics. With the use of a simple conversion table the acoustical quality and mechanical characteristics of various objects can be determined whether or not they are finished instruments such as violins, bows, upper and lower plates, etc, or raw unfinished material such as live trees, logs, unfinished plates, bow blanks, etc.

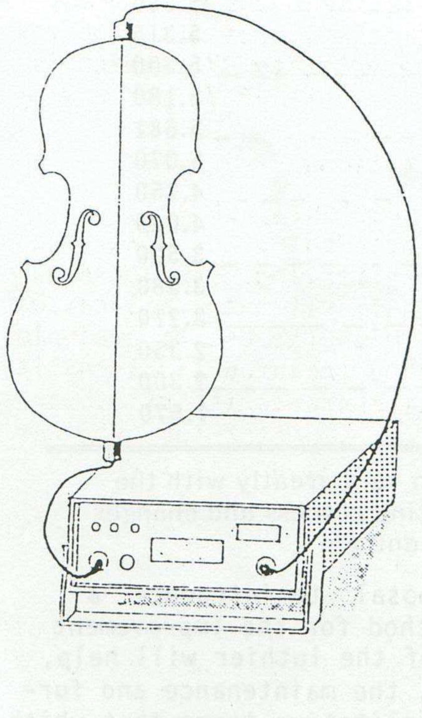
With relative measurements it is also possible to identify the seasoning stages of wood and its moisture content. Besides, it is possible to determine if the wood is worm eaten, if there are any resin pockets, splits, etc. Whatever is strange or foreign in the internal structure of the wood will cause a variation in the time of transit of the sound wave as revealed by the apparatus.

With this prospect a vast field is opened for further research. When enough appropriate statistics are obtained it will be possible to prepare tables and charts which will describe the elasticity "E" of the wood throughout all phases of the violin making process from the raw wood to the finished instrument.

Our own experiments made during the course of this project have demonstrated that some treatment causes the final V_1 to be relatively lower than that of the raw wood. On the other hand every luthier knows, for example the effect of the thickness graduation of the wood on the tone of the instrument.

Also it is possible to follow the evolvement of V_1 during the seasoning of the wood and to establish the maturity of an instrument: when it is at the peak of its performance and when it begins to decline. Also it can be de-





Value of Velocity of sound in finished bows — TABLE 1

MAKER	Finished Bow	Raw Wood
Tourte	5.460 + 2%	5.569
Tourte	5.047 + 2%	5.147
Tourte	4.738 + 2%	4.832
Peccatte	5.294 + 2%	5.399
Peccatte	5.129 + 2%	5.231
Sartory	5.320 + 2%	5.426
Sartory	4.768 + 2%	4.863
Lamy	5.290 + 2%	5.395
Lamy viola	4.740 + 2%	4.834
Hill	5.445 + 2%	5.553
Hill (gold)	5.278 + 2%	5.383
Hill viola	5.250 + 2%	5.355
Bechini	5.407 + 2%	5.515
Lucchi	5.605 + 2%	5.717
Lucchi (ironwood)	5.445 + 2%	5.553
Lucchi (ironwood)	5.564 + 2%	5.675
Lucchi	5.688 + 2%	5.801
Lucchi viola (Peccatte copy)	5.658 + 2%	5.771
Lamy cello	5.232 + 2%	5.336
Winterling cello	5.552 + 2%	5.663
Maire cello	5.248 + 2%	5.352

These values should be augmented by 2% to obtain the value of the raw wood because the void of the mortise slows the velocity of sound. It is the same situation for the violin after the purfling cut is made.

termined what positive or negative effectsare caused by restoration of antique instruments.

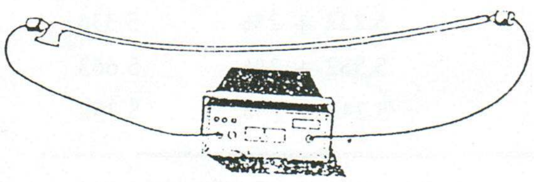
With the above hypothesis for the construction of instruments it has been recently possible for M° Lucchi to verify, test, and document research in the field of bow making.

The research was initiated with the selection of wood with the maximum of V_l and density. Then the bows were constructed and V_l of the finished bows was tested. Finally, the bows were tested by playing on a violin. The results of these tests were amply positive.

Next it was decided to extend the research to old bows (however, taking into consideration the toll taken by extended use through the years toward the "weakening" of the bows). Previous electronic measurements have not always satisfactorily confirmed the excellence of famous bows. With our apparatus tests on old bows were in agreement to tests conducted by playing the bows on a violin. This is shown in Table 1.

In regard to new bows, M° Lucchi noted in passing that, after selecting two bows that by empirical texting seemed to have analogous characteristics of elasticity, it was shown that one bow was better than the other when tested by the apparatus. This was confirmed by the practical test of playing the bows on a violin. The differing V_l as measured on these bows revealed that they were not of the same quality even if the bows were made the same way and with the same level of workmanship.

Another method which has amply been experimented with has produced satisfactory results in identifying other kinds of woods that have superior V_l and Q (Coefficient of resonance). This is documented in Table 2.



With these premises, opportune will be the possibilities for conducting further research among luthiers in regard to the selection and use of materials. Data revealed by use of our ultrasonic apparatus will provide luthiers the possibilities of periodical comparison and discussion during formal or informal meetings.

TABLE 2

Some types of luthier wood and the relative excellence found by our research.

MATERIALS	Minimum	Maximum
Pernambuco	4.350	6.000
Spruce	4.400	6.000
Incense	–	5.550
Amaranth Zapatero	4.650	5.480
Boxwood, Exotic	5.320	
Snake Wood	5.250	
Curarire Gauyaco	4.400	5.250
Ironwood, Black	4.650	5.250
Maple, Frisé	3.300	5.150
Brazil Wood	4.200	4.950
Ebony	3.370	3.960
Boxwood, European	3.300	3.900
Axemaster	3.450	3.805

TABLE 3

MATERIALS	Velocity of Sound
Graphite Fiber	6.330
Steel C 40	5.400
Glass	5.360
Steel Fe 37	5.315
Steel 2000 S	5.300
Steel Inox	5.180
Aluminum	5.681
Aluminum	5.070
Iron	4.750
Copper	4.020
Bronze	3.500
Cast Iron	3.380
Brass	3.270
Silver 800	2.350
Plexiglas	2.300
Lead	1.570

These values can vary greatly with the melting and casting process and changes in the alloy percentage.

The proposal to introduce a scientific method for the improvement of the craft of the luthier will help, without doubt, the maintenance and furtherance in qualitative terms that which is desireable in the market place. Above all it will be of advantage to the luthiers that don't have any apprehension that an electronic apparatus may diminish their sensibility, personality, and