Inventing the Savart Cello

An idea that needs lots of work before it can be useful

Three reasons to build a low-cost starter cello

1. I saw this story in a North Carolina newspaper in 1993:

WHEN HE PLAYS, THEY LISTEN

Music teacher helps youth open special gift

Playing the cello may be beyond David Davis' reach - no mater how good he is

BY BRIAN TOMLIN High Point Bureau

Brendan Slocumb

David's mom, Marie Davis

HIGH POINT - Throw out all your images of cello players; of string quartets delighting the guests at smug wedding receptions; of debutante daughters and sophisticated sons sawing away in the parlor while mummy and daddy sit in stiff-backed, Victorian charis, sipping brandy. The violin's third cousin has made the trip across town ? to David Davis' house. When Davis picks up a bow, props a cello between his legs and sets his fingers to their wonderful work, music teachers stop what they're doing.

They see that he is only 14. They see that he doesn't even own a cello. They see that a special gift could go unopened.

"I put a piece down in front of him to sight read and he just blew me away with it," said Brendan Slocumb, who taught Davis last spring at Griffin Middle School in High Point." Being a musician, I do camps and clinics and what not," Slocumb said. "You see a lot of kids, but this just totally overwhelmed me."

The problem is that Davis' family is overwhelmed, too ? by bills. And bad luck. His 39-year-old mother, Marie, is a licensed practical nurse, but diabetes, asthma, high cholesterol and a back injury will keep her out of work indefinitely. His father, Allen, works as a saw operator in a furniture-frame factory. The job pays $5.60 per hour. To the Davises; the $600 cost of a good used cello may as well be $600,000. The same goes for the $210 cost of

Please see **CELLO**, Page **A2**

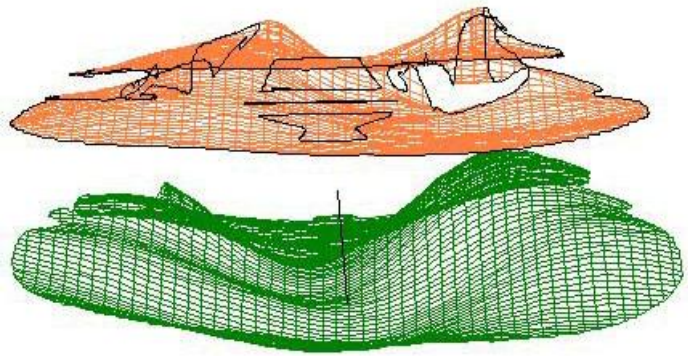
"News & Record" Greensboro North Carolina (June 28-30, 1993)

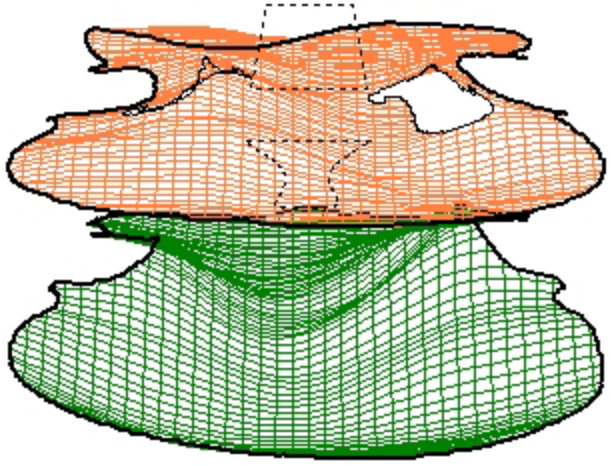
Two more reasons ….

2. Many college music education programs require that students to learn to play all or most of the instruments in their "family". Why not start early?

3. Some parents might want to "pluck along" with a young child who is starting to learn the violin. A cello is a perfect accompanying instrument and the bass part would be easy to learn.

Experimental data on two quality violins at air resonance.





The physics of how violin plates move is very interesting….

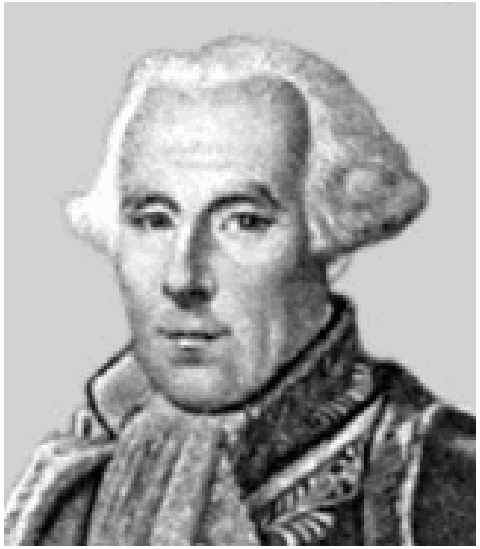
I used to call this the "Box Cello" project.
Then I discovered this fellow:

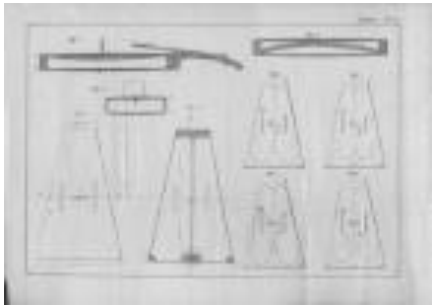
Félix Savart

From Wikipedia, the free encyclopedia

Félix Savart (June 30, 1791, Charleville-Mézières, Ardennes – March 16, 1841, Paris) became a professor at Collège de France in 1836 and was the co-originator of the Biot-Savart Law, along with Jean-Baptiste Biot. Together, they worked on the theory of magnetism and electrical currents. Their law was developed about 1820. The Biot-Savart Law relates magnetic fields to the currents which are their sources.

Félix Savart also studied acoustics. He developed the Savart wheel which produces sound at specific graduated frequencies using rotating disks. Félix Savart is the namesake of the unit of measurement for musical intervals, the savart, though it was actually invented by Joseph Sauveur.





From a website I learned that in 1819 Felix Savart also developed what he called a "rationalised Violin"

1. It was “met with approval by the academy in Paris”.

2. Apparently in the Post-revolution climate France, people were open to a re-appraisal of everything including the violin!

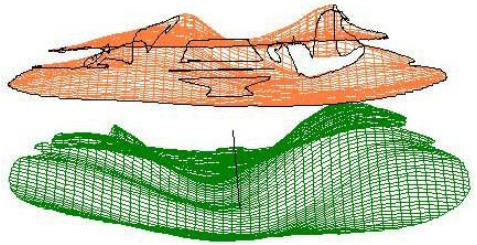
3. However this violin didn't replace the normal violin and it shifted into folk music use.

Michael J King, http://www.michaeljking.com/fiddles.htm

Though it is difficult to imagine an ugly instrument seeming “modern” in 1819, keep in mind that Stradivari’s “golden period” of violin making ended in approximately 1720.

The Italians were forgetting how to make great violins!

- The goal is not to make a better cello, but one that
  - has adequate quality for a beginner
  - is very simple to make

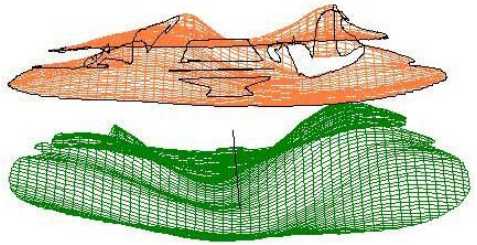


Reasons to make it a box:

1. Cheap and simple is beautiful cheap and complicated is pretentious.
2. Historical context (French revolution!)
3. We will probably need dozens of prototypes before getting an adequate sound out of the homemade cellos. Keep it simple!

The motion of the front and back plates is critical.

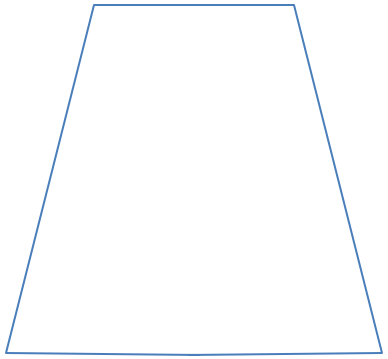
If we are lucky, the following "trick" might enable us to get it right:



Two prototype cellos will be constructed.

The "ribs" will be built solid with bolts that will permit quick replacement of "belly" and "back".

It should be possible to "rebuild" a cello in a day simply by changing the plates.



A child's cello so simple a high school shop can build it.

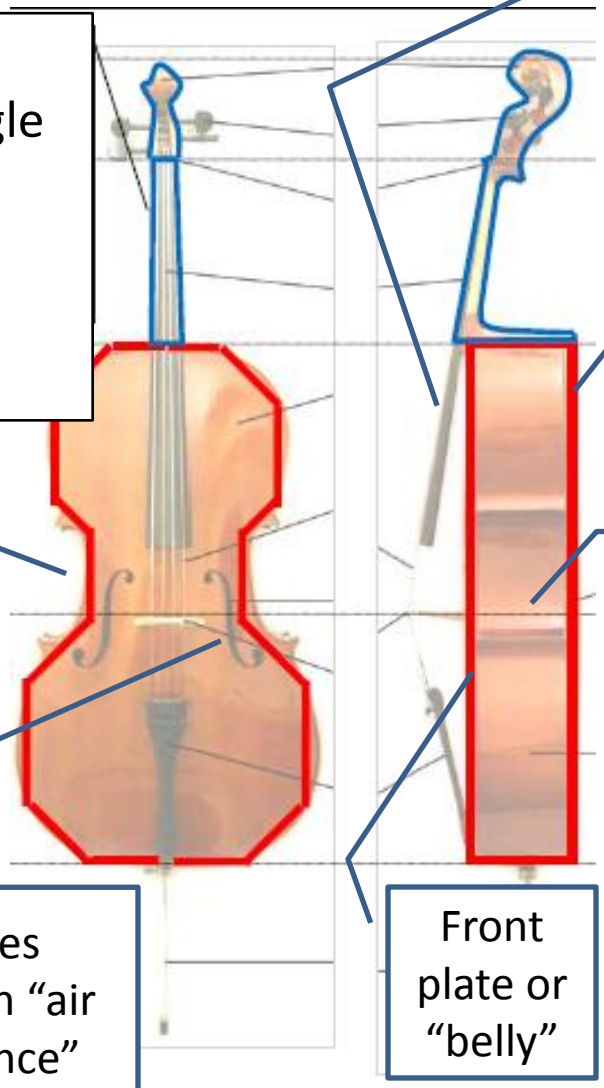
With only two strings a simple plank can serve as fingerboard.

The front and back plates are attached by wing nuts so as to be easily removed and replaced.

With some trial and error and a bit of luck, a beautiful instrument might emerge.

Children can get by on a one octave range for a while!

Top part is the neck and fingerboard. Formed from a single furring strip. Needs not extend over body of cello for starter instrument. Two stringed instrument is OK



Fingerboard cannot touch moving belly

Back plate

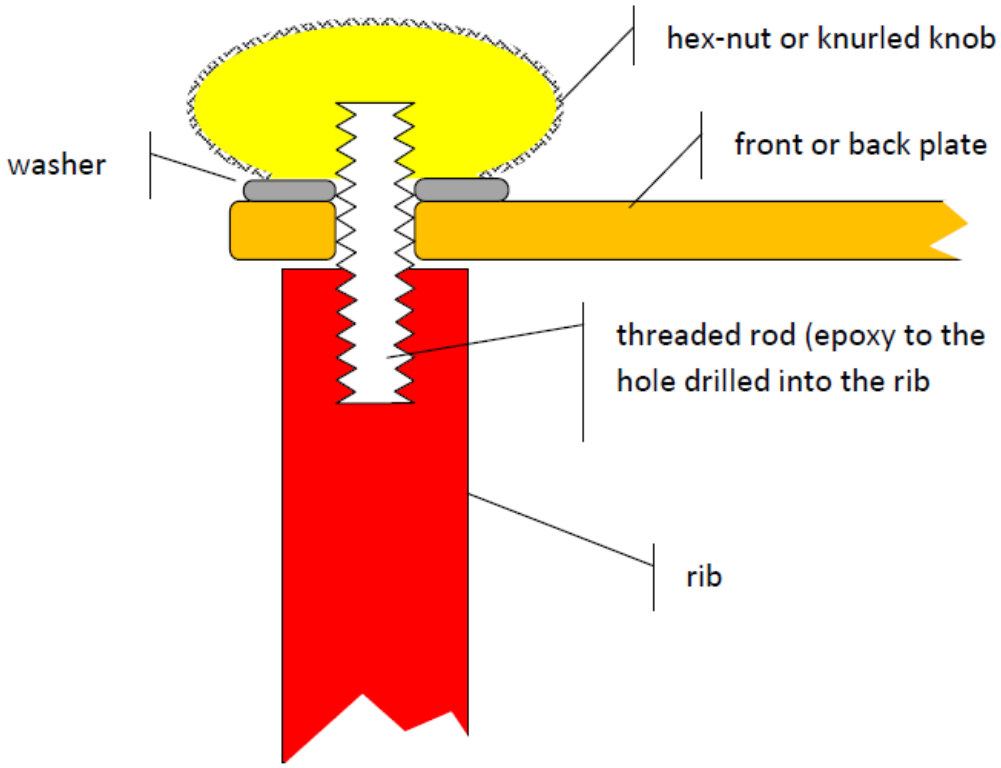
Sides are called “ribs” and move for violin family instruments. Will be largely stationary for Savart-type cellos.

Front plate or “belly”

F-holes establish “air resonance”

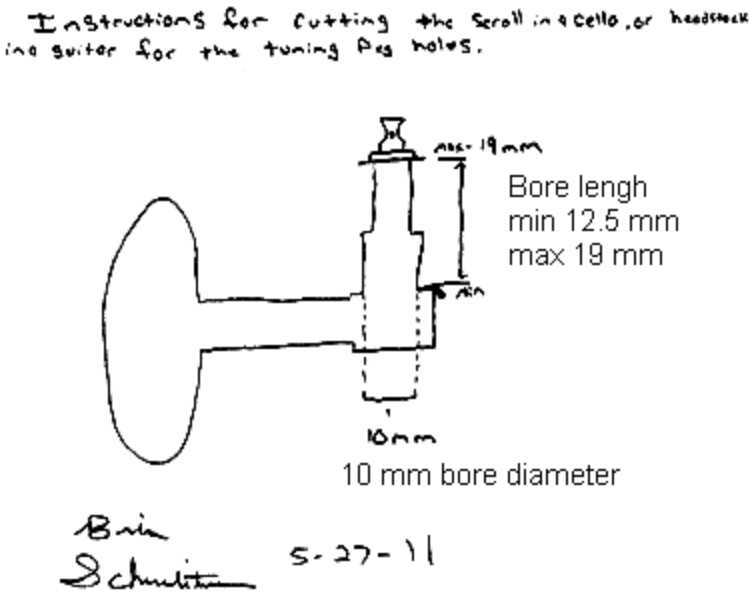
Need room for bow

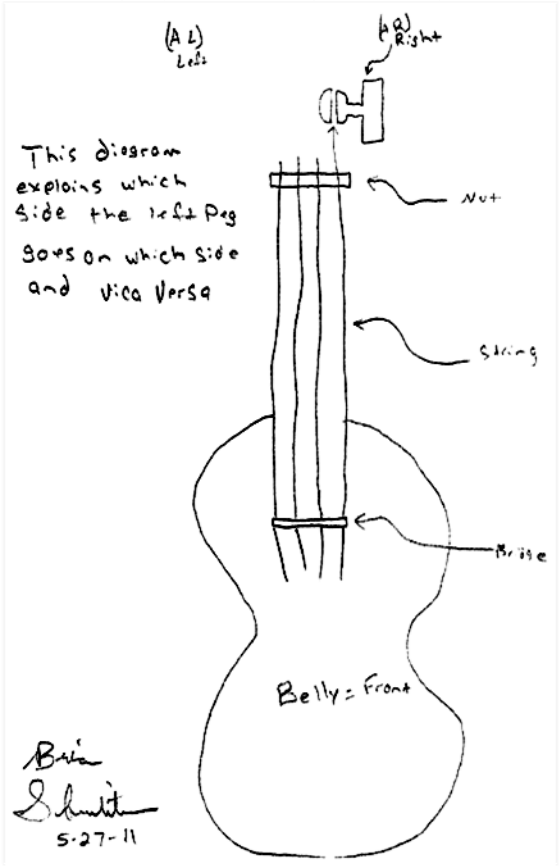
Attach top and bottom plates using machine screws to facilated replacement. These plates are critical to cello performance and will be the subject of much experimental investigation.



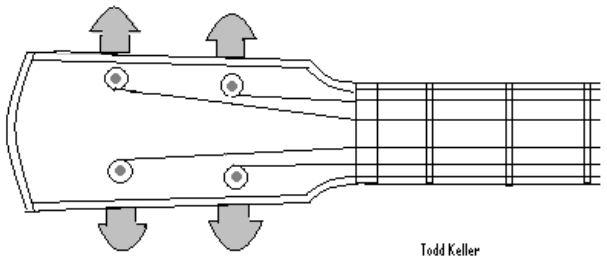
I explained this research to students in General Education Science courses, and devoted several labs to how one goes about designing a new device. Some student efforts are shown:

Purchased 6 guitar worm-gear pegs for approx. $25. Shown below are (1) proper orientation for the "left" and "right" handed pegs and (2) bore hole diameter (10 mm) and pegboard depth (range is 12.5 mm to 19 mm).

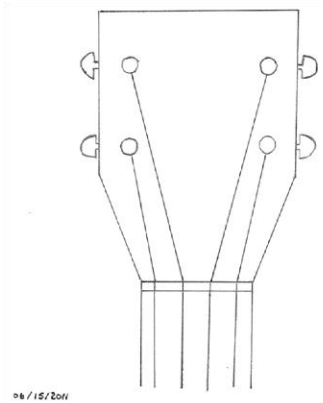




Preliminary ideas on making that pesky neck:



Todd Keller
06-15-11



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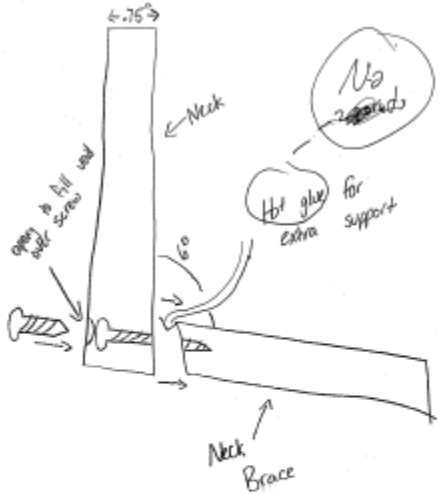
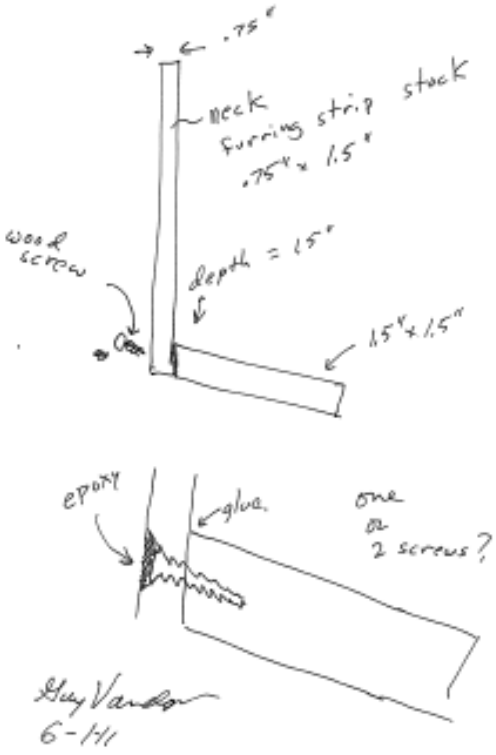
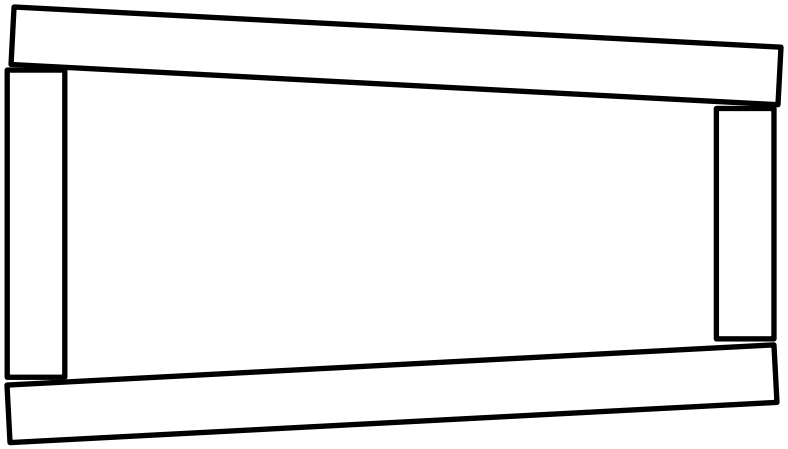


Brad Pratt
6-1-11



Guy Vandegrift
6-1-11

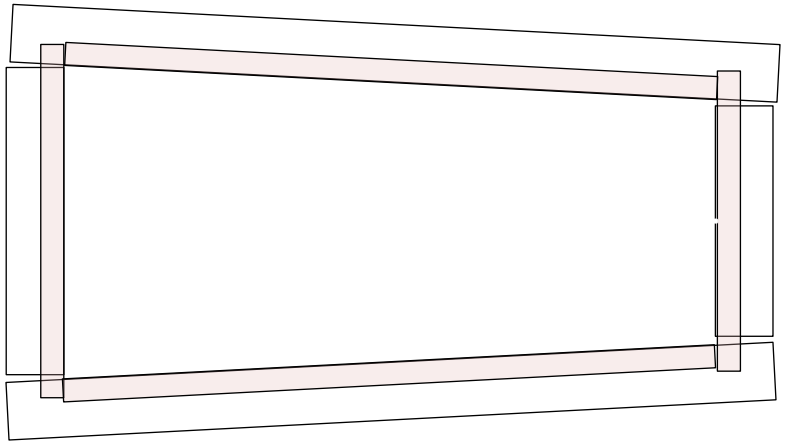
1.5 x .75 in furring strips
Lengths: 20 in; 6 in; 8 in

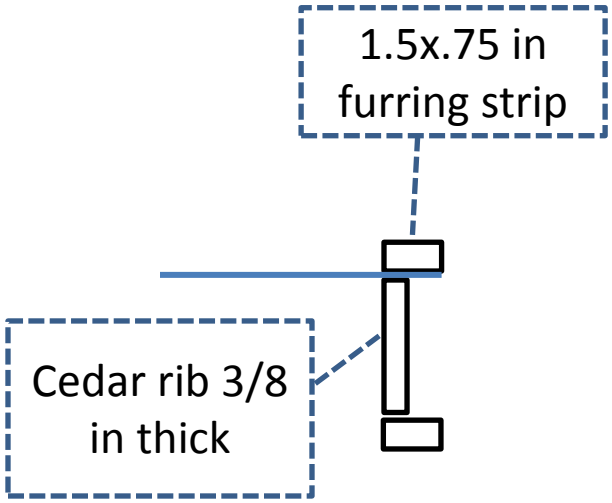


scale 5:1

K. K. later pointed out that we can easily cut these boards so they can fit.

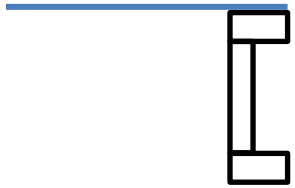
Ribs are boards 5/8 in thick.
Rip boards 3.5 in wide.
Board lengths:
17 in; 7.25 in; 9.25 in
(avtually 9 3/8; 7 3/8)



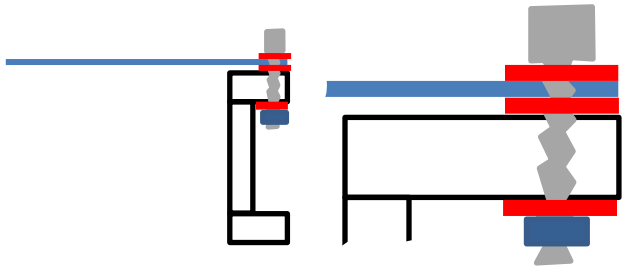


Original plan called for 3.5 inch ribs because furring strips went outside.

Cedar ribs
1.5 x 8.5 cm



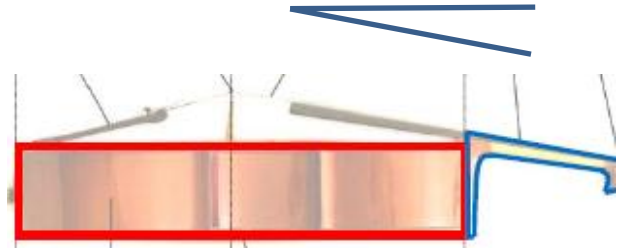
New plan puts furring strips inside, so we want to use the smaller (scrap) ribs 2.9 in wide.

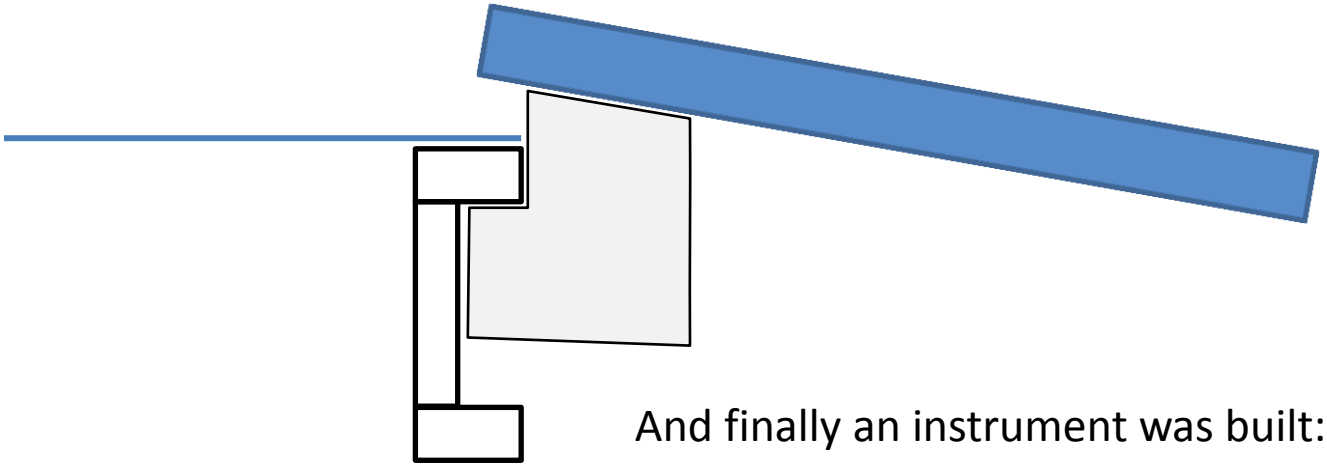


New idea: use washers (red) to keep plates off ribs and enhance buzz.

The air gap will be part of the equation. The extra plate freedom might enhance sound.

11 degree fingerboard angle

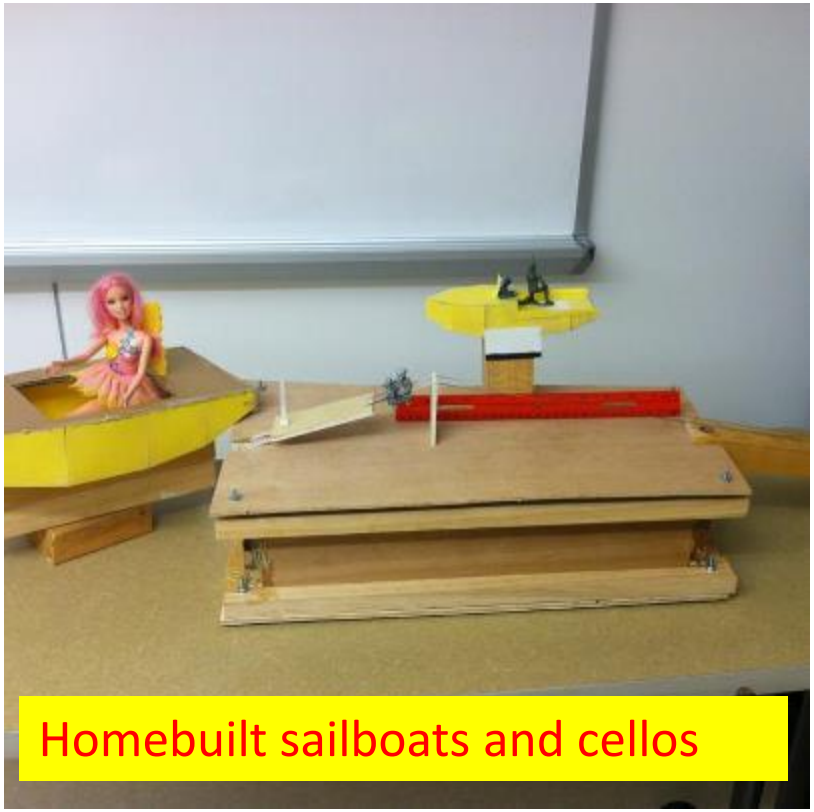




And finally an instrument was built:

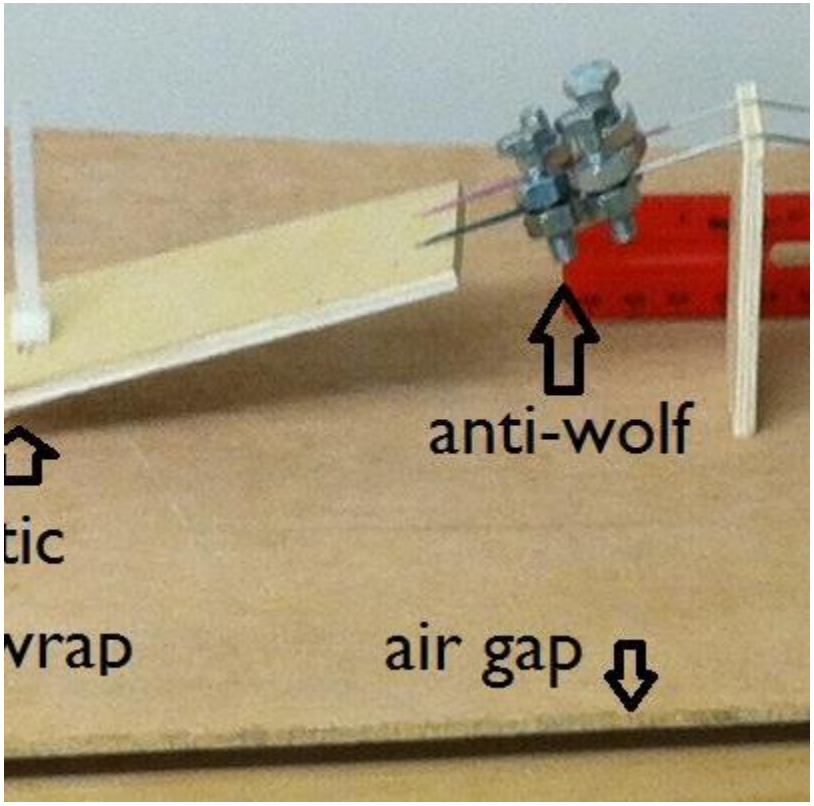
My so-called research:

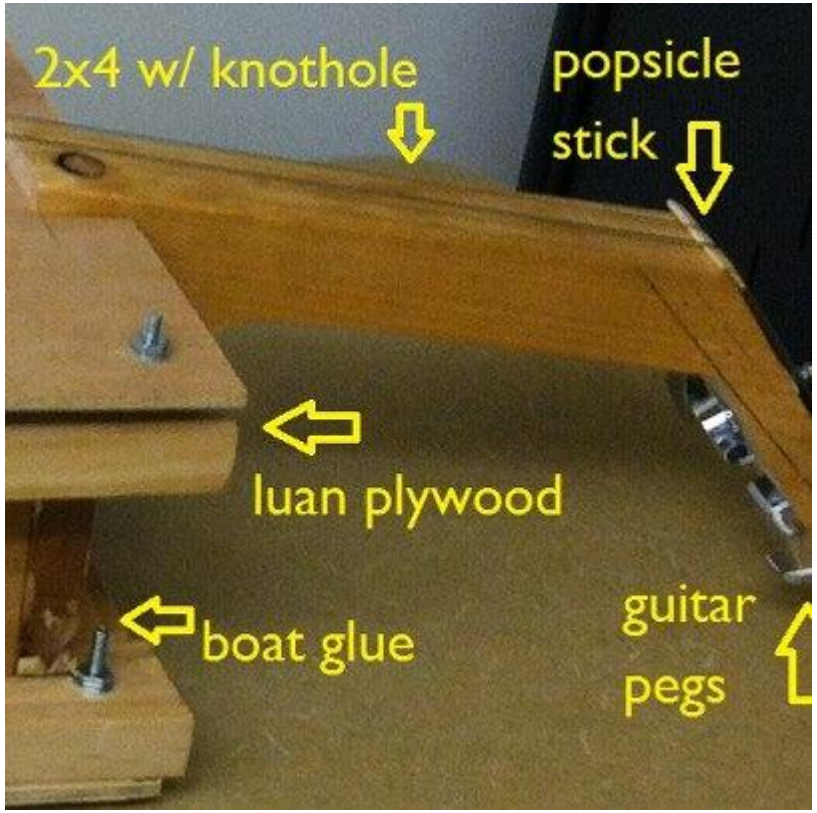
1. Find something with physics that is complicated, but not too complicated for students to understand.
2. Understand it well enough to make radical design changes.
3. The goal is to make something very easy for an amateur to construct.



Homebuilt sailboats and cellos

Research Philosophy: "Real" research must have unknown outcome and useful purpose. To engage Lake Campus students, the technical issues must be accessible to students without advanced training in math, science, or engineering.


anti-wolf
tic
vrap
air gap


2x4 w/ knothole
popsicle
stick
luan plywood
boat glue
guitar
pegs

Status Report as of September 12, 2012

1. Built a pair cellos with luan plywood (4 mm thick). Open strings were G&D.
2. Learned that back plate must be solid on ribs to avoid “wa-wa” change in pitch as player pressed back of cello.
3. Sound was pleasant but somewhat muted. Absent are those changes in timbre over the range of the instrument that makes the violin-viola-cello so enchanting. There might be an air resonance somewhere on the top string.
4. Investigated one inch wide luan plywood strip and were unable to excite standing waves. More precisely: The fundamental mode happens at low enough frequencies, but above about 100 Hz, we only get the first mode, up to perhaps 500 Hz. Cause presumed to be the extreme damping of luan underlay plywood. Will next experiment with 1.5 inch strips ripped from construction grade plywood.
5. Time to think about how wood vibrates: (see next page)

http://hyperphysics.phy-astr.gsu.edu/hbase/music/barres.html#c1

edge.rit.edu/content/P08003/public/materials.xls:

Plywood:
Young's modulus in range
*1.001-1.885*10^6 psi*
*Average is 9.95*10^9 Pa*

We think the modulus of luan underlay plywood is about half that.

Density in range
43.7-49.94 lb/ft^3
Average is 750 kg/m^3