

## University of South Carolina Aiken Aeolian Harp

Note - Click on the images below for larger pictures of the Aeolian Harp.



The Venture Grant Aeolian Harp is portable and this [picture](#) was taken in back of the Post Office by the power dam and lake in Vaucluse, SC.



Henry Gurr showing placement of guitar pickup electronic transducer on harp. The shape of the harp in this [view](#) is distorted by the camera angle.

### THE HARP AND THE CAMERA IN LITERATURE.

The inspiration to explore and create the USCA Camera Obscura and the Aeolian Harp at USCA has come directly from literary author Owen Barfield. In his Essay *The Harp & Camera*, Mr. Barfield discusses the Aeolian Harp and Camera Obscura as metaphors of human mental process as is contained in the literary traditions of the romantic poets. As further illustration of the Harp & Camera confluence, we have duplicated below Aeolian Harp excerpts from the book *The Mirror and the Lamp, Romantic Theory and the Critical Tradition*, by Literary critic M. H. Abrahams, Oxford Press (1953). For Aeolian Harp continue reading below. Click here for [Camera Obscura](#).

**Excerpt:** [The familiar Neoplatonic (Neo-Plato) figure of the soul as a fountain, or an outflowing stream, is also frequent in romantic poetry, although this too is usually reformed to imply a bilateral transaction, a give-and-take, between mind and external object. Wordsworth, who spoke of poetry as an overflow of feelings, also spoke of whatever he saw, or heard, or felt on his visit to the Alps as

but a stream  
That flowed into a kindred stream; a gale  
Confederate with the current of the soul...

This image of confluent streams, like that of the lamp, Coleridge reiterated in the poem he wrote in response to the Prelude. We must also take special note of the image of the Windharp which both

Wordsworth and Shelly used as a construct for the mind in perception as well as for the poetic mind in composition. It is a curious twist of intellectual history that Athanasius Kircher, who claimed the invention of the Aeolian Harp also perfected the Camera Obscura which had been employed as a mind-scheme by John Locke, so that the same man was in part responsible for the artifacts used to give structure to antipodal views of the human mind. As early as 1795 Coleridge had suggested the Harp as an analogue for the thinking mind:

And what if all of animated nature  
Be but organic harps diversely fram'd,  
That tremble into thought, as o'er them sweeps  
Plastic and vast one intellectual breeze,  
At once the Soul of each and God of all?

--a proposal no sooner made than recanted, for the sake both of his fiancée and The Incomprehensible, " ... as mere bubbles on a vain Philosophy's aye-babbling spring!" Even at that stage in his thinking, Coleridge was apparently troubled by the necessitarian implications which emerged clearly in Shelley's later use of the same image. "There is a Power by which we are surrounded", Shelley says, "like the atmosphere in which some motionless lyre is suspended, which visits with its breath our silent chords at will". Even the "most imperial and stupendous qualities", though active "relatively to inferior portions of its mechanism" are nevertheless "the passive slaves of some higher and more Omnipotent Power. This Power is God; and those who have "been harmonized by their own will ... give forth divinest melody, when the breath of universal being sweeps over their frame". End quoted passages from M. H. Abrahams. **End Excerpt.**

Professor David Lavery, who is the "brains" and "motive power" behind [owenbarfield.com](http://owenbarfield.com), has included Owen Barfield's essay *Harp and Camera* as a reading in his advanced English Classes. I can no longer find any reference to this.

(( Thanks to Elisabeth Barns for "Inspiring Creative Ideas: A Demonstration Lecture on Art-Science-Literature"., at the USC-Aiken Ruth Patrick Science Education Center Planetarium, Tuesday, April 26, 1994 7:00 p.m. - 9:00 p.m.

## **Welcome to THE WONDERFUL WORLD OF AEOLIAN HARPS!** by Dr. Henry Gurr

The Aeolian Harp (Wind Harp) makes a weird-wonderful, strange-beautiful music entirely in response to the wind. Besides being an object of history and a significant literary symbol + metaphor, the Aeolian harp is an interesting (and therefore excellent) means to demonstrate the physics theory of vibrating objects. Easily demonstrated in a physic class are wave and harmonic modes of vibration, resonance, feedback regeneration, and wind flow instability. The Aeolian Harp has been known (and used) since antiquity. It received considerable literary and musical attention during the Romantic Era.

Part of the "unworldly" sound of an Aeolian Harp sound comes the fact that the wind driven string do not usually "play" the fundamental note for that string. Normally the wind "stirs up" (i.e. drives at resonance) several simultaneous higher overtones, which are most often non-harmonic combinations (i.e. dissonant!) These "overtone" notes go as hi as the 5th overtone and even going up to as high as the 11th overtone!! (I would have to check my notes on this.) This may seem like an inexcusable waste of a perfectly good fundamental and lower harmonics. But this is the way it is, and this is what makes it nearly

impossible to "tune" a Multi-string Aeolian Harp so it will be harmonious! As a consequence, all multi-string Aeolian Harps sound more or less the same, despite various tuning arrangements. So it is a real challenge to go the next step and get some sort of music quality "beyond the ordinary" in a Wind Harp. However, one virtue of a multi-stringed harp is that there can be a variety of string diameters, and hence the harp will sound over a wider range of notes and wind speeds. Concerning the fundamental: I seem to recall that I was able to get the longest string of my experimental harp to respond its fundamental under ideal very low speed winds. It was quite a low note because the string was ~ one twentieth inch diameter and was 8 feet long. Although I have said that it hardly matters how an Aeolian Harp is tuned, many harp builders have their own technique favorite tuning method. For example Ross Barrable says "The strings on [my] wind harps are tuned to the pentatonic, 5 note scale, commonly heard in oriental music. Harmonics produced by the wind harps are long tones, that stimulate deep levels of relaxation, and subtly expand our band of conscious awareness."

So it is that wind harps do not have to adhere to any particular standards or common expectations. They just have to be beautiful, fascinating, inspire awe, and cause a smile. Oh, .... and stand the test of time would also be nice.

One Harp Builder wrote: Also I wanted to thank you for sending the very interesting articles concerning wind harps and the camera. [*The Harp and the Camera* by Owen Barfield] That [article] was a bit of a surprise at first and I'm sure I'm going to need to read that again. However, I can tell you that I had the feeling of understanding right off. The first time I ever heard a wind harp was just outside of Aspen Co. It was one of Ross Barrable's small ones. I was completely taken by the sound right from the start. I couldn't walk away from it I was so engrossed. I had trouble understanding why the people I was with didn't react the same way. I think that subconsciously I must have recognized that the sound was "important". After reading the articles you sent, it's clear that people far smarter than me have given a great deal of thought to wind harps and the effect and meaning of their sound. My motivation to create a high functioning wind harp is redoubled."

#### **HOW TO EXPERIENCE THE "AEOLIAN HARPS" AROUND YOU.**

The musical sounds of an Aeolian Harp are the results of vortex "swirls" flipping around in the back of the strings... left-right.... left-right... You may watch these vortexes in the left-right ripples moving along a flag during a medium breeze. It is this very same alternating push-pull (at resonance frequency) that can cause a flexible suspension bridge to twist and sway larger and larger..... until destruction. It was this over stress from excessive twisting, that destroyed the Tacoma Narrows Bridge (Galloping Girtty) <http://www.enm.bris.ac.uk/research/nonlinear/tacoma/tacoma.html>

Aeolian Harp sounds can also be experienced during the daily activities of the very observant. For example, press your ear tightly against the pole that holds up electrical power wires. In a good strong wind will hear an "extra hum" from the Aeolian forces on the wires. this sound will be in addition to the normal 120 cycles per second hum of AC power which you will hear with or without any wind. The "moan" of the wind in pine trees, or the "woo- woo" of tree limbs in fierce strong winter winds, are "natural", Aeolian Harps. It has been said that the 1 inch diameter rods that form the "X-Braces" of traditional (leg supported) water storage towers, will shake violently in a strong winds, due to the alternating push-pull of Aeolian Forces. You may, in strong winds, hear whistle-like sounds (or "woo- woo" sounds) from open holes and slots, such as large cracks in doors. Be sure to investigate these sounds. They are closely related to the sounds from Aeolian Harps.

#### **Bill and Mary Buchen Describe the History of Aeolian Harps.**

The harp transforms wind energy into musical sounds known as Aeolian tones, named after Aeolus, the

god of wind in Greek mythology. The wind harp is one of the oldest musical instruments discovered by man. According to legend, King David hung his harp in an open window and heard it played by the wind. In more recent times, Aeolian tones can be heard singing from telephone and power lines.

When an Aeolian harp string is activated by the wind, the fundamental is never sounded, only the overtone series. Wind velocity is directly related to the pitch heard by the listener; the greater the wind speed, the higher the activated overtone. The resulting tones have a shimmering, ringing quality.

In accordance with the laws of fluid dynamics, when air flows past a cylinder (in this case, a string), it sheds vortices to either side. These are shed alternately in a stable and regularly repeating pattern. When the frequency of this oscillation matches the frequency to which the string is tuned, an Aeolian tone will result. The string always vibrates in a direction perpendicular to the wind. Credits to Bill and Mary Buchen at <http://www.sonicarchitecture.com>

#### **AEOLIAN HARPS: SOME GENERAL INFORMATION.**

The following information was assembled to assist people, like yourself, who have asked me questions about how to build an Aeolian Harp music instrument or learn more about their long and influential history. I believe that, for most people, the World Wide Web (computer Internet) is one of the most easily accessed sources of a great deal of accurate information concerning the Aeolian Harps. Accordingly, I have below also given network web addresses of interesting web sites. If you do not have your own computer, your local public library (and even a computer store) may be willing to help you. Major Libraries around the world do have considerable information about the Aeolian Harp. However, library information is most useful for study of the history of the harp and is harder to access due to physical distance.

I trust you will find this information interesting and helpful. By return mail, please confirm receipt of this document and let me know if it has been of help and answered your questions.

WARNING !!!! DANGER TO LIFE AND SERIOUS DAMAGE TO EQUIPMENT may be present when attempting to use any form of electrical or electronic equipment such as may be suggested herein. User assumes all risk. Persons unfamiliar with electricity and electronics should get assistance from experienced people who can safely work with electronic guitar pick-ups, microphones, tape recorders, audio amplifiers, and/or public address systems. Places that sell electronic equipment may be able to help!!!! WARNING !!!! User assumes all risk.

#### **A) The best introduction to the Aeolian harp is listening to one!!! You may try the following:**

1) **Mr. Uli Wahl's WebPages have many Aeolian Harp MP3 audio recordings of the sounds of Aeolian Harps** as well as recordings of many other wind driven music instruments. You will have to search up and down this page to find what you want to listen to. He has instructions to down-load into your computer the correct software to hear his recordings play on your computer's sound system. **NOTE:** Mr. Wahl's WebPages are in **German and English**. You will have to **scroll down** (usually) to find the English. <http://members.aol.com/woinem1/index/soundex.htm>

Mr. Wahl's NeuHarf1 recording is the most enjoyable.

<http://members.aol.com/woinem4/sounds/neuharf1.mp3>

**Attention:** The best way to play these mp3 files is to ask your computer to down-load and save them. I

suggest this because, my the Internet Browser called Firefox will play Mr. Wahl's mp3 files successfully for approx 10 seconds, but for some reason will not play the entire time of say 120 seconds. This may be due to a computer security precaution of my university. My MS Explorer Browser does not have this problem.

2) You can hear a portion of Mr. Roger Winfield's "Windsongs--The Sound of Aeolian Harps" from the web at <http://www.windharpmusic.com/listen.html> One of the best recordings is "SoundClip1", with many others to illustrate Mr. Winfield's High Quality CD. The following page has many hi quality color photos of Mr. Winfield's Aeolian harps:<http://www.windharp.i12.com/harps.html>  
NOTE: Your computer must have the software called Quick Time Player, RealPlayer, Real Audio. These are readily available as a free down-load when prompted. Of course your computer must have a sound card and loud speakers. Most computers have these accessories.

2) Cassettes or CD's of "Aeolian Harp Music" are available by order or at music stores, such as " *Windsongs--The Sound of Aeolian Harps*" (SDL-394) by Roger Winfield, produced by:

Saydisc Records  
Chipping Manor (telephone: Dursley (0453) 84 5036)  
The Chipping  
Wotton-Under-Edge,  
Gls. GS12 7AD, ENGLAND.

Mr. Winfield's CD is of excellent musical quality and realistically demonstrates of all of the different sounds that Aeolian Harps can and will make. It is definitely worth purchasing and may be special ordered at most music stores or various web sites found by web search with name Saydisc Records. I notice that web music sites show that Mr. Winfield has a second CD out, called "Voices of the Wind (SDL-428)". Mr. Winfield has placed his harps on public display in parks in London in the summer of 1998 according to a newspaper article.

Note 1) I believe that some parts of his Aeolian Harp Music recording CD (especially SoundClip1 & 2) may have been created by slowing down the speed of the original soundtrack by playing the tape recorder at say 1/2 or 1/4 of the original (normal) speed. This is most probably the case at the beginning of the part called "Winter Wind". If my memory is correct, this part of Mr. Winfield's CD is where there is a very low note that goes on and on (steady sustained low note) for a long long time. This note is way too low for any of the Aeolian Harps in any of Mr. Winfield's photos. I believe if he had a much bigger harp as indicated by this very low musical note, he would have shown it in those photos. Hence my guess about his slowing down the tape recorder. So if he either a) slowed down the tape recorder or b) had a much much larger harp, with much much bigger diameter strings, which he did not show in any of his photos! The harps shown in those photographs I believe are likely an inexpensive construction with wood (and/of plywood) painted to look like something rather wonderful. His electronic pick-ups in all three cases are standard (six string) electronic guitar pickups positioned just as is done in an ordinary electronic guitar. Notice that his Aeolian Harp strings are not a whole lot longer or different diameter than ordinary guitar strings.

Note 2) I think the sound of the "winter wind" itself was recorded separately and later "dubbed in with the Aeolian Harp Music.

Note 3) By Mr. Winfield's own statement his recordings, went on (continuously) for months. This gave him plenty of different harp sounds, so he was able to choose the (infrequent) good portions that are the very good stuff he has in his ~ 1 hour recording. If a person were to do say 200 different one hour recordings at random, on the best of all A. Harps, none of these 200 would be as good as Mr. Winfield's CD!

**B) People who actually hear Aeolian Harp Music or Roger Winfield's "Windsongs" CD,** (see links above) will experience sound tones (Especially the second selection) that build and mix; ebb and flow; similar to certain of the piano compositions of Fyderyk (Frederic) Chopin 1810-1849. I am not much of a music expert, but I hear piano imitations of an Aeolian Harp in #29 & #51 of Chopin's Four Impromptus Opus (Opera), 29, 36, 51, and 66. So.... as you listen to Chopin's music .... see if you can detect the "tone pattern influence" of the Aeolian Harp!! As evidence that Chopin must have been fascinated with Aeolian harps, consider the fact that Chopin actually composed a piece called *The Aeolian Harp; Etude in A flat Major*. Unfortunately, however, this piece sounds to me **nothing** like an Aeolian harp! I can only surmise that the person playing the piano had never heard an Aeolian harp and was possibly misinterpreting the sound. It is also possible that this Etude was composed early in Chopin's composing years, prior to developing his "true response" to the influence of the Aeolian Harp. I hope that some one with a good ear for Aeolian Harp music and expertise in Chopin will check out my conjecture. Please let me know your conclusions. **Mr. Wahl's NeuHarf recording shows sounds somewhat like**

**Chopin.** <http://members.aol.com/woinem4/sounds/neuharf1.mp3> Here is an interesting passage from a WebPage that is **no longer available**. I hope it is restored because there was a wealth of music information and sound files there: [[[The Etude in A flat major for piano (1836) by Frederic Chopin (Op. 25, no. 1) is sometimes called the "Aeolian Harp" etude, a nickname given it by Robert Schumann . An impassioned melody is picked out by the fifth finger of the pianist's right hand, over a background of rapid pedaled arpeggios. *Sound file of a performance, with sheet music, from ChopinFiles.com (http://chopinfiles.com/Opus25-1.html)*]]]

**C) Fyderyk Chopin lived during the Romantic Era, during which Aeolian Harp "music" was widely experienced** by many poets, painters, musical composers, and ordinary people. People during this time were very, very, very aware of, and interested in nature! (The passages by M. H. Abrahams, given above, speak to this point also.) The music of the Aeolian Harp is strange and utterly different from most music composed and played by humans. For writers and poets of the time (such as Coleridge, Shelley, and Wordsworth), the Aeolian Harp and how it was acted upon by natural processes, became a widely used metaphor for how humans were correspondingly acted upon by nature. It would be very surprising if the very striking and different music of the (commonly available and literary influential) Aeolian Harp would not have a substantial impact on the composers of that day! So we can surmise that Chopin was not the only composer who incorporated tone patterns reminiscent of the Aeolian Harp! So.... was the Aeolian Harp a primeval tutor to a generation of music composers? To me it is certainly a lively possibility. Persons interested in learning about the "general climate" of the romantic era will find much valuable information in the additional books mentioned below. This would provide a good starting point in the search for the connection between the Aeolian Harp and the music of Chopin and other composers of the romantic era. If you know of any music composition that seems to mimic the Aeolian Harp, or otherwise influenced by the harp, please let me know. Like wise if you know of other Chopin's work that has the "Harp Influence, please write or email.

**D) For one of many articles on the literary/poetic connection to the Aeolian harp,** see the chapter "The Harp and the Camera" in *THE REDISCOVERY OF MEANING AND OTHER ESSAYS*, a book by Owen Barfield<sup>1</sup>, available from most bookstores by special order from Wesleyan Press or order off of web sites that sell books. Mr. Barfield got a great number of his ideas concerning the harp and its connection to the romantic era, especially poetry, from the book *MIRROR AND LAMP* by Professor M. H. Abrams, Oxford University Press (1953). This book should be in most libraries. "The Harp and the Camera" essay, plus my desire to find interesting ways to teach physics were the precipitating factors that got me involved in Aeolian Harps. Persons who want to learn more about the possibilities of the Aeolian Harp and the Camera Obscura in the area of science teaching (also literature teaching) may wish to read my Venture

Grant Aeolian Harp Report. You should know that Mr. Barfield's most influential book is *SAVING THE APPEARANCES*.

**E) For further information on the Aeolian Harp**, look up "Aeolian Harp" in GROVES DICTIONARY OF MUSICAL INSTRUMENTS (be sure to get the book (Volume) that says Instruments). This article has a picture that would help cabinetmakers to construct an Aeolian Harp. It basically is a lightweight wooden box, which holds the strings tight and functions as a "sound board" plus resonating "sound-box. Some sort of "soundboard" + "resonating sound-box" action is required, since the unaided string vibrations of an Aeolian Harp do not make hardly any sound unless you press your ear tight to the frame of the Harp. Almost any type of metal (or even plastic) wire can be used as strings for an Aeolian Harp. People who go fishing know where to buy different sizes of fish-line that are fairly successful. However you should avoid the type of guitar wire that is "over-wound". This is the type of wire that has an irregular surface due to winding a smaller wire around a larger wire. See "**References**" below for more good books.

**F) The picture of the Venture Grant Aeolian Harp Seen At the Top of This Page**, may also give you ideas as to how to construct an Aeolian Harp. But be aware that without a "sounding board" as mentioned above, there **MUST** use some sort of electronic "pick-up" and electronic amplification and loud speaker. The twenty (4 inch long) "posts" shown in the picture will (eventually) hold an "electric eye" assembly to function as electronic "pick-ups" for my harp. In several musically successful (preliminary) tests on my Venture Harp, these "posts" have been used (temporarily) as mounting points for electronic guitar pickups. The electronic guitar pickup was placed next to the strings in as is done in an ordinary electronic guitar. Of course if a magnetic guitar pick-up is used the "strings" must be of steel wire and rusting in outdoor weather is a problem. The USCA Venture Grant Harp **must** have electronic amplification to be heard. But this is currently my hang up. Several years ago I got stalled in my search for a way to perform this amplification that fits my standards for size and weather resistance. I have yet to find a satisfactory solution and get going again on this project. Thus I have as yet no recordings but will be glad to supply this when I get some good sound.

Click here to see (in a new browser) my [Venture Grant Aeolian Harp Report](#).

**G) The following professional sculptor manufactured our Venture Grant Aeolian Harp.** Mr. Carroll's Aeolian Harp sculptures may be viewed in the two web sites below. To find his harp, look around at the pictures until you find three tall red curved spires.

Rodney Carroll                      Phone: 410-752-2481  
920 Clifford Street                Fax: 410-752-2481  
Baltimore, MD 21223 USA        Email: [rodney@toad.net](mailto:rodney@toad.net)

<http://www.rodneycarroll.com>

**H) The following artist makes a full line of Aeolian Harps for outdoor garden locations.**

Ross Barrable,

Pagosa Springs CO 81147,

[http://www.palmdesertartistregistry.com/ross\\_barrable.htm](http://www.palmdesertartistregistry.com/ross_barrable.htm) <http://www.soundscapecinternational.com/>

An <http://www.Google.com> web search for "Ross Barrable" or "Harmony Wind Harps" will show several art gallery companies that handle Mr. Barrable's work. For example see <http://www.toklatgallery.com/>

Many of Mr. Barrable's Soundscapes Harps seem to have a "trumpet shaped cone". This must function like/as the harp "sound board". It is hard to tell how the strings are attached to this "sound board?" but around the edge of the "trumpet shaped cone", as in the Wind Singer, is a likely possibility. Soundscapes Wind Singer sound board" appears to be the (thin?) flat metal plate at the bottom. The strings, I believe, are attached in holes along the upper edge and pulled up, which makes them pull the flat metal plate tight like a drum-head. As I recall, there have been Aeolian Harps made with long suspended cables, doing something similar. The ends of these cables pull tightly on the edge of a piece of sheet metal. Of course the material of the metal is composed and how the metal is shaped and how thick, is bound to give a "coloration" to the resulting sound. I should think it might sound "tinny", or "hollow", some what like the old hand crank "Victrola Record Players" when they play the old 1920 records of Mr. Caruso Singing Opera. But I really haven't heard any of these metal sounding boards, so I shouldn't speculate. BUT .... the "sound coloration" has a direct relation to what that thin metal, in its final mounted and string pulled tight configuration sounds like, when you stroke it or thump it where the strings are actually attached.

**I) Below is the address of a man who makes wooden Aeolian Harps which are used in an (open) window location.** He is a very helpful person and I have one of his wooden box type Harps designed to be used in an open window. The sound is not very loud, but otherwise the harp is reasonably successful:

Music Maker's Kits Incorporated.  
14525 61st Street Court North.  
P.O. Box 2117  
Stillwater, MN, 55082-3117  
Phone (612) 439-9120

**J) Also the Internet Links below also shows places where you may find other persons who make harps.**

#### **M) Important Aeolian harp Design Considerations.**

I agree with Mr. Uli Wahl, who sent me the following: "What I really want is that people begin to THINK over the problems [involved in Aeolian Harp Construction. I do not want] to give ready solutions. What I really like is to discuss IDEAS with others and to see them growing. .... I would assume, that "ready" things become boring to people very fast, for they thus cannot see the amount of manpower which was needed. .... for me personally, the more valuable thing is the way, not the aim..." To this I, Henry Gurr, would add, the more you participate by direct "hands-on" building and experimenting, the more the Quality of your whole life is enhanced. To see this read the book *Zen and the Art of Motorcycle Maintenance*. You can learn more about this book on my Professor Henry Gurr Home webpage.

#### **0) What Tones (Frequencies) Will My aeolian Harp Make? Some General Rules You Must**

**Remember:** For an Aeolian Harp, the wind will **only** augment those tones (frequencies) that the "string" can already naturally resonate at: **For any string**, these are the same frequencies, you can hear when it is stroked by a violin bow.

I could give you the physics equations for the tones (frequencies) that a string will resonate at, but it is simply better to remember that the relations for any string go as follows: Higher tones come from lighter weight, shorter, & tighter strings. Lower tones come from heavier weight, longer & looser strings. You already know this from observing many stringed musical instruments.

Therefore, to get the the lowest notes, you must have very large heavy and very long wires, of low tension. These give low frequency POSSIBLE TONES:

Now on The Seolian Harp, the wind "acts on these possibilities" to give you a result, just like a musician

playing his instrument: So strangely enough, for very low notes you need VERY slow wind speeds, sometimes as slow as the speed of a walk, to act on a large diameter string. This is in accord with the Strouhal Equation below. As I have stated in this document, the string must be **smooth**.

The mathematical relation for what the wind does to a string is the Strouhal Equation => Aeolian Tone Frequency = (0.185) (Wind Velocity)/ (Diameter) 0.185 = Strouhal Number, a dimensionless constant), frequency in cycles per second, Wind velocity in meters per second and Diameter in meters. See Groves Musical Dictionary of Instruments, or Google for [Strouhal Aeolian Harp].

**1) Many strings will give a variety of notes and overall play a larger portion of the duration of any available wind.** Many different wire (string) sizes will increase the overall time the harp actually sounds. This is because each string size will respond to its own different wind speed. When you have many sizes of strings, many will do nothing, but (with many strings you have increased the chance that) the one string that may be "just right" for that wind speed, and it will be the string that will make music. Also, a wide range of string sizes will give a wide range of musical notes. Small diameter strings produce high notes and larger diameter strings produce lower notes. This, I believe, multi-string design will increase music appeal. Of course, when many strings are used (as on traditional stringed instruments), the question comes up as to how to tune the strings in comparison to each other. As I said above, in my experience the Aeolian sounds are often disharmonious when, as is the case, they make two notes on the same string. This dissonance is due to the fact that the notes sounded are very much higher than the fundamental of that string. These facts, plus my experience hearing a variety of harps, makes me tentatively conclude that almost any tuning scheme, including no tuning at all, makes hardly any difference in one's enjoyment of the unique sound of the Aeolian Harp. However you should be aware I am not music expert and have relatively small knowledge about the tuning of Aeolian Harps. All this said, my Venture Grant Harp, when I get back to finishing, it will be tuned (as a first try) to every third string one octave higher, with the two strings between the octaves, set to 3rds and 5ths. I have no idea how well this will work out. My document [The Venture Grant Aeolian Harp Report](#) has more information. Please contact me if you need more information. **Attention, Please do be aware:** To a large degree, all Aeolian Harps sound pretty much the same, so the thrill of the first encounter wears off pretty fast!! **So the real challenge is** to go the next step and get advanced music quality beyond the ordinary!!

**2) A great deal of attention should be given to creating an adequate "sound board".** A very effective and efficient "sound board" is **required**, as is true in all stringed music instruments. Spend some time in a study of how strings are mounted to the thin flexible bodies of traditional stringed music instrument. You want to carefully study just **what is "making the sound"** in traditional stringed instruments (guitars, violins, banjos, pianos, successful Aeolian harps, etc). Without the "sound board action" of these instruments, you would not hear very much. If, for example, harp strings are mounted solidly to a metal pipe heavy enough for structural purposes, there will only enough sound for a single person with their ear held IN the end of the pipe. I would say, in addition, the sound in the pipe would possibly be very full of "echo" and sound quite "hollow". A "sound board" can be of metal, but much experimentation is needed to insure that the metal itself does not "color" the resultant musical sound. Harp builders are **URGED TO MAKE A MOCK-UP** of your intended design. Each time you make an experimental setup (mock-up), you will get instructive examples how to "get the sound out". The more designs you try the more you will learn. Some of your mock-ups (both successful and unsuccessful) will be valuable "special acoustical effects demonstrations". These can be used as "learning devices" for people who are deeply interested in musical instrument design and/or science of acoustics. To learn how you can get greatest amount of sound from a Harp, I suggest you study the sound board on an ordinary piano. See how the sound from the string vibration (PERPENDICULAR TO) the sound board shakes the (relatively thin) sound board by way of the

string pressing (quite purposely) on the sound board. This is done by way of the added piece of wood called "the bridge". Similar principles are seen in acoustic guitars and even the box type window wind harps. Jeff Boring has reminded me that you will get more sound if the resonant frequency(s) of the soundboard are the same as that for the strings, both fundamental and higher modes of vibration. To say it differently, the soundboard's resonant frequency(s) should match the frequencies of the sounds you expect the board to be "sounding". However, since most soundboards are also part of a hollow box. there is additional opportunity/requirement. The air in the hollow box **also** has a series of resonances!! For these there will be the frequencies of a fundamental vibration resonances and higher modes (overtone). If these are likewise chosen/tuned to the frequencies you want to hear, you will get louder sound output from your harp. Here again, you should study traditional stringed music instruments to see how these principles are carried out to a fine degree of perfection. But your eye has to learn what to see, and your hands must learn what to build. The books *Horns, Strings, and Harmony*, by Ralph Benade AND *Zen and the Art of Motorcycle Maintenance*, by Robert Pirsig, can help you with these learning and seeing processes.

**3) Should various wind driven "clappers" or (hammers) be added to an Aeolian Harp?** A large part of the magic of a "normal" Aeolian Harps comes from the fact that it has **no apparent means for making the sound!** This gives the feeling that the music is of .... and entirely of .... nature herself! It seems like you are hearing "The Music of the Spheres". The Aeolian Harp Designer should work to preserve this feeling for the Aeolian Harp and thus help the listener to properly be "in-tune" with the larger natural reality around the harp. Additionally Aeolian Harps could be constructed so people would be invited to make their own music by playing on the harp. Of course the strings would have to be quite rugged for this "audience participation". And hopefully some monster would not use a club or huge rocks or attempt to climb on such a harp. My Conclusion: All the above together say it is **not** a good idea to add mechanisms, such as clappers, to a traditional Aeolian Harps.

**4) String spacing must not be too close.** It is possible to get a bank of parallel Aeolian Harp strings **too** close together (to each other) to obtain successful Aeolian Harp vibrations, sounds & tones. For example, I exposed to strong winds, the strings of an ordinary upright piano. These piano strings were mounted to a standard (open) cast-iron frame, of standard construction. This frame held the typical two banks of over-lapping strings. The sound board was of course removed so the wind had plenty of un-obstructed exposure to many of the shorter strings and as well many of the longer strings. However I got disappointing results. I am reasonably sure that the strings being too close together was the biggest part of the problem. And I am also sure part of the problem was the irregular surface of the "over-wound" wires for the larger strings. In view of what I have seen with this test, I say the following: Small diameter strings up to 0.030 inch diameter, shouldn't be closer than say 1/4 inch without making tests to be sure all is ok. Large diameter strings up to 0.200 inch diameter, shouldn't be closer than say one inch without making tests to be sure all is ok.

**5) Choice of materials is critical.** I urge all harp builders to do considerable experimenting on the choice of material for either the strings or the sounding board . In an Aeolian Harp, the designer wants to make the largest possible amplitude of mechanical vibrations of the strings acting on the largest possible sounding board. This will produce the largest (loudest) harp sound. This is a critical need under conditions of low wind speed, (which is the way wind is most of the time). Also the designer wants to maintain sound quality. Therefore keep in mind the following: Steel, stainless steel, brass and aluminum all are fairly efficient in preserving the amplitude of mechanical vibrations once they are started to vibrate. Hence these are good materials. To understand this: a) Think how very hard steel wires are used in hi quality pianos and guitars. b) Think how brass is used in hi quality church bells. c) Think how aluminum is used in hi quality tuning forks. (I believe aluminum is among the best for a tuning forks (i.e. has least damping = least energy loss of most common metals). To my mind copper will perhaps produce a

characteristic "dull-dead" sound. Do you remember how the copper cowbells sound in Switzerland? Of course this dull-dead "copper sound" may be exactly what you want to create. So the only way to find out, is to make comparative experimental tests using side by side setups as close as possible to what you desire in your completed Aeolian Harp. **Experimental trial setups**, being simple and inexpensive, can save a lot of wasted time and money and heartache. Since wind is unpredictable you may want to construct an inexpensive "wind tunnel" for your experimentation. An ordinary window fan (with variable speed control) and some cardboard duct is all you need. I could send a description how I made my wind tunnel as an email attachment. Be mindful that brass and copper will weather to copper green color and rainwater running off your structure after several years will color any thing in its path copper green. Of course this may be what you want. With the exceptions of poor resistance to weathering, wood is a suitable good choice for Aeolian Harps. This is seen in the demonstration wood's good qualities in traditional stringed music instruments.

**6) Be sure the wind has un-obstructed flow towards your banks of strings.** Most Aeolian Harps have one or several banks of parallel strings side-by-side, much like those of a lyre or a standard symphony orchestra harp. Be aware that the wind should be roughly perpendicular to the plane of the strings for best effects. But angles up to 70 degrees either way, from perpendicular, will give good results. In addition, Aeolian response will likely get reduced or muffled, in the strings which are "down wind" from another part of the harp structure or some other bank of strings. I have not actually seen any muffled results, but again experimentation should be done to find out the extent of such effects. Of course the muffled effects of various forms of wind blockage, might actually be what you want!

**7) Electronic Guitar "Pick-Ups" will "Bring Out" Interesting Sounds in Weak Wind.** As an alternate to a sound board, you may use various electronic vibration "pick-ups" plus electronic amplification plus loud speakers. Electronic sound amplification is actually quite good, but be aware that this requires more expense, more complexity, a source of external power, and there will be a constant maintenance problem, especially because of weathering. You may successfully use either magnetic pickups (such as on an electronic guitar, see below) or a device called a piezo transducer or possibly called a piezo sounder (see below).

**a) How To Add Ordinary Electronic Guitar Pickups to an Aeolian Harp.** To see how to mount a magnetic pickup on your harp, study how it is done on an electronic guitar. If you have (or can view) the photographs included in Roger Winfield's Windsongs CD (See item A) above), you will see how he incorporated ordinary electronic guitar "pick-ups" on a crossbar, as close as possible, to the strings of his Aeolian Harps. His placement of the guitar pick-up is quite similar to that used on most electronic guitars and is quite successful. Of course if a magnetic guitar pick-up is used, the "strings" must be of steel wire and their rusting in outdoor weather is a problem. Magnetic guitar pickups may be purchased at most music stores, or <http://www.windworld.com/products/magspotPU.html> . (I have been unsuccessful in locating a web site that shows web photographs of Mr. Winfield's harps. If you have useful information please let me know.)

**b) How To Add A "Piezo" Electronic Guitar Pickups to an Aeolian Harp.** A piezo transducer device is similar to the active element that often is used in "crystal" microphones or telephone mouthpieces. I am able to purchase these transducers for a few dollars each at the United States electronics store called Radio Shack. Look for item 273-073 or 273-064. You will have to pry open the plastic case and remove the thin brass disk that is about 2 centimeters in diameter. An experienced electronics technician will recognize how to connect the wires from the disk, to the wires on the coaxial microphone cable that should be at least 2-3 meters in length. The cable should be attached to a microphone plug that fits your audio amplifier, which in turn is connected to suitable loudspeaker. Steps for installation: First have your audio (stereo) amplifier AC power off and volume turned to minimum. Then plug the microphone cable into

your audio amplifier. Caution: Have the loudspeaker and the piezo transducer separated by more than 3 meters, other wise you will get a very loud squeal from "microphone feedback". Cautiously turn on your amplifier AC power and slowly turn up your amplifier volume while lightly blowing on the transducer. You should readily get microphone type results. The piezo transducer is quite sensitive, and will pick-up the slightest vibration or noise, even birds singing 5 meters away!!!! Turn off the power to your audio amplifier. With the string of the Aeolian Harp loose, slide the piezo transducer under the Aeolian Harp string between the string and a so-called "bridge", which will push the transducer sideways against the string. As the string is re-tightened, the pressure of the string may bend or crack the somewhat fragile transducer, so a tiny piece of soft wood (smaller than grain of wheat) should be used as a cushion between the string and the "active" side of the transducer. Theory: The string vibrations cause rapidly changing pressure on the transducer, which in turn places a rapidly changing (small) voltage on the attached wires which is in turn amplified and changed to sound by the loud speaker. Caveat: Although these piezo transducers are inexpensive, reliable, and quite good for the Aeolian harp application, it is likely there are other pick-up devices available that I have not discovered yet. I have not attempted any systematic search for better transducers. If you have any additional knowledge, please let me know.

Here is a link to an article on how to make a Piezo

Pickup. [http://ecklunds.com/frets/lutherie/homebrew\\_piezo.htm](http://ecklunds.com/frets/lutherie/homebrew_piezo.htm) The original article (the one I went by to make my pickup) was published in the March 1987 issue of Electronic Musician magazine. The article is called "Two Buck Pickup" by James Chandler. I don't have an electronic copy to send you.

### **8) A Simple Wind Tunnel Constructed for Aeolian Harp Research:**

**A simple Wind Tunnel Is VERY important for Aeolian Harp research and comparisons.**

Traditional Wind Tunnels have found their greatest use in aircraft aerodynamic research. In the "test section" of such a wind tunnel must have the smooth air flow called laminar flow, i.e. no turbulence. To achieve this, aircraft aerodynamic research wind tunnels often have a "bell shaped" entrance for the wind to come in. The fan, which causes the air motion is placed at the exit of the tunnel. This general design is also a successful wind tunnel construction for Aeolian Harp Research.

**Description of my Wind Tunnel:** My wind tunnel exterior (i.e. the tunnel "tube") was made from corrugated cardboard box material. The wind tunnel entrance for the wind, was an open rectangle about 2" (~5 cm) high, and about 30" (~75 cm) wide. The width should be wide enough to hold the various Aeolian Harps to be tested. The wind tunnel exit "tube" was tailored to fit to the exterior shape of my fan. The tunnel "tube" (length about 40" (100 cm). was so constructed to make a uniform gradual change in shape from the shape of the tunnel entrance (rectangle) to the shape of the exterior of the fan (square). My fan was an ordinary common window fan, about 24" X 24" (~50 cm X ~50 cm). I used a variable transformer (called an auto-transformer) to adjust the wind tunnel fan voltage speed the normal 115 volt alternating current, to any where from zero volts to the full power 115 volts. Thus the fan speed could be precisely set to any speed I wanted. Once the speed was set, the tunnel would stay at that windspeed for long periods of time. One detail: Most of my Aeolian Harps that I wanted to test, were the "window sill box type" with a flat "cover" over the top surface of the box Aeolian Harp. This would hold the wind to a ~1" (2.5 cm) space surrounding the strings. To achieve good control of the wind over the strings, it was sufficient to hold the Aeolian Harp snugly to the wind tunnel entrance. There was no need to 'fit' the Aeolian Harp to the precise shape of the tunnel entrance. With this configuration, I believe all portions of the string will have nearly the same windspeed.

It took me about 2 hours to "cobble up" my wind tunnel, so you should make one too. You will be most gratified that you made your own Wind Tunnel

### 9) Other Miscellaneous Information re Aeolian Harps. (May duplicated parts of the above.)

I have experimented with the science of harps and pianos quite a bit, and thus hope the following is useful information.

1) Your experience with music and the close study of traditional music instruments, should serve you very well in your efforts to construct a good hi quality sounding Aeolian Harp.

2) I urge you to do some experimenting on the choice of material for either the strings or the sounding board. In an Aeolian Harp, the designer wants to make the amplitude of the mechanical vibrations in the sounding board or the strings as large as possible, and thus produce the largest (loudest) sound. Also the designer wants to maintain sound quality. Therefore keep in mind the following: Steel, stainless steel, brass and aluminum all are fairly efficient in preserving the amplitude of mechanical vibrations once they are started to vibrate. .... Think how very hard steel wires are used in hi quality pianos and guitars. .... Think how brass is used in hi quality church bells. .... Think how aluminum is used in hi quality tuning forks. I believe aluminum is among the best for a tuning forks (i.e. has least damping). .... To my mind copper will perhaps produce a characteristic "dull-dead" sound. Do you remember how the copper cowbells sound in Switzerland? Of course this "copper sound" may be exactly what you want to create. So the only way to find out, is to make comparative experimental tests using side by side setups as close as possible to what you desire in the end. Experimental setups, being simple and inexpensive, can save a lot of wasted time and money and heartache. I could send my Aeolian Harp Venture Grant Report describing my use of an inexpensive "wind tunnel" to do experimentation. I could send it as an email document or as a Claris Works attachment (most convenient) or as a MS Word attachment.

3) Be mindful that brass and copper will weather to copper green color and rainwater running off your structure after several years will stain "copper green", any thing in its path. Of course this may be what you want.

4) Before building an Aeolian Harp, or even experimenting, be sure to study all the web addresses on this WebPage so you may see what other people are doing.

5) In my experience the Aeolian sounds are often very very disharmonious when the Wind Harp responds to a wind speeds that are constantly increasing and decreasing. (Rarely is the wind speed steady.) Because the wind tends to vibrate the strings at the 5, 6, 7,th etc, etc overtones, AND because the wind speed is going up or down, the A. Harp is quite often sounding dis-harmonious sounds in all different tone directions. Also in very strong winds, Aeolian Harps make two non harmonious notes simultaneously on the same string (9th, 10th, 11th, etc overtones). For this reason I don't think different kinds of tuning don't really make any big difference. Despite all of this, typical Aeolian Harp Builders make their harps with strings of many different diameters but tuned to same fundamental. Some builders tune to a single note, such as Concert C. I have been asked about pentatonic tuning. My guess is that pentatonic would be just fine and as good as any of various tuning methods, I have heard of. I have even seen diatonic tuning mentioned in the Aeolian Harp literature. Nevertheless my Venture Harp, when I get back to finishing it, will be tuned as a first try, to every third string one octave higher, with the two strings between the octaves, set to 3rds and 5ths. Although I have no idea how well this will work out, I chose this "scheme" because I understand that is how wind chimes are often made to sound, and I expected people to stroke or play simple tunes on this Aeolian Harp. Also this harp was to be a Physics Lab demonstration device. I wanted it have many strings cover three octaves and have the tuning typical of a piano for the purpose of demonstrating music ideas having nothing to do with A. Harps. I have been satisfied in preliminary experimentation with this harp. But this whole project got put on hold three years ago and I haven't got back to it since. The above mentioned [Venture Grant Aeolian Harp Report](#). has more information. Please

bear in mind the following: I am not musically inclined and have small knowledge about the tuning of Aeolian harps.

**Mr. Jeff Boring asked:** How do you determine the resonate freq. of a devise that is already made? Or maybe the better question is "how do I pre-determine the resonate freq. of a devise I'm going to make? Is there anyway to know ahead of time what I'm working towards? Do I simply make the devise, determine the freq. and then string it up to reinforce that freq? If the answer to that is "Yes", then what is the best method of determining the freq of the device? One site I read said I should record the sound waves as I thump the device and pay attention to the pikes and valleys of the trailing sound waves. I don't think that sound very effective.

**My Somewhat Lengthy Response To Jeff Boring** (Which will eventually be properly edited and improved.)

Since you have a guitar you can do more experiments in order to quickly/easily gain more experience. For example, you could try your guitar in a very strong wind. You will find that there is almost no Aeolian sound with the wind perpendicular to the guitar body. By contrast, the guitar with medium wind parallel to the front of the body of the guitar, will give some weak Aeolian vibrations. (Of course, the guitar response in very strong winds will be larger.) The fact that the guitar doesn't work very well is itself instructive. It's partly because most of the strings are "down-wind" from another string. Also because the airflow over the body sets up bad turbulence before the wind gets to the strings. I never tried it, but a "vee shaped wind funnel"= two flat sheets of cardboard to direct the air at the strings might eliminate these problems. Since you own a guitar, you should do all manner of acoustic experiments with it: Keep on "tapping, thumping and pounding on" your guitar and learn what happens. That is how all of our traditional music instruments were developed into their present highly refined performance! Only in the last 50 years has modern electronics and a developing "musical science" as in "Horns, Strings and Harmony" made further (small !!) improvements.

On your guitar, you will be glad you experimented with the comparison of "sideways" string vibration, with "up and down" vibration. You will see that this is quite instructive and that there is a very noticeable difference: As you would expect, "sideways" string vibration gives a weak sound, and "up and down" string vibration gave a much louder sound. This should make sense, and corresponds to the operation of a loudspeaker: There are good reasons for the loudspeaker to vibrate perpendicular to its face, and not "sideways'.

Soundboards are vibration energy "transducers": They move the vibration energy from one system to another. When a string vibrates the "bridge", that vibrational energy is passed to the sound board. (That is what the bridge on any stringed instrument is designed to do! ). The soundboard then begins to vibrate and disperses vibrations through bracing inside the guitar, if present. This causes the air inside the boxlike shape of the guitar to agitate. It bounces around inside, causes the air inside the "box" to resonate and get louder. Eventually the sound bounces out the soundholes.

**Studying, and Participating In, the Phenomenon Called Resonance.** To learn about resonance, find a coke bottle (or similar), and learn how to blow over this type container till you get a loud tone. To do this, form your lips, with a hole, like a flute player. Then, again like the flute player, hold the open hole of the coke bottle to your lower lip and blow (somewhat down) but basically over the hole in the coke bottle. Adjust the shape of your lips, strength of blowing, and angle of blowing until you learn how to make the loudest tone sound. You will find it best to direct the direction of your blowing at the edge of the coke bottle opposite your lips. Practice with other bottles, especially those that have the smaller size of hole. Also try a one gallon glass cider jug. It is somewhat more difficult, but gives a pleasing low base note!! Don't worry if you don't have perfect tone results from your bottles.

Once you are successful at getting loud tones, called resonance, then you can start learning:

a) The "resonating" sound you got is a musical tone (i.e. musical note) which had a certain # of cycles per second called the "frequency" of the musical note.

b) Smaller bottles have high note (high # cycles per second) and

c) Large bottles have a low note (low # cycles per second.)

d) It is important to see that the size of the bottle (how much contained air volume), controls which musical note the bottle will make. This is the note will be made loud through the resonance process.

e) It is important to see that flutes, whistles, and organ pipes all produce musical notes in the same manner as your "blowing on a bottle". Be sure you understand how these several instruments are doing the "same thing". The clarinet, obo, and bassoon also use resonance. But they are different in that these instruments use a reed to start the resonance. (Information on the web may also help with the idea of resonance.)

e) I suggested you do the above so you would now understand the following important idea:

f) The air-volume "inside" the guitar is also capable of doing the same thing as your bottles. The guitar strings, when they vibrate, will shake the bridge, and this in turn, vibrates the body of the guitar. The vibration of the guitar body (really a sounding board) may cause the air-volume "inside" the guitar to resonate. And this resulting resonance will amplify (i.e. make much larger), the sounds the strings are trying to make!! Just what the guitar builder worked to hard to achieve!! Moreover, the guitar's body, being a some what flexible diaphragm, like wise have its own resonances actions. This resonating vibration also may be tuned to match the general resonance frequency (tone) of the guitar's vibrating string are trying to make. Nearly all stringed instruments do this same "double action": Both the inside air-volume **and** the flexible body of the guitar are purposefully built, so each have certain resonance frequency(s) that will make louder the vibrations of the strings. The same principles may, of course be used to help an Aeolian Harp make the loudest possible sounds. Again, you should try to achieve the above mentioned resonance frequencies (both the inside air volume and the flexible diaphragm) to have frequencies around the general frequency that the strings themselves are trying to make. But don't worry if you don't have perfect understanding! So long as you are paying attention and thinking, you will move in the correct direction. I should here mentioned that any sort of strings attached to a flexible board (or metal sheet) will make enough Aeolian sound, that you will be thrilled with your harp!!

A soundboard of most stringed music instruments, should be light, thin, thus flexible. However, you must have enough thickness to achieve structural integrity. Also the thickness must be such to achieve the above mentioned resonance around the general vibration frequency of the strings. Thus there is a great deal of study and experimentation with different bracing patterns on guitars to achieve this. Remember that the sound board is also part of the "sound-box"/ The air-volume inside the "box" of the itself also should resonate to the general string frequency, and thus yield louder, more bull bodied, sound.

**Experimentation Is Very Important!!!**

**A Review of the Above, But With a Different "Slant"!!**

**Get Your Hands On a Guitar, or Other Stringed Music Instrument: 1) Learn How It Is Constructed. 2) Learn How a Music Instrument's Construction Provides For It's Musical Qualities.**

Get hold of an actual music instrument. Ask a friend or go to a guitar store and ask to look at one of their old guitars in a back corner. In general, study lightness of construction and thinness of the soundboard. Notice where the guitar is heavy, thick, and stiff. Thump on your guitar all-over its various sides and listen to the sounds. Notice how the thin flexible surfaces produce sound and the curved surfaces and thick parts don't make much sound. Notice where the guitar has different bracing patterns on the inside. For the most

part you will see that the top surface under the strings, acts as the "soundboard" of the guitar. A soundboard should act as a somewhat flexible diaphragm and not as a flexible membrane. This part does most of the vibrating and not the sides and back, and this is what produces the sound. Some guitar makers have made a thicker ring around the perimeter of the soundboard to inhibit interaction with the sides because the guitar sides tend to produce non-harmonious tones when vibrated. In fact that's why the sides are so "curvey" and not very high top to bottom. By construction the top surface of the guitar promotes the above mentioned resonance action, thus making louder the tones of the strings. You may actually feel these sound board vibrations. To do this, lightly touch various places of the top surface of your guitar, while you pluck (mostly low) notes. (To do a "pluck", pull up the string and suddenly let-go, so the string vibrates up & down.) Contrast with an equal "sideways" pluck. (To do this pull the string sideways, and let-go.) You should see that the loudness (and top surface vibrations) are greatest for up-down string vibration verses side ways vibrations. Think about this, and it should be obvious why you get these results. On guitars the open "hole" is placed at the center for probably for a good reason, and the bridge is placed at the "one quarter point" of the guitar body. I have a suspicion that this may be also a best place for the bridge action. The flexible flat metal strip at the base of a guitar, that holds all the strings tight, to the base of the gaiter, does not touch the diaphragm; it only hooks on to the ridged side. Again for a very good reasons. The size (diameter) of the hole is a very important. In fact it is a convenient way to "tune" (i.e. adjust) the resonance frequency of the inside air-volume, so as to best make loudest the desired vibration frequencies of the strings. The resonance frequency of the air-volume inside the soundbox can be changed by changing the size of the soundhole. The bigger the soundhole, the higher the resonance frequency. Why does the hole size matter? You should read up on "Helmholtz Resonators" in an encyclopedia or possibly physic text books. Incidentally for the hole to be the only controlling factor in adjusting the resonance frequency (of the inside-air-volume), the air-volume must have no other leaks! The whole air "cavity" should be "tight" like a well made boat. There must be no leaks other than the big hole! What determines the musical note, of any given string, in a music instrument? The length tension, diameter and density of the string, all have a factor in the resulting musical note = the cycles per second =frequency. However, once a certain string has been installed, the tension is by far the easiest way to tune the string.

**You can also learn from the construction principles of other stringed music instruments.**

Most of the guitar "principles" discussed above, obviously apply to the other stringed instruments such as the Violin (and its cousins: viola, cello and base vile), zither, lute and orchestra harp. However the vibration actions of a violin (and its cousins) are different because they have their strings vibrated by a violin bow, rather than plucking. A violin's bridge is placed near center of the soundboard and is, in contrast to the guitar, quite high. With this construction, the horizontal stroke of the violin bow, combined with the high bridge, actually "twists" the soundboard. Guitar "principles" discussed above are also found in other stringed instruments like the piano, harpsichord, and banjo, except these instruments do not have an enclosed box added to their soundboards.

**All the Guitar "principles" Discussed Above, Are Object Lessons for Builders of Aeolian Harps!!**

From the above would-be Aeolian Harp Builders should have learned that:

- 0) Aeolian Harps will give a lot more sound if they have a soundboard. The soundboard should be somewhat flexible. To do this, make it flat (like a board) and comparatively thin. Curved surfaces, like an automobile fender, added to it's rigidity, and thus it will not be able to do it's job. (
- 1) Aeolian Harp strings must cause the soundboard vibrate perpendicular to it's surface. 2) And ideally, the soundboard should move as a single unit, not breaking up into smaller vibrational nodes.
- 3) And where you place the "bridge" (if any) on the soundboard is also an important consideration. The center vs. part way out from center, will change the loudness and sound quality.
- 4) If you add a "box" to your soundboard, it should be well sealed except for the "hole"

5) The sound box hole, itself must have the optimum size, achieved by experimentation.

5a) You may avoid the complications of soundboards and sound-box. One way to do this is to use electronic pick-ups, amp fliers, and loud speakers. But be aware these have their own difficulties.)

6) Builders should realize that the length of the string affects the intensity of the tones. The longest strings will produce the loudest tones, because they "have the most wind" exposure from which to gain energy.

7) The diameters of the strings and the wind velocity are responsible for the frequency of the resulting Aeolian tone. Aeolian Harp.

7a) For best results, Aeolian Harp strings should be true cylinders, like common ordinary fish line or common fence wire. Some Aeolian Harps builders believe the braded plastic strings give the best sound, as opposed to various strings that have a smooth cylindrical surface. So you might want to give that a try. If you want to use magnetic pickups with strings that are not magnetic, you can add a short length of magnetic wire to the nonmagnetic string. I have found that crimping a piece of small diameter stainless syringe tubing, around the string, works well. Or even a small piece of a magnet could be used. You will find it best (for a variety of reasons) to add the magnetic material near the end of the string.

8) Remember that, for any one string, the musical notes from an Aeolian Harp, are mostly the much higher harmonics of the string. Unless the wind speed is very low, the wind will not "play" the fundamental (ground-tone) for that string. (Note: The fundamental is the lowest frequency the string will "sound" and is (mostly) what you hear if the string is plucked.)

9) Most Aeolian Harps have many strings, but the strings are of many different diameters.

10) Many different diameters make the best use of many different wind-speeds, and give a more interesting variety of tones. Many Multi-Stringed Aeolian Harps have strings same length. In general, small improvements are achieved by "tuning" (of the strings to each other). Many harp builders prefer to tune the lowest notes (i.e. fundamentals) of all these strings to be in unison or octaves. These builders say that tuning the strings to include "the fifth" (pentatonic) is less satisfactory. And adding other tunings such as thirds, diatonic, etc is by far even less satisfactory.

11) The reason for the choices in 10) above come from the fact that the Aeolian sounds from the wind are typically the very high modes of vibration of the string. These higher modes, called overtones, are dis-harmonious. And you can not stop these dis-harmonious frequencies!! Thus, no amount of "tuning" can make the harp a whole lot more harmonious. As I have said above, Aeolian Harp tend to give the highest modes of string vibrations. This happens most often in very strong winds. So in strong winds, there tend to be several these simultaneous "overtones" at once and they are very dissonant, even shrill. These sound un-pleasant to most people. By contrast gentle winds, will yield the lower harmonic tones, nearer the fundamental. These will typically have enough distance from one another, so you will get pleasant, more harmonic musical tones in relation to each other. These gentle winds often go (not in form of gusts) but in shape of long "waves" so the strings can react fast enough to play a long series of ever changing and harmonious tones. With gentle winds, you likely have pleasant accords/harmonics changing slowly in never repeating rhythm/ combinations.

12) There are many good choices for the materials of your Aeolian Harp. For the most part the materials chosen for the strings and the body of your harp should be chosen based on cost, appearance, ease of manufacture, and ability to with-stand weather. In general, the choice of materials will not greatly affect the sound quality of your harp. For choice of materials, you should be guided by Traditional Music Instruments and other Aeolian Harp Builders. For the most part, you can get the same vibrational/resonance frequency characteristics from most metals. However: Avoid copper because it will be too "dead" (i.e. vibration absorbing). Steel on steel will be easier to weld, but you need to get it "thin" enough. Although it will rust, steel can be painted to prevent rust.

13) Be sure the wind blows "directly at" your Aeolian Harp Strings with no obstructions. This means your

strings should not be "down wind" from parts of your structure or even other strings! Some box-type Aeolian Harp Builders, will "stagger" the string height from the top of the box, to make sure each successive string is not exposed to the turbulence of the adjacent strung up-wind.

14) What you decide upon should be based on experimentation. Always experiment extensively to help guide your design and materials choices. If you have already built (or purchased an Aeolian Harp, you can use it as an experimental "platform" to help guide your design of your next and better harp. A wind-tunnel is a great way to experiment. It is inexpensive and easy to make. Mix reading about Aeolian Harps along with your experimenting: The more you experiment, the better you will understand your reading!! the more you read the more you will understand your experiments!! Read + Experiment = Synergism!!

15) The above considerations will make your Aeolian Harp design problems more difficult, but in the end will yield a better harp!!

**Best of luck with your efforts. Please let me know your results and post your Aeolian Harp Pictures and Aeolian Harp Music on a WebPage for all to see and learn from!!**

#### **L) Interesting Internet Links that have good information on Aeolian Harps.**

The Wikipedia has much good up-to-date information (and links) about practically all topics, including Aeolian Harps: See [http://en.wikipedia.org/wiki/Aeolian\\_harp](http://en.wikipedia.org/wiki/Aeolian_harp)

A very interesting site having, links, much history, several diagrams, and a photo of a box type of A. Harp. Wind Harp Europe = <http://members.aol.com/woinem1/index/eolsharf.htm>

Great photos of a very large Aeolian Harp having (I believe) metal "sound boards" at bottom of strings. Wind harp = [www.nfo.edu/harp.htm](http://www.nfo.edu/harp.htm)

A web site that has an excellent diagram showing how to make an A. Harp + links to 8 other A. Harp sites.

Little Harp = <http://www.art-robb.co.uk/aeol.html> His old site now dead: [www.argonet.co.uk/artlute/aeol.html](http://www.argonet.co.uk/artlute/aeol.html)

A site that shows the Aeolian Harp at "The Wilds" an animal park near Zanesville Ohio. Wild Wind = <http://www.yourradioplac.com/tourism/wildsharp.htm>

This site shows how to make a wind music Instrument made of plastic bottles.

Plastic Bottle Wind Organ <http://w1.neuronnexion.com/~dferment/ukplasto.htm>

Bill & Mary Buchen, of Sonic Architecture Incorporated (TM) have made many Aeolian Harps. Their web site does yes work but you will have to explore around a bit to find what you are looking for. <http://www.sonicarchitecture.com/> Also have a look at.

Ron Konzak's Aeolian Harps looks like it has many links

<http://www.konzak.com/windharp/whlinks.html>

Ross Barrable's "Harmony Wind Harps"

<http://www.soundscapecinternational.com/>

A site which shows three huge proposed sculptures of Guitar, Violin, and Banjo. This, if constructed, will be giant Aeolian Harps.

<http://appalachianheritagealliance.org/EKHeritageMonument.htm>

Report from Jeff Boring: During the day I work as a computer systems manager for LabCorp in Burlington NC. That distracts me from the important things in life like wind harps and rock walls. I have a thing about building rock walls. Check out my rather simple website <http://home.alltel.net/jeffboring/> if you are interested in seeing my rock wall project. If you look closely on the last rock wall project photo you will see my existing wind harp in the background. Click on "Aeolian Harps" in menu to see my two Aeolian Harps. <http://home.alltel.net/jeffboring/windharp.htm> Mr. Boring recently emailed the following: One photo that shows Opus 1 (which you have seen before), and Opus 2 (which you have not seen). I incorporated many changes in Opus 2 based on the conversations I had with you about the poor performance of Opus 1. In short, I made Opus 2 larger with longer and more strings. Also I made the soundboard flat instead of arched like it was in Opus 1. In addition I made sure that the soundbox was sealed everywhere except for the sound holes which I made smaller. I determined the tuning of the strings by placing sand on top of the soundboard and plucking the strings while tuning the strings. I observed the sand and would stop tuning when the sand began to dance. Opus 2 functions noticeably better than Opus 1 but is still short of where I want it to be. .... I have not given up. I haven't made much progress but I haven't given up. In fact recently I've been talking to various people about this project and I'm wanting to get started on Opus 3. I just need some ideas on how to proceed.

Recently found by Google: File Format: PDF/Adobe Acrobat - The wind, blowing around the wire of the Aeolian harp produces, the vortex-shedding phenomenon and Strouhal, observed that the sound frequency was dependent ... [FLOW AROUND MODIFIED CIRCULAR CILYNDERS](#)

**N) Persons who are willing to share Aeolian Harp knowledge and answer question.** First all the web addresses on this page should be reviewed to see what other people are doing and perhaps answer your own questions, but is you still have questions the following persons may be willing to help.

1) Mr. Uli Wahl might possibly share ideas with persons working on Aeolian Harps. He has communicated to me much, and seems quite knowledgeable in many aspects of music and Aeolian Harps. His web address is below. **Attention: Mr. Wahl will share mutual exchange of ideas and will expect you to be an equal partner in the sharing!** As I have also have experienced, too many would be harp builders want free information, but will not reciprocate with equal effort. Nor do they share their efforts or ideas with the larger Aeolian Harp Community. This is very discouraging, and produces well known consequences, which you may think about! Uli Wahl has communicated to me much, and seems quite knowledgeable in many aspects of music and Aeolian harps. He seems quite willing to write to persons working on Aeolian Harps. **NOTE:** Mr. Wahl's WebPages are in **German and English**. You will have to **scroll down** (usually) to find the English. <http://members.aol.com/woinem1/index/>

2) Many places above I report the Harp building experiences of Mr. Jeff Boring. <http://home.alltel.net/jeffboring/windharp.htm> . He is willing to answer questions and offer email advice help to Aeolian Harp builders and enthusiasts. You may reach him at [jeffboring\\_alltel.net](mailto:jeffboring_alltel.net)

3) If you live near a high school, College, or a University, you might be able to ask the person(s) there, who teach physics, to help you. Science teachers, in general, will be fascinated to hear an Aeolian Harp (or it's music), and that would be a way to get to know a new person who will have ideas to help you.

4) More names will be placed here ASAP.

**O) Additional Information.** Over the years I have received information concerning location of Aeolian Harps in various places in the United States. A three page document, LOCATION OF MAJOR AEOLIAN HARPS IN UNITED STATES, will be emailed or snail mailed upon request. This information should be considered as out of date and somewhat unreliable since it has been collected from a variety of people and no attempt has been made to verify the accuracy. If you need this information, please send a large self-addressed envelope plus about \$1.00 worth of postage stamps.

**P) If you find errors or have suggestions to improve this site, please take quality action and let me know. My addresses, email, and link to my Home Page are below.**

**Please let me know if any of this is any help to you.** I certainly wish you much success and satisfaction from the construction of your Aeolian Harp. Please let me know of your progress and place your photos and sounds on the Internet for all to see and hear !!!! I will be happy to place a link to your Internet Site on these pages! Final thought: I almost never get any reply when I send information and this is discouraging.

Having read the above, you now may wish to go on to the following of pages:

[How I Came To the Books of Owen Barfield.](#)

[My Work With the Camera Obscura.](#)

[My Venture Grant Aeolian Harp Report.](#)

**Good References:** Reading the book "*Horns, Strings and Harmony*" by Ralph Benade may help. One of the best English books on Aeolian Harps is "Instruments and the Imagination" by Thomas Leroy Hankins & Robert J. Silverman. See also their article "The Aeolian Harp and the Romantic Quest of Nature. Regarding the physics of voice generation and resonance, you might want to see the article from Science News, December 16, 2000, which talks about a study which challenges Raleigh's reasoning on flag motion in the wind. It refers to a study by Jun Zhang outlined in the December 14, ?1999? journal called Nature. Also reading about "resonance" in physics books (or information on the web) may or may not help you.

WARNING !!!! DANGER TO LIFE AND SERIOUS DAMAGE TO EQUIPMENT may be present when attempting to use any form of electrical or electronic equipment such as may be suggested herein. User assumes all risk. Persons unfamiliar with electricity and electronics should get assistance from experienced people who can safely work with electronic guitar pick-ups, microphones, tape recorders, audio amplifiers, and/or public address systems. Places that sell electronic equipment may be able to help!!!! User assumes all risk. WARNING !!!!

### **Appendix 1: More About the Spiritual Aspects of the Aeolian Harp: Is There a Metaphysical Connection of the Aeolian Harp With the Music of the Spheres, and Other Examples of What Might be Called Naturalistic Physics? A Comment On the Practice and Concept of the Aeolian Harp.**

Professor Michael Gregory, Editor of H-NEXA, sent me this above question. My response follows. By Henry Gurr:

Although I have never heard the term "The Music of the Spheres" applied to the Aeolian Harp, it seems to me quite appropriate to do so. Let me explain. Earlier peoples response to the "influences" of the Heavens, which included the Aeolian Harp, and indeed every thing else in the natural world, were all part of a one common world view we moderns would to well to understand. People 2000-3000 years ago, naturally thought that God, or The Gods, or some higher "spirit creature" (power) played upon the Aeolian Harp thus making the music. From more general evidence, I surmise that earlier peoples considered every

action in the world, every thought that came into their mind, and even physical illness, was the result of actions by these invisible "spirit creatures". (In the previous sentence, I can not say "caused by", because those people did not have our concepts of physical causality!!) Although quite foreign to us in 21st century, this basic (and all pervading) "spirit creatures" world view continued through the Romantic Era.

The Romantics were quite fascinated with the music of the Aeolian Harp precisely because they were generally fascinated with all aspects of Nature. As I understand it, they were looking for guidance or clues or appropriate Metaphors for understanding their human place in the Cosmos. The Romantics looked to Nature and Natural Phenomenon for guidance: Hikes and mountain climbing in natural environments, nature poetry, natural landscape in art paintings, were the many ways in which Romantics sought answers or sought participation in the spirit of Mother Nature (Goddess Natura). In this environment, the Aeolian Harp had considerable literary and musical fascination and impact. In fact the Aeolian Harp explained metaphorically the process in which our brains respond to the Cosmos and Nature. Thus it is easy to see how the sounds of the Aeolian Harp, along with the other sounds of Nature, could be considered, by the Romantics, "The Harmonious Music of the Spheres". Did the Romantics seek a "Naturalistic Physics" to describe every physical process or material existence? Perhaps so. What do you think?

As I understand it, Johannes Kepler had a method to determine the relative spacing of the planets in the solar system, which involved a complicated physical fitting (nesting) of Platonic Regular Polyhedra. He considered this, and all his astronomy work, a study of the Harmonious Music of the Spheres. For Kepler, the planets seen in the sky were Heavenly Spirits up in Heaven. Each planet was moving eternally in its perfect circle, and filled the Heavens with "Heavenly Music". Again, similar to the expectations for the Aeolian Harp, Kepler along with all earlier people was looking for messages, (influence) from the heavenly spirits (planets\_ and rules for the spirit governed Universe.

This whole world view that brought earlier peoples to pay so much attention to spirit creatures, Owen Barfield in his book "Saving the Appearances", has called "original participation". Another example: Astrology in our own time is a relic "left-over" of this same participation mind set, handed down to us from ancient times as early as the Ancient Chaldeans and Babylonians.

What I have given above is bound to be controversial and possibly rejected by current scholarship. Since I am a physicist, and not a literary expert, I can only plead that these ideas are interesting and seem valid and worthwhile to me. I will be glad to receive your considered opinions. Please communicate if you desire more information. Some of these ideas might well be added to an educational program like NEXA. The Aeolian Harp could well assist in H-NEXA goals. It will be my pleasure to continue this conversation with any one interested. Please contact me at address below.

Henry Gurr, Professor of Physics Emeritus,  
University of South Carolina Aiken

**Appendix 2. An Email, From An Artist Tells How He Became Interested in the Aeolian Harp.** I do not recall what, if anything I told you about myself in our conversation years ago, so I will note a few things here for your information. I am an individual artist here in Montana working primarily with forged and fabricated metals, along with carved stone and cast iron. My interests are fairly broad, and I do work including forged architectural metalwork, public sculpture, and of course wind instruments. My first connection with Aeolian vibration was in my youth, while walking along abandoned railways with the old telegraph wires still in place. I imagine that experience was repeated countless times across the continent. For me it was significant, and while still a teen, I built what would be the first of a long progression of instruments which made use of the harmonic relationships possible between the wind and a series of stretched strings. Having a laymen's interest in physics, I studied what I could about the basic

phenomena involved, mostly spanning from the mid nineteenth century to the present. I also am quite interested in the relationship between number and harmony, and so of course tried to familiarize myself with Pythagorean thought, as well as Helmholtz, Raleigh, Strouhal, Partch, etc. The instruments I build are all large outdoor pieces, which have in the past decade been thirty feet in height. I found some time ago that it was best to make my own strings, which are conventional in that they are built with a single wire core (stainless steel music wire) wrapped like piano strings with copper. The machine I made can spin strings any length I need, and involves dies that work with different sized core wires and wrap wires, so that I can adjust my diameters accurately. I have found that aluminum makes a good compromise between acoustic warmth and durability in the construction of soundboards. All of the harps I have built are entirely acoustic in operation. They do not require any sort of amplification. My current interest is in stringing the instruments to produce Aeolian chords which are based in conventional musical chords through the use of simply proportioned string diameters. I have done some work with this, but testing these things is a dicey operation with the variables inherent in outdoor installations. I have built a large rotating testing device to be used indoors, but haven't been able to follow through with all the actual experiments I want to do yet. It would be really fun to devote more time to basic research, but finances do not allow for it. Regarding the physics of voice generation and resonance, you might want to see the article from Science News, December 16, 2000, which talks about a study which challenges Raleigh's reasoning on flag motion in the wind. It refers to a study by Jun Zhang outlined in the December 14, 1999 journal called Nature. Jeffrey

**Henry Gurr reply:** I looked at the Nature and Science News articles mentioned above. Fantastic pictures and GREAT way to show public how an Aeolian Harp works because a single cylinder in place of the thread in the same apparatus shows (similar) beautiful Von Carmen Street swirls. These are the left-right swirls, which cause the reaction force to make the Aeolian Wire vibrate at resonance. Of course once such an apparatus is available, then the silk thread swirls would be "icing on the cake" to show people! I believe every thing they say has great merit, but I lack sufficient knowledge to comment on the fine points of their argument.