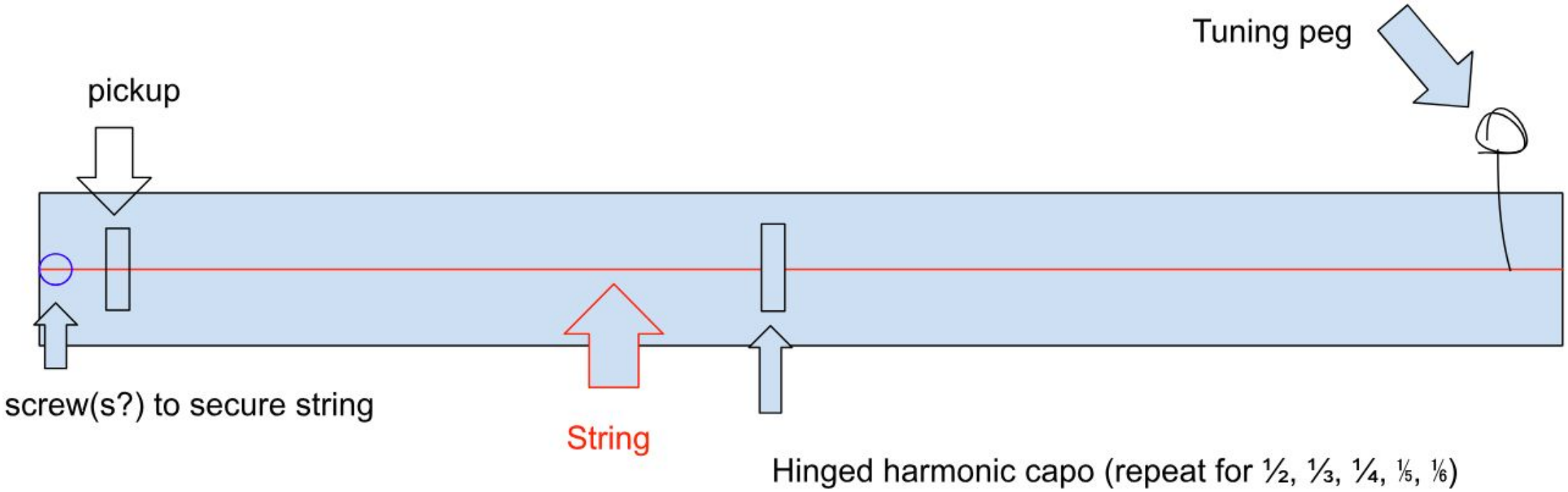
The Harmonic “Oud”

Overview

- The concept
- Harmonics
- Constructing the “Oud”
- The “Oud” in practice

Concept

- Engineer an “Oud” designed to play harmonics
- Design special capos/frets to create nodes in the string when plucked/bowed



Background on string vibrations

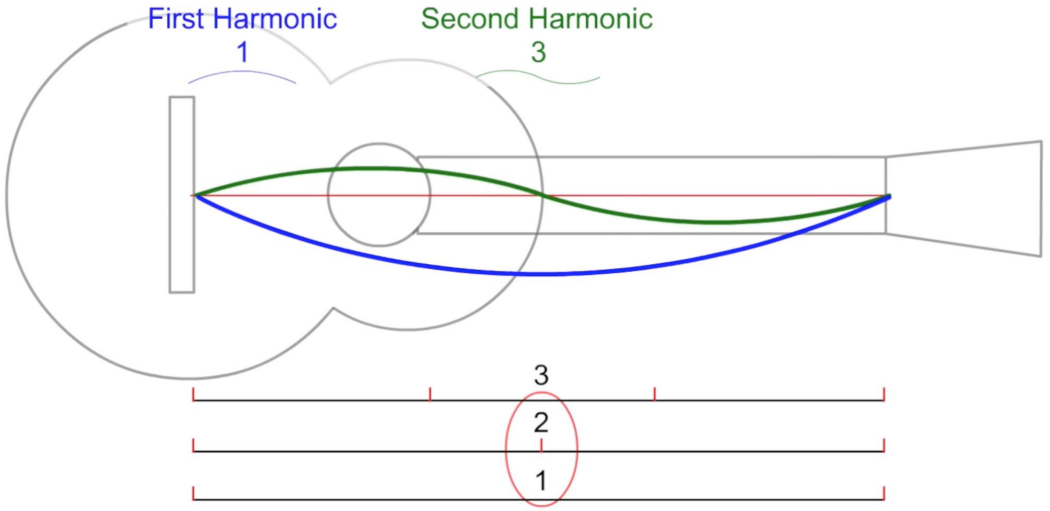
- When plucked/bowed, a tense string vibrates, generating pressure patterns in the air around it
- Those pressure patterns/string vibrations can be represented as a sinusoidal wave, calculated as: $v = \frac{\lambda}{\tau} = \lambda f$ where *v* is the speed of the wave, λ is the wavelength, *T* is the period, and *f* is the frequency
- At normal atmospheric pressure, *v* is equal to the speed of sound, 340 meters per second
- The wavelength is a product of the tension of the string and the length of it. *v*=340m/s=(1/2L*SQRT(T/μ))λ=μ/T. μ is the linear mass density of the string, T is the tension of the string, and L is the length of the string.

Background on harmonics

- When a string is plucked, it vibrates not just at its full length but also in segments, creating harmonics, which are integer multiples of the fundamental frequency. These harmonics are produced due to the string's natural vibrational modes, boundary conditions, and wave interference. The combination of the fundamental frequency and harmonics gives each musical instrument its unique tone.

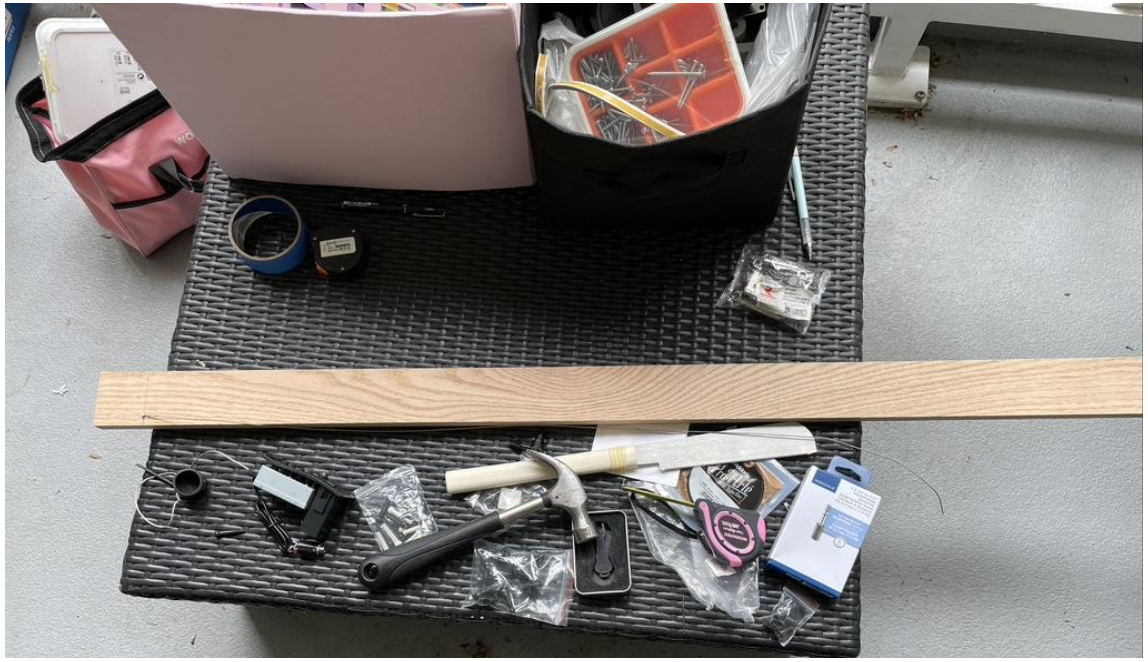
Background on Harmonics continued

- If we wish to emphasize the harmonics in a string, we can create a node in the string, so that the wavelength along the string is 1/x, creating a frequency x times that of the fundamental in the string
- x must be a whole number, such that you have a second, third, fourth, etc harmonic



Construction of the “Oud”

- To demonstrate this principle of harmonics, we engineered an Oud with harmonic capos/frets, halving the length of the wavelength in the string by gently stopping the string from vibrating, creating the nodes located at ½, ⅓, ¼, etc. multiples of the string

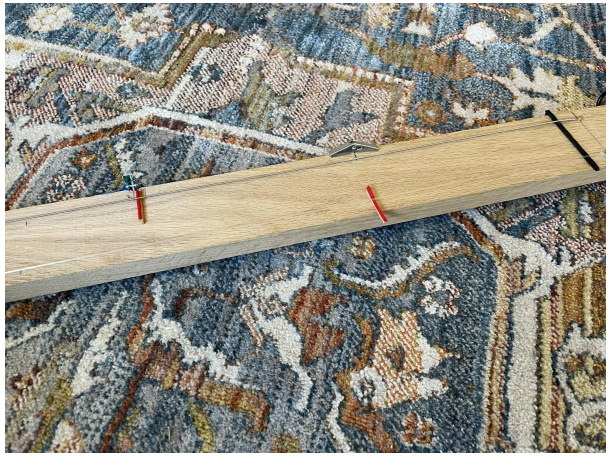


Construction of the “Oud” continued

- We fixed two strings to a piece of oak board, using tuning pegs at one end to create the tension required in v==(1/2L*SQRT(T/μ)) λ=μ/T and allow us to tune each string to a different standard known pitch. (for ease of calculations)

The harmonic “capos”

- To create the harmonics in the string, we engineered three “capos” using aspen splints (matchsticks) and felt
- To demonstrate the difference between a harmonic and simply shortening the length of the string, we included two steel spring-loaded pivots (toggle bolts) to reduce the length of the string by ½ and ¼



The ”Oud” in practice