Simple Plucked and Blown Free Reeds from Southeast Asia

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The origins of the free reed mouth organs of Southeast Asia are lost in the prehistory of the region. This paper explores principles of construction and acoustical properties of two of the simplest of these instruments. The plucked, mouth resonated lamellophone, common throughout the region and known by various names, is made by cutting the sides of the vibrating tongue from a single piece of wood, bamboo, or metal. The tongue is not plucked directly, but is excited by plucking the frame. The instrument is played by placing the reed tongue over the lips of the player using the vocal tract as a resonator. It is also possible in some of these instruments to produce tones by blowing. The free reed horn, also given a variety of names by different ethnic groups, consists of the horn of a water buffalo or cow, hollowed out and fitted with a single metal or bamboo free reed at about half its length. Sometimes a section of bamboo is substituted for the horn. Three pitches are possible when this horn is played by blowing the reed: one with both ends of the horn open, one with the narrow end closed with a hand, and a third with the wide end closed. The pitches can be bent somewhat by adjusting the hand position.

1 Introduction

Free reed instruments were widespread in Southeast and East Asia and were developed long before the "modern" Western free reed instruments, including the harmonica and the accordion-concertina "squeezebox" family, which originated in Europe only about two hundred years ago. Detailed general information on the history and organology of the Asian free reed mouth organs is available in the article by Miller [1].

This paper deals with two of the simplest of these instruments: the plucked, mouth-resonated free reed and the free reed buffalo horn, in which a single free reed is mounted in the side of the animal horn. We also consider a simple instrument with a resemblance to both: the *enggung* of Bali, a single mouth-blown free reed without a pipe-resonator. Study of these simple instruments will further the understanding of the acoustics of the free reed coupled to a resonator in the Asian free reed mouth organs. (See Reference [2] for a summary of this work.)

2 Free reeds

A reed is the generic name given to a vibrating tongue when it is used as the sound generator in a wind instrument. What distinguishes the free reed is that its dimensions are slightly smaller than the opening that it covers, so that when blown it vibrates back and forth through the opening in the manner of a swinging door. In Asian free reed instruments the reed is typically constructed by cutting three sides from a single strip of material, which is very often metal, but sometimes bamboo or other plant material.

Figure 1: An example of a cane or bamboo free reed from a Southeast Asian gourd pipe

3 Plucked Instruments

Before considering free reed wind instruments, we can look at some related Southeast Asian instruments of ancient origin. These are the mouth-resonated lamellophones ("Jew's harps") common throughout the region. They are made - like the free reeds - by cutting the sides of the vibrating tongue from a single piece of wood, bamboo, or metal. The tongue cannot be plucked directly, but is excited by plucking the frame. The instrument is played by placing the reed tongue over the lips of the player and using the vocal tract as a resonator. An example of such an instrument, the *danmoi* from Vietnam, is shown in Figure 2.

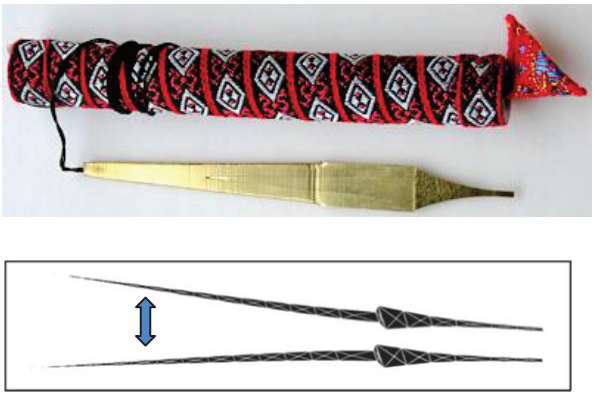

Figure 2: The *danmoi*, a mouth-resonated lamellophone from Vietnam, constructed from a single piece of brass, with a diagram of the tongue vibration below. The plucked end (right) also vibrates.

To play the instrument, the player places the reed tongue over the lips and plucks the end of the reed plate. The pitch is changed by altering the vocal tract, as shown in the spectrogram in Figure 3. Here the fundamental vibrating frequency of the tongue is 84 Hz. Areas of greater intensity indicate greater amplitude of the harmonics in certain regions, producing the effect of pitch change.

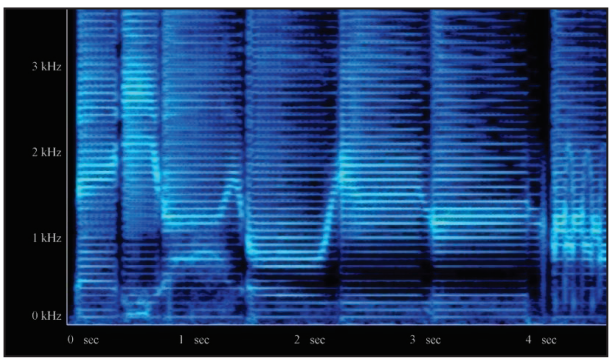

Figure 3. A spectrogram of several tones played on the *danmoi*.

4 Mouth blown free reeds

4.1 The *huntoong*

Although the origins of Southeast Asian free reed instruments are unknown, it appears that that the mouth-blown free reeds and the plucked instruments share a close relation. With some instruments, depending on the details of construction, it is possible to produce tones by blowing as well as plucking. This is demonstrated in the case of the *huntoong* shown in Figure 4. Although this instrument is probably intended as a plucked instrument it is possible to make it also sound as a wind instrument, as illustrated in Figure 5.

Figure 4: A *huntoong* from Thailand.

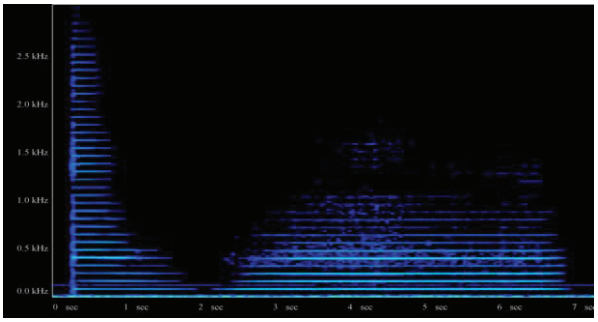

Figure 5: Spectrogram of two tones played on the *huntoong*. In the first case the instrument is plucked; in the second it is blown. The spectral components of the two differ, as well as the attack transients.

4.2 The *enggung*

The relation between the plucked, mouth-resonated instruments and the blown free reed is further illustrated by the *enggung* of Bali, shown in Figure 6 with accompanying sound sample in Figure 7. This instrument is constructed from a single piece of bamboo and includes a handle. Although it has a striking resemblance to the plucked instruments, is it designed as a wind instrument: a single reed intended to be blown. As in the case of the *danmoi* and similar plucked instruments, the player can vary the pitch by changing the shape of the vocal tract. The spectrogram in Figure 6 shows the player varying the pitch by altering his vocal tract.

Figure 6. The *enggung* from Bali.

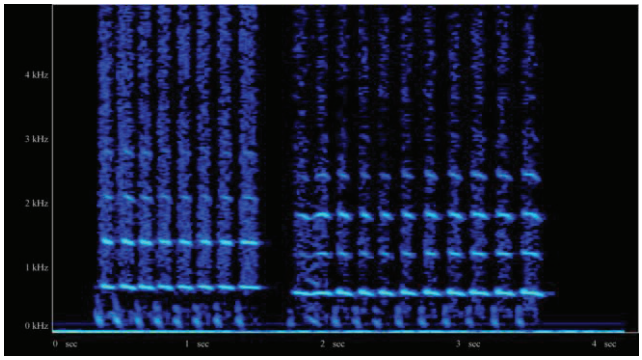

Figure 7: Spectrogram of two tones played on the *enggung*.

It can be seen in the spectrogram that there are changes in both the frequency and the relative amplitudes of the harmonics, resulting in a change of tone quality as well as a change in pitch. This can be better seen in the two spectra shown in Figure 8.

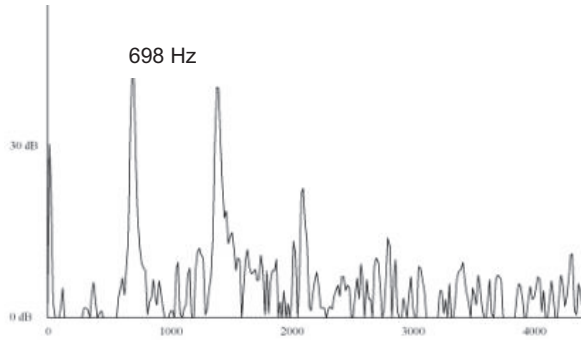

Figure 8a: Sound spectrum of the first tone played on the enggung, with fundamental frequency 698 Hz.

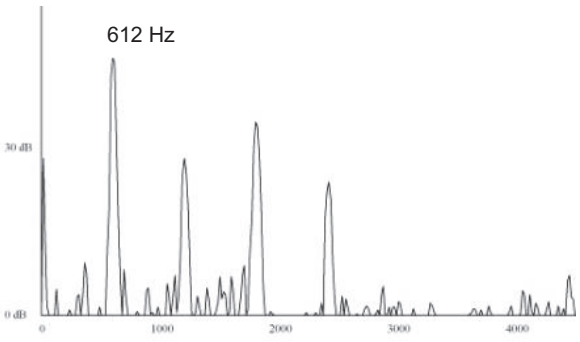

Figure 8b: Sound spectrum of the second tone played on the enggung, with fundamental frequency 612 Hz.

4.3 The free reed horn

The free reed horn is one of the simplest of the free reed mouth organs, traditionally used for used for ritual purposes or alarm signals. It consists of a horn of a water buffalo or cow hollowed out and fitted with a single metal or bamboo free reed mounted in the side. Figure 9 shows an example of one such horn.

Figure 9: A free reed buffalo horn (The narrow end of this one is closed). The inset shows a view of the reed.

Three basic pitches are possible, one with both ends of the horn open, one with the narrow end closed with a hand, and the third with both ends closed. In some cases the narrow end of the horn is permanently closed, allowing just two pitches. The pitch can be bent between these basic pitches by partially covering the open end. This is illustrated in Figures 10 and 11.

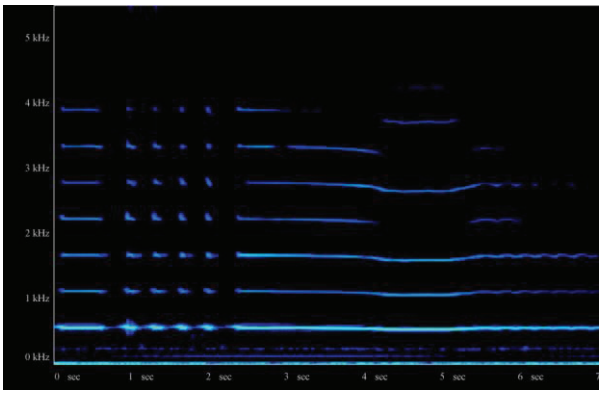

Figure 10: Spectrogram of two tones played on the free reed buffalo horn. In the first case the large end is open; in the second it is closed.

It can be seen in the spectrogram that once again both the sounding frequency and the relative amplitudes of the harmonics change. This is shown in detail in the two spectra in Figure 11.

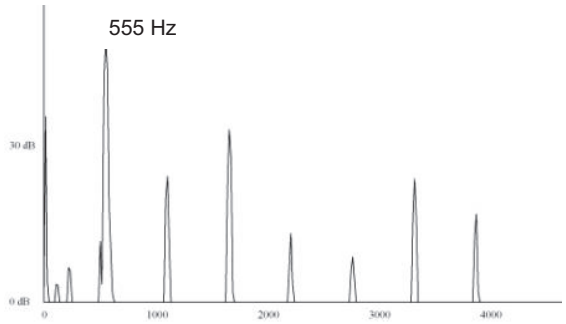

Figure 11a: The sound spectrum of the first tone played on the free reed buffalo horn, with the large end open: The fundamental frequency is 555 Hz.

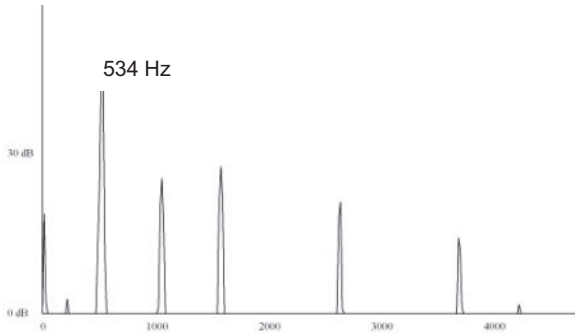

Figure 11b: The sound spectrum of the second tone played on the free reed buffalo horn, with the large end closed: The fundamental frequency is 534 Hz.

4.4 Free reed mouth organs

Most Asian free reed instruments employ free reeds mounted in bamboo pipe resonators. In some cases a single reed is mounted in a pipe with finger holes, so that the pitch can be varied by changing the effective length of the pipe. Other instruments consist of a set of bamboo reed-pipes that produce one note per pipe, with each pipe mounted in a wind chamber. An example of this is the gourd pipe shown in Figure 12. In these instruments the sounding pitch is determined by the pipe resonance, so that pitch bending using the player's vocal tract is essentially eliminated.

Figure 12: A Southeast Asian gourd pipe

In an instrument like this gourd pipe a finger hole is drilled at a point that destroys the pipe resonance and prevents the reed from sounding unless the hole is closed. The reed, enclosed in the gourd wind chamber, is mounted in the side of the pipe, which is open at both ends. The player can change or bend the pitch by covering or partly covering the lower end of the pipe with the thumb. One or two tuning slots are cut into the pipe, determining the effective acoustical length. The vibrating frequency of the blown reed can, within certain limits, be pulled to match the pipe resonance. Tuning the instrument is done by means of the position of these tuning slots.

Earlier investigations [2, 3] showed that the sounding frequency of such a reed-pipe combination is above the frequency of a measured impedance peak of the pipe, as would be expected for a "blown-open" or (+,-) reed in the classification of Fletcher [4].

Using calculated impedance curves and modelling the reed as a damped harmonic oscillator with the phase relation between the reed and the pipe as in the model of Fletcher in Reference 5, the sounding frequencies of the reed-pipe combinations can be calculated. Details of these calculations, which agree well with the measured sounding frequencies, can be found in Reference 2.

The spectrogram in Figure 13 is shows a demonstration of pitch bending using the thumb on each of the five pipes of the gourd pipe.

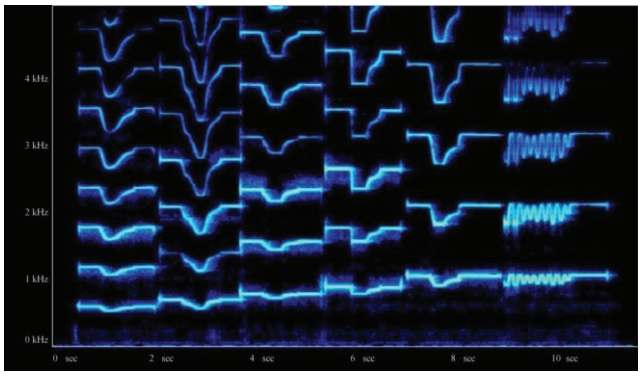

Figure 13: The five-note pentatonic scale of the gourd pipe, with pitch bending on each note using the thumb to close the lower opening of the pipe.

5 Conclusion

As well as being of musicological and cultural interest, the study of these instruments suggests possibilities for continuing research. In particular, an instrument like the single-reed *enggung* opens possibilities for research into the role of the vocal tract in pitch bending involving a resonator (the vocal tract) on the "upstream" side of the reed, with the situation not complicated by the interaction with a resonating pipe. The characteristics of the buffalo horn add to studies of coupling between the free reed and a "downstream" resonator, with a somewhat unusual reed-resonator configuration.

Acknowledgments

The sound files used to generate the spectrograms, as well as the photos for Figures 4, 6 and 9 are reproduced with the kind permission of Pat Missin, and can be found on his website: http://www.patmissin.com/ [*last viewed 15 May 2014*].

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References

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[5] N.H. Fletcher, "Excitation Mechanisms in Woodwind and Brass Instruments," *Acustica 43,* 63-72 (1979).