FROM A LUTHIER'S NOTES:

SOME THOUGHTS ON SOUNDHOLES

by Sebastian Stenzel

The soundhole is one of the most misunderstood parts of guitars, lutes and ouds. Many people think the sound which reaches our ears is coming out of this hole, as if it was the "mouth" of the instrument, a (mis-)conception that is reflected in the Spanish name for it: *la boca*. The human voice, in fact, is a kind of wind instrument, and the modulated air stream wave coming out of the mouth is carrying indeed most of the sound energy. With plucked instruments, however, the situation is very different. The sound we hear[1] is mostly radiated off the soundboard, which in turn was set in motion by the strings. The soundhole, alas, has almost no part in radiating sound energy. Then why is it there?

The main function of the soundhole is to reduce damping that would occur if the air inside the instrument body was closed in. Think of the difference in the sound of closing a car door when the other door is open, compared to when it is closed. This is the effect of air damping. Without a soundhole, a lot of energy would be used to compress and decompress the air volume inside the instrument, energy that would be lost for radiating sound. Without a soundhole, the efficiency of the soundboard as a sound radiator would be diminished.

There are other functions, too (and I don't mean to show off skills and taste in rosette making and ornamentation). One is that it is one of the factors[2] defining the lowest resonance of the instrument, which is the fundamental Eigenfrequency of the air volume inside the body/the bowl, also called Helmholtz-resonance[3] (HR). This resonance is of great importance for the timbre of all acoustic string instruments, and especially for the bass response. A soundhole increases the frequency of the HR; a larger soundhole more, a smaller one less. However, the effect the size of the soundhole has on the HR is often overestimated, provided it is within the common size range[4].

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1 Room reflections not considered

2 The others are: volume, shape of the body, position of the soundhole, stiffness of soundhole edge, stiffness and mass of soundboard and back and sides/the bowl. All of these aspects matter, and they are often underestimated. A tighter waist in the plantilla of a guitar, or different curvature in the bowl of an oud, for example, have greater influence on the HR than the size of the soundhole, and the stiffness of the body even more so.

3 Hermann von Helmholtz was a brilliant physician and physicist in the 19th century. In 1863 he published "Sensations of Tone" which can be considered the beginning of modern acoustics. To analyse natural sounds, he used a set of round glass bottles, that would resonate when the examined sound contained the Eigenfrequency of that specific bottle.

4 Around 58 cm^2 in both guitars and ouds, if you consider the open area, i.e., the rosette discounted; with lutes, there is a greater range, as there are so many different types of lutes. However, there seems to be an optimum ratio between air-volume and soundhole size.

Some instrument makers (most notably Antonio de Torres Jurado) saw the increase in HR-frequency as a disadvantage, and to bring it down, a so-called "tornavoz" was often used in the late 19th century. A tornavoz is a perforated, slightly conical tube of thin brass of the same or slightly larger diameter as the soundhole, reaching from the edge of the soundhole almost to the back of the guitar, where it rests on small wooden feet. It is, as it were, shielding off the soundhole, thus lowering the HR. At the same time, the air within the tornavoz becomes a resonator of its own, and to tune this well in relation to the HR is a critical factor in its use.
Nowadays, some guitar makers use a moderated version of a tornavoz, in most cases a wooden ring of typically only two centimetres length inside the soundhole. But even without any tornavoz, the "air-pillow" in the soundhole is a resonator of its own, which couples with other air- and back/bowl-resonances and contributes to the timbre of the instrument.

Even before I started to build ouds, I was wondering why so many of them have three soundholes, one larger and two smaller ones, in most cases with rosettes. But when I studied old pictures of ouds, I found that this had not always been the case, and especially in the first part of the 20th century, many ouds had only one soundhole. As I saw mainly disadvantages in adding the two small soundholes, because 1) they increase the HR, 2) they reduce radiation surface in the most important area, 3) they decrease stability, 4) they add work, up to now, I never made an oud with three soundholes. But why are they used so much then? Last year, out of curiosity and to test my own theory, I asked two experts the following question: „Please tell me, straight from your gut, why do you think the two small soundholes are there in most ouds?"
The first person I asked was Khausrow Maulana (خسرو مولانا), one of the most brilliant acousticians and musicologists in the world, who, among many other contributions, has compiled the probably largest iconographic data base of old oriental instruments there is. His answer: „It's a mistake!"
The second person I asked was Mustafa Said (مصطفئ سعيد), oud player, singer, musicologist and winner of the first Aga Khan music award. His answer was: „Only for ornamentation, of course!"
But is it that simple? Just a mistake, just ornamentation? I think there must be more to it. If you look at old ouds, it is obvious that good soundboard material was scarce. The soundboards were often made of several pieces of Lebanese cedar, or different local pine or spruce species, any of which were not really suitable as tonewood, meaning, the wood gave a dull sound, and especially higher frequencies were very much dampened. The availability of good strings wasn't any better, and good gut strings were simply not affordable for the average musician. My theory is that the oud makers wanted to "squeeze out" all higher frequencies they could from their instruments to make them sound brighter and less dull and to improve projection[5]. And the most efficient way to do this

5 Projection is very much frequency dependent. There will be another note on this topic.

was to bring up the HR, hence the two additional soundholes made sense. Of course this was not the result of a scientific analysis, but of trial and error.

Generally, I find it very fascinating to unravel the reasons behind every detail in musical instruments, and I am convinced that in all instruments that have historically evolved, there is no accidental detail, everything makes sense in the context of the whole instrument, the material, the music of its time and the sound ideal of its time. Therefore, I am very suspicious of sudden breeches of continuity in the evolution of any musical instrument, unless the changes in construction or material are based on a very deep understanding of material properties and acoustics.
Not to be misunderstood, I want to make clear that I do not propagate to get rid of the two small soundholes in oud making. There is the aspect of sound ideal, and that is very much subject to change. On the other hand, it often takes surprisingly long for changes in technical methods or material to reflect in instrument making. For example, it took about 50 years that the invention of wound strings reciprocated in the construction of guitars. When musical ideas change, it usually reflects much faster in instrument making.
There is, of course, no right and wrong when talking about sound ideals. But it is always good when you know why you are doing something.

There are many aspects of soundholes I have not even mentioned here. Why have guitars no rosettes like ouds and lutes?, or the other way round?, why have all attempts to move the soundhole to a different, supposedly better, place never been accepted by the majority of players?, what effect has the stiffness of the edge of the soundhole?, just to name some.
There is a lot to be said in answer to these questions, but here I only want to say that musical instruments are not, in my opinion, just rationally designed machines. I see them almost as living entities, like plants or animals. They have evolved over centuries, they have their own DNA, as it were. “Deconstructing” them just won’t do. And that, in my opinion, is a good thing.