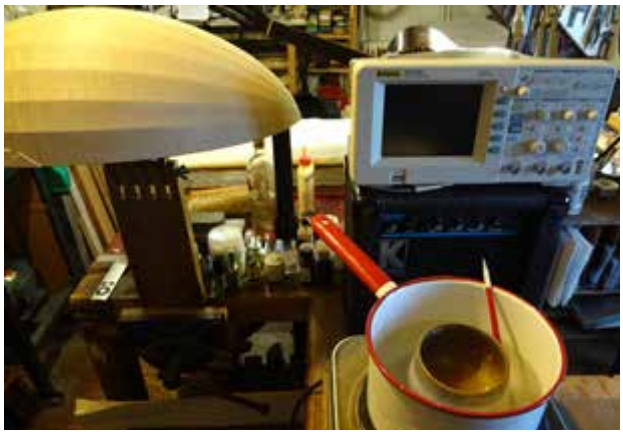
Lute amplification: old technologies meet new



Not enough thought has been given to the amplification of lutes for public performance, although guitars, both classical and steel string, are regularly and sympathetically amplified.

As well building lutes, I have made and repaired steel string acoustic guitars and have fitted amplification to many. I am a pickup installer for Headway Music Audio Ltd. of Oxford. Outside of work hours, I've played in rock bands, jazz bands and folk groups giving me the chance to observe and use various amplified musical instruments. One of the bands owns an Allen and Heath 20-channel powered mixer and speakers which have proved very useful for testing amplified instruments.

To help understand the possibilities of lute amplification, here is a summary of current methods of guitar amplification.

Guitar amplification today

The most obvious method of amplifying a guitar is to place a microphone (mic) in front of it. Although this can work well and is often used for recording, the instrument needs to be kept at a fixed distance from the microphone, not always an easy task when performing in front of an audience.

A second technique involves using piezoelectricity. This is electricity generated when particular materials are squeezed or submitted to pressure. The material is so sensitive to pressure that a disc about 15mm in diameter attached to the inside or outside of a guitar will generate an electric signal that can be used for amplification. This device is known as a bug and is common and often inexpensive. The sound from these bugs is often not very accurate, and worse, unless fiercely glued in place, they can fall off at the most inconvenient moment.

A typical bug attached to a 1/4 inch jack socket. The socket and bug are attached to the outside of the guitar using double-sided tape.

Better quality bugs are available. One company that makes them is K&K in Oregon. They are more expensive, but create a much more realistic sound. K&K have developed various systems, some using arrays of bugs inside the guitar.

The same piezo material that is used in bugs has also been used to make pickups that fit under the saddle of the guitar. The strings press down on the saddle which transmits the string vibrations to what is known as an under-saddle pickup. Under-saddle pickups are commonly and successfully used on both Classical and steel string guitars. There are many manufacturers; Ashworth, Fishman, Headway, Martin to name a few.

An Ashworth under-saddle pickup in the bridge of one of my own guitars.

In the world of music amplification, it is common practice to raise or lower the volume of high, middle or low frequencies of a sound. This is done with an electronic tool known as a graphic equaliser. Boosting or reducing bass or treble can help to help create a more natural sound. The sound is said to be EQ'd (for equalisation). Graphic equalisers come in many types including some mounted in control boxes fitted into the side of a guitar.

There are drawbacks to using under-saddle pickups. They create a sound which is particularly strong in certain higher frequencies. Often this can be heard as the final reproduced sound, though a bit of EQ can be very effective. There is also an occasional concern that the acoustic sound of the guitar is altered by the presence of the under-saddle pickup. However, this is still the most common form of guitar amplification.

The Oxford based company Headway is supplying a new type of under-saddle pickup, the Snake. It looks like a metal sheathed cable just under 2 mm in diameter. It is easier to fit than some other types and, in my opinion, gives a very accurate representation of the sound of the guitar.

The Headway Snake

The Headway Snake attached to a 1/4 inch jack socket. The jack socket is usually fitted through the end block of the guitar and doubles as a strap holder.

All of these methods generate a tiny amount of electricity which can be amplified and passed to speakers. The electricity from the piezo materials is so very small that it benefits from an

intermediate amplification before it gets to the main amplifier. The intermediate device is called a pre-amplifier (pre-amp).

Piezo materials generate electricity in the region of a millionth of a volt, abbreviated 1 µV. A pre-amp amplifies this by a thousand times to a roughly a thousandth of a volt, or one millivolt, abbreviated to 1 mV. Most mics have similar outputs of a few millivolts and all amplification systems will easily accept this level of electrical signal.

Headway make two types of pre-amp worthy of mention. The first is their EDB-2. This is an electronically sophisticated black box, 138 x 93 x 38 mm, which accurately amplifies the signal from the pickup. It also includes a volume control, graphic equaliser and much more. These pre-amps are not inexpensive, but they are excellent. In use, they can be attached to a music or mic stand, be worn on a belt or simply rest on the floor.

The Headway pre-amp EDM-2.

Headway's second type of pre-amp, the HE4/G.FEQ., is miniature and fits inside the guitar. It is a cylinder 70 mm long and 13 mm in diameter. It is attached to a 1/4 inch jack socket which is mounted in the rear block of the guitar. Pre-amps require power, so a 9 volt battery is needed inside the guitar. The battery is best fitted to the front block and lasts about a year. It can be replaced when the strings are changed.

Headway's miniature pre-amp, jack socket, Snake and battery.

If the pre-amp and battery are a little heavy for very light instruments, at least that weight does not interfere with the soundboard. The reproduced sound from this system is powerful and convincing.

The wire (lead) which connects the piezo pickup to the pre-amp is very vulnerable electronically. All wires can act as antennae, picking up electronic and radio signals from mains, electric

machines, computers, taxi radios etc. These unwanted signals are called interference. The longer the wire the stronger the interference generated.

The electric signal from a piezo pickup is minuscule and can easily be overwhelmed or just spoiled by interference. Often this appears as a strong hum or hiss. It is therefore important to keep the lead from the pickup to the pre-amp short; less than a metre is recommended. This is one reason why mounting the pre-amp inside the guitar is so successful—the wire connecting the pickup to the pre-amp is extremely short.

Yet another method of amplification is to use a miniature mic mounted inside the guitar. Some of the best acoustic guitar amplification that I have heard has come from blending the sound of a piezo under-saddle pickup with that of an internal microphone.

Electric guitars work on a different principle. Moving a metal wire through a magnetic field generates electricity. Electric guitar pickups use that principle and create electricity directly proportional to the vibration of the metal strings above them. This will not work on lutes or classical guitars as they do not have metal strings. Steel string acoustic guitars and many other wire-strung instruments can use this principal.

There are magnetic pickups for steel string guitars which fit in the sound hole. Some of these also have a small mic attached and the system blends the signal from magnetism with that from the mic. Such combinations can be very flexible, producing accurate acoustic sounds as well as unusual and innovative tones.

Two current examples of lute amplification

There are several reasons why the amplification of the lute will always be different from that of the guitar. First, the lute is lighter, weighing about two-thirds as much as a guitar, and care is needed not to add too much weight to the instrument. Second, the lack of a sound hole means there is no access to electrical equipment fitted inside the instrument. Lastly the bridge design is different from that of a guitar and does not use a saddle, rendering most under-saddle pickups unusable.

Nevertheless, there are some successful examples of lute amplification. Ronn McFarlane, a lutenist from the USA, has been using amplified lutes for some time. He writes:

> . . . I have K&K pickups on four of my lutes, and I'm pleased with them (made in Oregon). The array of four piezo pickups are glued inside the body of the lute, beneath the bridge. Sometimes I also run it through a Headway DI box [pre-amp] (made in the UK) before the signal reaches the amplifier.

Lynda Sayce and Charlie

Lynda Sayce is a well-known British lutenist who is not afraid to push the boundaries of lute authenticity. David van Edwards has made her a large and beautiful theorbo after a 1614 instrument by Matteo Buechenberg in the V&A Museum, which she calls Charlie. The usual method of airline travel for a musician who plays a large instrument, is to purchase an adjacent seat for the instrument. Cellists do this regularly. However, at over 2 metres long, Charlie is too large for an aircraft seat.

Before construction, David and Lynda devised a very clever method which allows both the neck and case to fold. She and Charlie can now travel on commercial aircraft, and together, they have toured Europe, Africa and the USA.

In 2011 Lynda asked if I could help her amplify Charlie. She wanted gentle amplification to enable her to play background music for social events.

I suggested using the Headway Snake on Charlie. I had to do a few modifications to the Snake (a small amount of soldering) and Lynda found a way to mount it on Charlie's bridge. The Snake sits in the groove at the rear of the bridge. The Snake connects to a Headway EDB-2 pre-amp and then to a small amp (AER Compact 60 acoustic amp) which is concealed beneath her chair. People rarely notice that the lute is amplified.

Charlie's bridge and the Snake

An amplified lute

Then, in 2013 Lynda Sayce asked me to make an amplified 7-course lute for her. The lute was to be easily plugged into a mixing desk or amp, just like many acoustic and electric guitars. It would be used on-stage, in performance, at functions and in workshops. The amplified sound was to be very close to the natural sound of the lute.

What follows is a description of the development of the electronics for the amplified lute. I first considered the the Snake but it has to be mounted on the outside of the lute. I saw no easy way to fit a socket for the Snake to the lute. Also, as mentioned before, the tone of piezo pickups is slightly untrue. There might be a better way.

I approached Drew Calderbank, a professional sound engineer. We have worked together many times and I knew he was familiar with amplification. When told of the project, he immediately thought a microphone might give a more accurate lute sound. He suggested a lavalier mic, the type used onstage for plays, musicals, TV, etc. They are very small, often being lost in the performer's clothing or hair. Their sound reproduction is very accurate.

Drew suggested we use a high-quality lavalier mic made by the Danish company DPA Microphones, the DPA 4061. Although originally intended for use with voice, it is also an excellent instrumental mic and is sold with adaptors to fit various instruments. The mic is 4.5 mm in diameter and its housing 12 mm long.

The 4061 mic is not cheap, so for testing, we hired one. In Drew's studio we attached the 4061 to Lynda's theorbo with Blu Tack. As Lynda played, I moved the 4061 to various positions on the

soundboard while Drew tried different settings on the mixing desk. In the end, Lynda, Drew and I all agreed that the DPA 4061 produced a very realistic lute like sound.

The 4061 now needed to be tested inside a lute. My second lute was built in 1976, and was still in the workshop. It owed a lot to Harwood and Isaacs and my then weekly lutherie tutor, Charles Ford, but was still basically sound. I decided to use this lute to develop ideas.

The Test Lute

The concept of fitting a mic inside the lute and having a socket in the front block was growing. My lute number 2 became 'The Test Lute'. It certainly needed some work after 40 years of knocking around the workshop. Several bars were loose, there were cracks in the ribs and its pegs had long ago been been used on another lute. I removed the soundboard, attached some lighter barring, repaired cracks and, on the lathe, I turned a set of simple apple pegs.

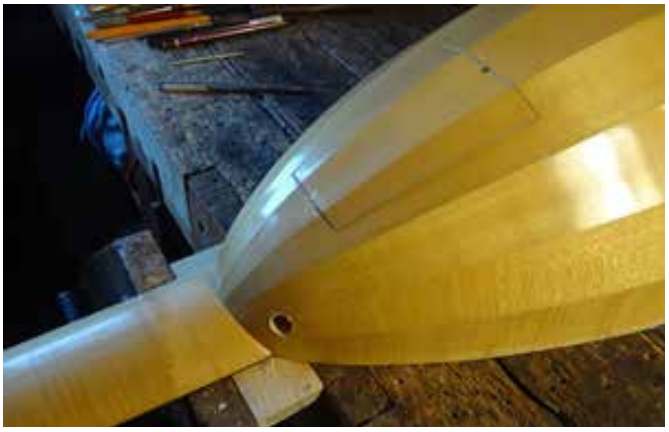
Before the soundboard was replaced, I cut a hole in the back of the lute naming it 'The Hatch'. This would allow access to the inside the lute without needing to remove the soundboard.

The hatch cut out of the body—the removed wood becomes 'The Hatch Cover'

The hatch cover was given a boxwood edging to compensate for lost wood. The hatch itself received another edging, this one to hold small brass nuts. The hatch is held in place with small brass bolts. The circular hole near the neck/body joint is a first (of very many!) attempts to fit an electric socket to the lute.

A length of 2 mm flexible wire was glued into the front block to allow the 4061 to be attached to it and placed in various locations inside the test lute.

One the right, the DPA 4061 mic and on the left its electrical connector, the recently invented Microdot.



The soundboard has been replaced and the mic located inside the lute.

Attaching the 4061 to the flexible wire, the mic was tested in various locations inside the lute. The best position for it was about 25 mm below the bar closest to the rose (the one between the rose and the rear of the lute) and slightly towards the treble side of the rose. The sound was clear and concise with no hint of boominess or echo from being enclosed. We had found the mic and established its position.

Wiring the DPA 4061

Three types of connector: on the left, the new Microdot, in the centre, a mini-XLR, on the right, a standard XLR. These are all jacks and they plug into comparable sockets.

Most amplification systems are fitted with XLR sockets and most microphones have XLR jacks. The two work well together using a lead that has an XLR jack connected to an XLR socket. The XLRs are very common.

A newer, lighter and smaller version of the XLR is the mini-XLR. Both the XLR types have three pins, one for earth (return of electricity) and two for electrical signals. These two can be used for stereo, or for two separate signals if needed.

The 4061 has a pre-amp which requires electricity and it uses the third pin for this. When the amplification system supplies electricity in this way it is known as 'phantom power'. The Microdot is a more recent invention and so far, seems only to be used by DPA.

The pre-amp for the DPA 4061 is small but comes inside a rather heavy and sturdy metal casing. Besides all its electrical jobs, it allows the lead from the mic, with its microdot jack, to connect to a XLR socket.

The DPA 4061 pre-amp

There were several problems to overcome to fit the 4061 and its pre-amp inside the lute. First, the pre-amp was too heavy. Second, the pre-amp connected to XLR, a system also too heavy. A mini-XLR socket in the front block seemed better. Lastly, the mic had a long and delicate lead not suitable for the performance floor.

Looking for solutions, I first found that the metal casing on the preamp unscrewed easily and the pre-amp worked perfectly well without it. It was now light enough to be inside the lute.

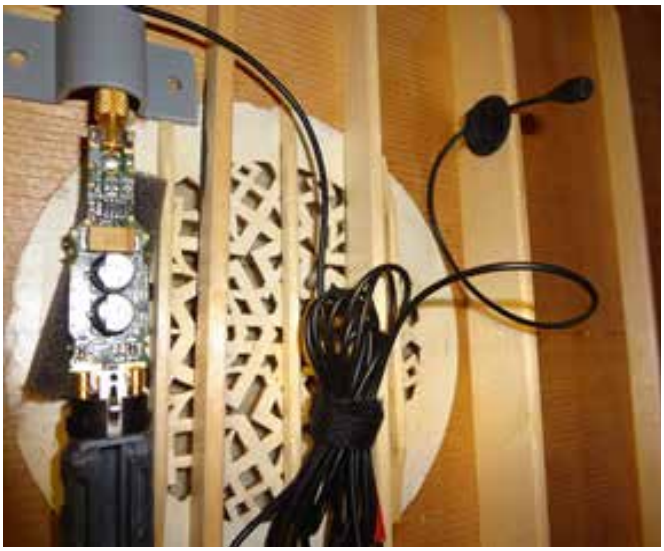
The pre-amp without its casing; gold XLR jack on the left and Microdot socket on the right.

I needed a way to connect the XLR output from the pre-amp to mini-XLR. I eventually found a type of XLR socket which came apart easily—most do not.

A dismantled XLR socket

The only part of the XLR socket used was the dark plastic connecter at the bottom of the photo. This was very light and fitted to the pre-amp perfectly. The pre-amp plugged into a partially dismantled XLR socket.

Wires soldered to the XLR socket connect to a mini-XLR jack fitted on the outside the front block. It all tested well and the weight was, I thought, acceptable.



The first position of the pre-amp

I attached the pre-amp and socket to the soundboard using clips provided by DPA and double-sided adhesive tape. This did not work at all as the pre-amp circuit board and socket kept falling out of the clip and the double-sided tape failed repeatedly. Also note the very long mic lead.

It was suggested that the pre-amp unit could be attached to the hatch cover. A broom clip did the job.

Hatch cover and broom clip.

Self-amalgamating tape expanded the diameter of the XLR socket so it fit snugly in the broom clip.

Hatch cover and pre-amp.

The 4061 mic was sent away to have its lead shortened. The hatch cover had been rather ill-used so I reinforced it with a linen backing.

Testing the Test Lute

I felt the Test Lute was ready, the lute played well and the microphone and its pre-amp worked. Lynda visited and played the Test Lute through the Allen and Heath powered mixer. The sound was realistic, powerful and adjustable. All were pleased.

Lynda playing the Test Lute in my living room in Malmesbury.

However, the socket for the lead was on the treble side of the front block and this interfered with the left hand high up the neck. One last mini-XLR socket was fitted, this time to the bass side of the front block, using a locally manufactured stainless steel washer.

Jacks and a strap holder fitted to the front block.

The test lute was finished in summer 2016. Lynda played it one more time and all seemed well. I began work on a new 7 course amplified lute for her. Lynda and her partner, Freddie Cale, have been extremely helpful and supportive of this project.

Lynda Sayce and Freddie Cale.

Front of the 1976 Test Lute; rear of the Test Lute showing hatch, mini-XLR able plugged in - the other end of the cable is XLR and plugs into any amplification system.