Brass Instruments

Experiments in Acoustics

Murray
The experiment that we are sitting in front of at the moment is an experiment, which is designed to investigate the way that lips vibrate in a brass instrument mouthpiece.

Now lips of course are normally coupled to the mouth of a human player but it's notoriously difficult to carry out scientific experiments on the human mouth. One obvious thing is that in this case we actually have a laser beam which shines down through the lips and that laser beam allows us to measure the opening and closing of the lips. Most human players rather object to a laser beam being fired through the back of their throats and out through their lips.

The lips we have here are in fact artificial lips, which are rubber tubes, latex rubber, filled with water. And that particular combination of rubber and water filling, rather accurately mimics the flexibility and density of the human lips and as a result if you get a pair of these and blow some air between them they vibrate in a way which is surprisingly similar to the way in which human lips work and it produces quite a realistic sound on a brass instrument.

And that's really the main motivation we have for working with brass instruments here, to try and unravel and really understand what goes on, in this fascinating thing when a brass player puts the lips against the mouth piece and buzzes.

Our pulse reflectometry experiment is designed to investigate the internal bore of a brass instrument. We send a pulse in through the mouthpiece end - that's something like a click and it travels down the tube and gets reflected back.

If the tube was just a cylinder with a closed end then the pulse would be reflected back with pretty much the same shape as the one we sent in but in a realistic instrument which has flares and valves and all sorts of things in it the pulse which comes back carries information about what it met on its journey and using some rather sophisticated computer processing comparing the returning pulse with the input pulse we can deduce the internal shape of the tube.

Jonathan Kemp
What we can see here is a measurement of the internal profile. We start off with source tube – that's the copper tubing – and then from that we step into the plastic coupler, which connects the trumpet with the source tube. And next we see the trumpet, and you can see how it flares out, as we know trumpets do, and there are no major blemishes in this trumpet, so the measurement is fairly smooth.

Murray
And that's a very useful technique because in many cases you can't actually get inside a brass instrument with all its coils and valves to do real measurements.

We've developed this technique to a level of sophistication where you can actually measure the internal bores of, not too long, brass instruments, with an accuracy of about 0.1mm.

This technique has already aroused some interest from manufacturers of musical instruments and one or two manufacturers have already been using it in order to develop and test instruments.