# GETTING TECHNICAL

## Is Brass Immaterial?

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The previous article in this series (The Brass Herald, February 2009) showed how strictly controlled blindfold testing with statistical analysis has been used to develop one of the world's most successful instruments, the Boosey & Hawkes 928 Sovereign Cornet. The use of this technique could be far ranging. For example, given enough time, one could test the wide range of add-ons, gizmos and gadgets which players buy, presumably to improve their performance but with minimal practice! Some items shown in Figure 1, like the tuning slide bends with 'C' shape, *look* as though they should perform better than the 'D' shape, especially if one believes that air-flow is all important. (Airflow is a subject to be explored in a future article.) Then there are the heavy mouthpieces and heavy bottom caps. Some caps come in different lengths and weight according to which valve they are attached to, not to mention the necessary 'O' rings. I know of no scientifically controlled studies which validate the claims that the manufacturers make for these items.

Similarly, the materials from which instruments are made and their finish (e.g. electroplating or lacquer) are much discussed, with some wild claims for enhanced performance, but these are rarely tested under controlled conditions. The materials of bells receive most attention from players and manufacturers, possibly because they are the most prominent part of an instrument. Players can certainly feel their instrument vibrating through their hands in addition to the lip interaction. If the material is vibrating, it could be radiating sound itself and affecting the vibration of the internal air column; either process may be beneficial, detrimental or insignificant. 'Pinging' an instrument bell with a finger is probably the brass players' allegorical equivalent to kicking the tyres of a car before purchase. There is no reason to suggest that either action gives any idea as to how an instrument or car is going to perform in practice.

I do not believe that there are any 'magic' properties of materials which, if one believes manufacturers' advertisements, always seem to *enhance* the musical properties of brass instruments. Do they ever *detract*? However, looking at the problem logically, it is reasonable to assume that, if the material is thick, the effect of the other parameters such as the position of stays, rim size, method of fabrication (one-piece/single seam/hand hammered) or coatings (e.g. plate or lacquer) would be negligible. We could also include post-manufacture cryogenic and annealing processes in this list - all worthy of controlled study if one had the time.

**Figure 1. Accessories for trumpets.**

There have been many tests, trials and measurements performed by both brass players and scientists (who often have their bias to a desired outcome), mostly superficially without a control or double blind trial. Throughout the instrument design process, the choice of material is always a vexing question especially as everyone has their own input to give on the subject. While most of my scientific and design work has concentrated on the design of the instruments' bore profile, it has also been essential to determine the degree to which the choice of material is important. On one hand, it is possible that the effect of material could be so great as to make the effect of my small bore changes immaterial. At the other extreme, material choice could have no influence on the player's perception at all. The following account records a series of tests I performed to determine to what degree the sound and its perception were affected by the thickness of bell material.

### The Tests

The tests were designed to determine whether:

1. Instrument bells vibrate?
2. The vibrations affect the sound?
3. A player can tell the difference?

### Preparation of Bells

The experiments were based on the thickness of brass as used in trombone bells. The trombone was chosen for its large bell surface area and its close proximity to the player's ear during performance. A set of six similar brass trombone bells were made from brass originating from three different sheet thicknesses. These had outer slide tube attached so that they could be slipped onto the tuning slide of the trombone very quickly during the tests. There were no additional stays or braces to dampen the bell vibration. As I only wanted players to judge the effect of bell thickness, other variables which are often overlooked by experimenters had to be standardised.

### Weight and Balance

Players are surprisingly sensitive to the difference in weight and balance caused by a small change in bell thickness. In our experiments, the thin and medium thickness bells had their own counterbalance to give an identical weight and centre of gravity to those of the thickest bell (Figure 2). Without this correction, players would certainly *feel* a difference.

### Bore Shapes

From earlier articles in *The Brass Herald,* the reader will be aware that changes to bore shapes are readily detectable by players. Thin bells tend to have a slightly larger bore shape than thicker bells when spun on the same steel mandrel. It was therefore very important to measure the sample bells internally and to make adjustments so that they became identical.

**Figure 2. Counterbalance for the lighter bells.**

### Do the bells vibrate?

Today this might seem a daft question, but in the early 1970s we did not know or have proof that instruments had any significant vibration when played. Laser holography was in its infancy and had only just been used by Karl Stetson to view the

vibration of violin bodies. It only seemed natural to apply this technique to brass instruments. The significant difference between these two groups of instruments is that the wooden body of a violin is essential to the radiation of sound whereas any radiation from brass is incidental. In this test, the three thicknesses of bell showed an exponential increase in vibration as the brass was made gradually thinner (Figure 3). This observation has been confirmed recently by subsequent experiments using state-of-the-art apparatus. The vibrations seen occurred at several frequencies which did not necessarily coincide with notes played. However, the predominant one shown here is about 250Hz (not far from a B-flat).

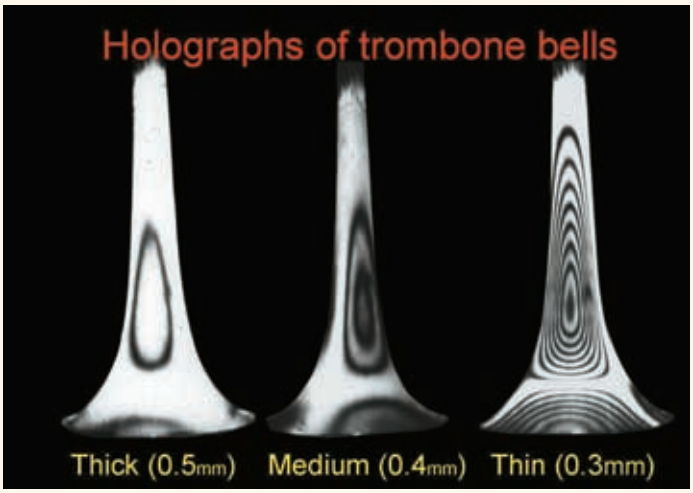

**Figure 3. Thinner bells have significantly more vibration.**

## Does the material thickness affect the sound?

The instrument was played by a very loud sound source (a siren) to see if the radiated sound from the bell was affected by the thickness of the brass. With fairly basic apparatus, we could detect a small increase in a harmonic of particular notes at the player's ear position which was caused by radiation from the metal surface.

## Can a player hear or feel this difference?

A blindfold test was organised in which ten top professional players from all types of trombone genres were employed for a session to test these bells. As in the previous article in *The Brass Herald*, the players were blindfolded and asked to play anything which might elucidate a difference and rate the trombone combination on a scale 0 to 9. The resulting statistics showed that no player could tell the difference between the thick and thin bells under these strictly controlled conditions. These results were very disappointing, compounded by the inclusion of an additional test using an electroformed copper bell. Although the bell was of a different shape, material and thickness, these changes were not noticed in the playing trial.

## Conclusion

Although the results showed that players could not distinguish between thick and thin bells under strictly controlled conditions, we can be satisfied that *no difference* indicates ideal blindfold conditions. This does not exclude the possibility that players *can tell the difference* under different playing conditions, but it does help to put 'material' in context when designing instruments. During the intervening years, the experience of these tests has made me quite sceptical about claims made by players and other manufacturers and very cautious about claims I make about my own instruments. You may note that we use only regular cartridge brass for all our instruments and still obtain superior results through accurate bore design. Take it all with a 'pinch of salt' and if it works for you, that's magic!

**Reference for further reading, available from smithwatkins.com website: R.A. Smith. The effect of material in brass instruments: a review. Proceedings of the institute of Acoustics (1986)**