GETTING TECHNICAL

Design by Science

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The previous article in this series (*The Brass Herald,* December 2008) explained that there is no such thing as a perfect instrument but one which might be the best compromise for an individual player. We will now discuss a scientific process which has been used successfully to find this best instrument in a manufacturing environment.

Small bespoke makers who specialise in a particular type of instrument can offer custom built instruments with different bores, leadpipes and bells, whereas large manufacturers can only afford to give players the choice of one or two models of the same type of instrument. They have to design an instrument which will be attractive to the *average* player. This process is not easy and it is not unknown for some instruments designed by the 'Logical Incrementation' method to take years to complete. With this method, known to the layman as *trial and error*, a professional player visits the factory and is paid a fee to test the prototype. Parts of the instrument are modified and re-tested to see if improvements have been made. There is a fair bit of luck involved here and we should not forget the subjective variation, where the same player may have a completely different response when the identical instrument is presented in a subsequent week (not forgetting the fact that an early conclusion to the work might terminate a regular income). This is a process to be seen repeated in most brass instrument plants throughout the world. Clearly there is also the danger that the resulting instrument is one which only that player prefers.

Fig 1. The gloves are on for the first test.

During the design process, there is a major problem with the maker interpreting what the player requires and converting that into a piece of rolled-up brass. The adjectives used to describe tone quality and response of an instrument, for example, are often ambiguous and sometimes confusing. For example, when someone says a sound is *bright*, some listeners might understand this to mean it is *sharp* and others as *shrill*. These are quite different musical attributes of intonation and tone quality.

In 1983, when I was a visiting Research Fellow at Surrey University, I teamed up with an experimental psychologist to develop a technique which would show a player's preferred instrument within a few minutes of testing. At the same time, the Boosey & Hawkes Sovereign cornet, the 921, was not satisfying a few of the leading players in British brass bands and I was asked to design an instrument to counteract this conflict. I chose eight of the best solo cornettists from the leading brass bands to undertake a series of blindfold tests to determine the tone and response characteristics they preferred. I will not reveal their names since the tests not only gave a measure of their preference but also of their skill in distinguishing between instruments!

What did these soloists prefer?

The first test compared cornets which were available on the market at that time i.e. the Sovereign 921, Bach, Getzen and Courtois instruments.

Due to the different physical configuration of each instrument, triggers and rings were removed from each sample and players had to use thick leather gloves with the blindfold during the tests to avoid any feedback stimulus other than the sound heard and response on the lips (Figure 1). Each instrument was given to the player in a prescribed random order (that is, the same order given in all tests to all players) and they were asked to score the instrument 0-9 for both response and tone quality. As we knew the bore shape of each instrument, a statistical analysis of the results allowed us to determine the preferred bore shape which lay somewhere between two of the samples.

The second series of tests was to explore this selected 'shape' in more detail, using six prototypes made from readily available parts (e.g. valve sections) and a set of specially designed leadpipes. This time, the players continued to use the blindfold but did not wear gloves as all the instruments were constructed the same way. The player was handed each instrument eight times in the same random order as in the first test, and after playing a free choice of notes or tunes we noted their score for preferred *Tone Quality*. The whole test was repeated for *Response*.

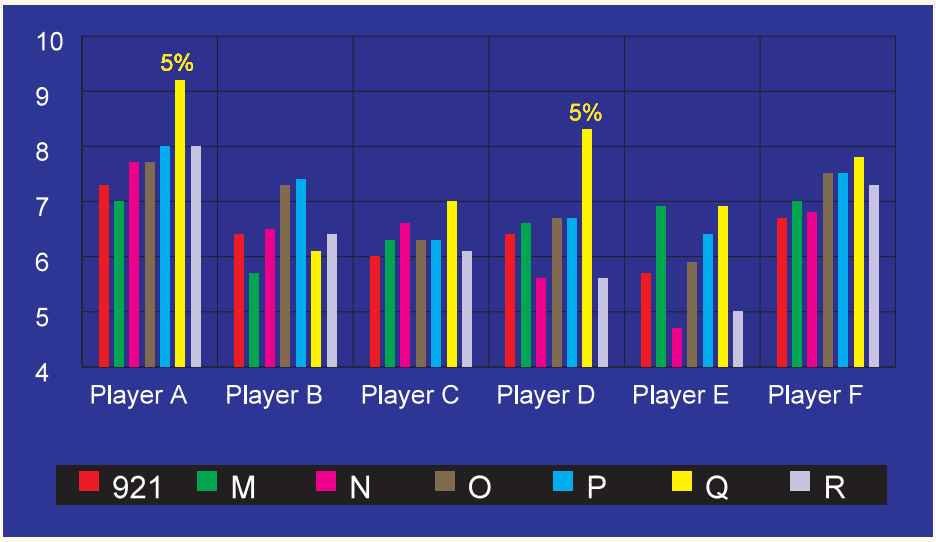

Fig 2. The results for the old 921 Sovereign and the six prototypes on the tone quality scale.

The Results

After averaging the scores (excluding the player's first seven results which were likely to be fairly random as the player had no reference point) and performing statistical analysis on the results, we could see a pattern in the preferences of most of the players. Figure 2 shows the results for the *Tone Quality* analysis and although prototype Q scored well with most players, it was judged *outstanding* with players D and A.

A five percent significance suggests that if the tests were repeated 100 times with these two players, Q would be the first choice 95 times! These players also showed exceptional skill in identifying musical differences between instruments. Similar results were obtained for the *Response scale*.

The ultimate challenge was to see how this new prototype 'Q' faired against the original competition. Figure 3 shows the comparison for both the Tone Quality and Response scales. The significance of prototype Q against the original B&H 921 and other instruments needs no further explanation, except that the result gave me, as a scientist, the confidence that if anyone else repeated the final test under similar conditions, they would get a comparable outcome. This confidence could be passed on to sales staff who often have little solid information to work with. Prototype Q became the 928 Sovereign Cornet which went on to be one of Boosey & Hawkes biggest selling instruments.

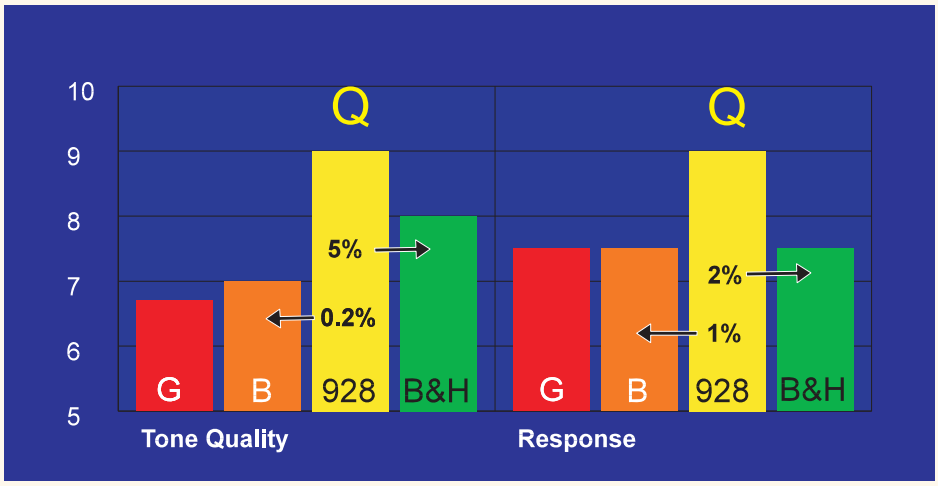

Fig 3. The results for the chosen prototype Q with the competitors' instruments.

Epilogue

Today, twenty-five years later, the parts of the 928 cornet are made by Schreiber in Germany and the instrument now lives on physically as the York-Preference cornet (since the demise of Boosey & Hawkes in 2005). The instrument has also been copied and made in France as the Besson 928. With changes to my original design (some unintentional) and the change in players' requirements over this long period, it is time the whole testing process was repeated.

As for the design of the 928, it might come as a surprise to the reader that the leadpipe was one of my first experimental designs and was made from two blended straight lines, the formula of each being fairly easy to remember!

With Smith-Watkins cornets, we do not need 'an *average* cornet to suit all' and have taken a step backwards in the selection process so that *all* players can have the choice of 27 different bores and leadpipes. The blindfold test is optional!