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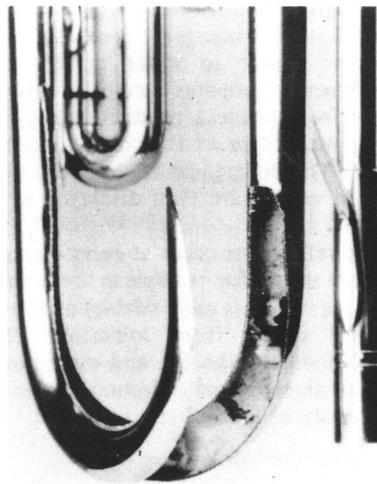
Ensuring High Quality in the Production of Musical Instruments

The author of this article Dr. Richard Smith has research degrees in both woodwind and brass acoustical design, and was for 12 years the chief designer with Boosey and Hawkes Ltd. With his own company in London, he now applies this broad experience to the design of bespoke brass instruments for individual players. Dr. Smith is also a competent musician and regularly plays contra bassoon in London.

Judgements of quality in wind or other instruments depend on two groups of factors: physical ones, which are theoretically measurable, and musical, which are more or less subjective. Physical judgements include assessment of weight, balance, dimensions, mechanical action and finish. These are all the subject of factory inspection, and when faults are detected during manufacture they can usually be rectified by an engineer or skilled craftsman. Perhaps 90% of quality control in instrument factories is concerned with these physical aspects. In the past, the control of musical quality has proved far more difficult. The factors involved — judgements of timbre, intonation, response (or ease of playing) are all highly subjective. There has been no way to measure the full tonal quality of an instrument. Each player brings different physical attributes and an individual technique to a wind instrument. Opinions about musical quality therefore depend on personal preferences which can sometimes prove fickle. Attitudes towards a given instrument can vary widely between players, audiences, recording engineers and so on. An instrument admired in a concert hall may sound indifferent in a recording studio. At the professional level, unmodified standard instruments are often criticised: there is no absolute standard of perfection.

The Prototype

When instruments are produced in volume, the objective should be to build accurate copies of a prototype. Clearly the musical quality of the prototype is of crucial importance, since it will be reproduced in every replica. While musical tastes are subjective, one can nevertheless use scientific techniques to determine the majority view about desirable musical qualities. During recent development work one manufacturer con-



ducted a large scale trial to compare seven well known makes of B flat trumpet. The trial, conducted in the United Kingdom, the United States of America and West Germany, involved controlled blindfold tests in which leading players were asked to score each instrument when played several times in random order. A statistical analysis of the results provided valuable information, showing the preferences of a wide range of players between instruments of known physical characteristics. This procedure was

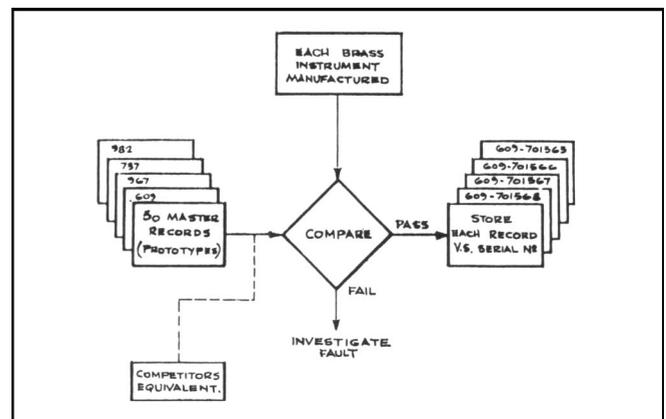
Top: The trumpet bell cut open to reveal loosely packed flakes of silver from the plating process.

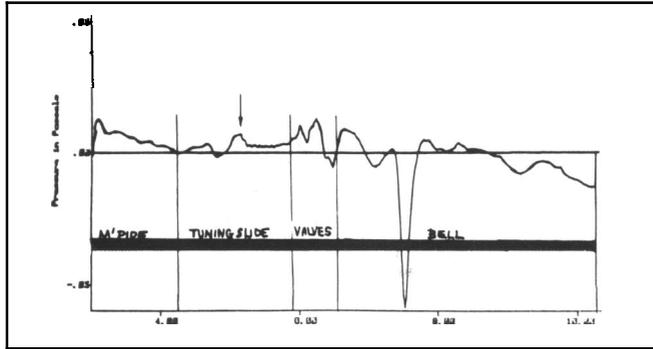
Right: The process of comparing each instrument manufactured with its corresponding master record. "Pass" refers to those records within a predetermined window. Should the instrument fail, the position of the fault will be indicated.

also used to develop the prototype Boosey & Hawkes 928 English style cornet, an instrument that proved remarkably successful when it was launched in 1984. The advantage of controlled blind testing is that results are remarkably consistent. A single test can produce a freak result, but statistical analysis of a player's average scoring for each instrument on one day will correspond closely to the same player's findings weeks later. The technique is therefore far more valid than the kind of testing most players carry out when choosing a new instrument.

Blindfold Tests

As already stated, this technique can be used by manufacturers to produce instruments that appeal to the majority of players — which is of course the volume manufacturer's objective. Unfortunately, however, not all players belong to the majority, so ready made instruments, however successful, will not suit everyone. The instrument selection procedure has, however, now been refined to a further level of detail, to meet the needs of discerning professional musicians. The player can make a series of controlled blindfold tests using not only different instruments, but instruments with a succession of alternative components. Consistent preferences are identified, and the process leads to an instrument specification that offers the best possible match to an individual player's preferences. This is a truly bespoke instrument. Some degree of choice in components has been available to trumpet players for many years, with different models offering alternative pipe, bore or bell. A wide choice of





An example of a faulty trumpet, said to be stuffy or resistant by a good player, is compared with its master or prototype record. A large reflection is indicated at one third of the way along the bell section.

components has always been possible but carried the risk that players would simply be confused. All this has been changed by analysed blindfold testing which allows the ideal instrument to be built up in logical steps.

Fallible Assessment

Until recently, few scientific techniques were available to help compare the full musical quality of a production instrument with that of the prototype. The only method of quality control available has been the subjective judgement of a skilled player, and most instrument factories retain the services of players who regularly test production instruments. This procedure is unavoidably fallible. Players are human, and therefore occasionally inconsistent. They may not have the same critical ability as the leading instrumentalists used for prototype development (it would be too costly to employ such players for testing on a regular basis). As result, it is quite possible for the musical quality of a production model to change or even deteriorate over the years.

Research to overcome this problem has been going on for some time. As a result, it has at last become possible to make precise scientific comparisons between the musical quality of prototype and production instruments.

The technique used is essentially simple, although a sophisticated computer program is used to interpret the results. In a process similar to sonar pulses, the equipment compares acoustic reflections from inside a production instrument with those of the control instrument. The differences between the two sets of echoes are then displayed as a graph.

Wave reflections occur at every change of bore shape, for example at the tuning slide leg (which is unavoidable) or at unwanted debris from soldering. The graph indicates the size and exact position of an abnormal reflection, so faults can easily be located and remedied.

Retained On File

With this equipment, it has become a simple task to inspect the internal valve/piston alignment — something

that cannot be done visually, even with the help of lights and mirrors. Leading players sometimes spend large sums having this alignment adjusted.

Given that master records can be retained on file, every instrument manufactured can be compared with the prototype. If the trace produced by a new instrument does not differ significantly from that of the prototype, the new instrument is passed, and its own trace filed under its serial number. This could prove useful years later, if the owner believes the musical quality has changed.

The equipment will therefore instantly solve problems such as that of a certain euphonium which became resistant or "stuffy". Unknown to the owner, a cigarette lighter kept in the carrying case had found its way via the bell into the smaller tubing. The location of the obstruction was immediately obvious when the instrument was compared to another. In the same way, some production instruments have unexpected internal faults. In a small batch of trumpets which passed normal testing procedures, one had a considerable flaw in musical quality when tested by a leading player. In the past, no matter how much trouble manufacturers have taken over quality control, players have perceived differences in musical quality between one production instrument and another. The technology is now available to check these differences, allowing manufacturers to make any necessary corrections before the instrument is released. So in future, both physical and musical quality will be improved and maintained at a high level. O