15th International Congress on Acoustics
Trondheim, Norway 26 - 30 June 1995

ASPECTS OF TRUMPET PLAYING

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SUMMARY

The acoustics of brass instruments is a broad field. Some elements, where the "human-factor" is not dominant have already been investigated. As one model, the author shows the influence of several trumpet mutes on the timbre, intonation and responsiveness of trumpets. The actual tone generation (embouchure) is very complex. The factors influencing lip action are so numerous that no quantitative theory can be formulated without further experiments.

INTRODUCTION

It is very obvious that a note with a defined intensity sounds different on various musical instruments. One trumpet also doesn´t sound like another trumpet. That is also convincing, but why doesn`t one and the same trumpet doesn`t always sound the same? There can be several reasons for this. The most obvious one is the use of different mutes, which changes the tone color of the sound intentionally. These effects of trumpet-mutes will be discussed first in this article. Even without mutes one tone sounds different on the same trumpet if different players produce it. This depends on the different tone generation and individual embouchure set-up. Finally analysis shows that even one player produces dissimilar timbres on the same trumpet for all his efforts. This is caused by the complexity of embouchure. The second part of this article deals with parameters which have an effect on this complex.

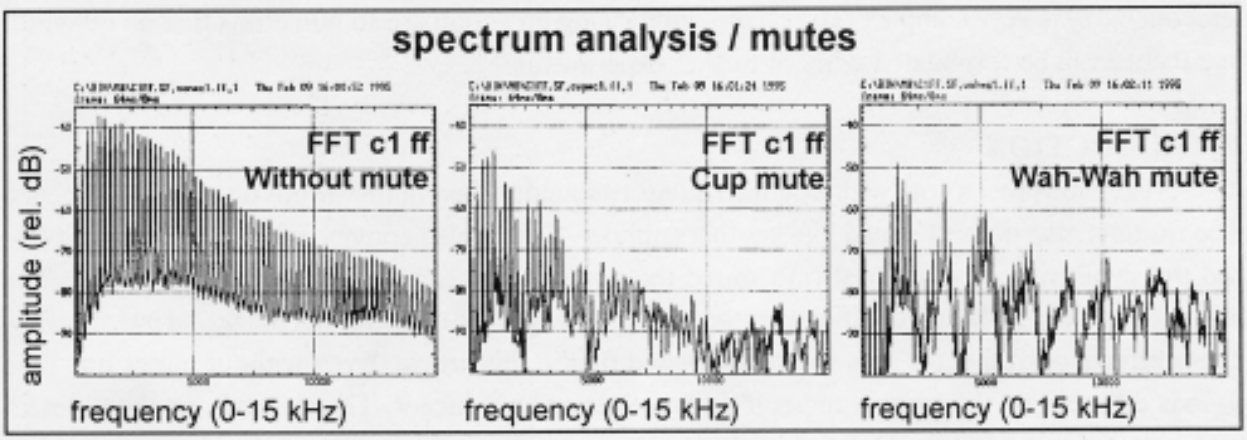
I. TRUMPET MUTES

1. types: brochures reveal many types of mutes. Surveys of the author result in a ranking list of types which are in use. **1. Cup** (93 % of using); **2. Straight** (92%); **3. Harmon** (75%); **4. plunger** or anything like (44%); **5. Wah-Wah** (40%); **6. Velvet** or Bucket (22%); **7. Whisper** (8%); **8. Hat** or Derby) (6,%); **9.Mega-Clear-Tone** (3,%); **10. Buzz WOW** (3%); **11. Mel-O-Wah** (2%); **12. Pixie** or Snubtone (2%) *[The Practicemute (47 %) is out of ranking, because different types are used as Practicemute].* The six most-employed mutes have been subject matter of an acoustical investigation.

2. dynamik: The dynamic range of the trumpet without mute depends on the register: about 30 phone in the lower and about 13 phone in the upper register (Meyer/1980). Measurements of a crescendo-tone in the unechoic chamber in the IWK reveal the following dynamic range in the lower-register (c1). The reference-amplitude 0 dB corresponds with the ppp (as soft as possible) on

the trumpet without mute. The range for the trumpet without mute and with the plunger almost opened is about 30 dB. The Cup, Wah-Wah, Straight and Velvet Mutes have reduced ranges of about 24 dB. The Plunger has 21 dB inin the almost-closed position and the Harmon has even only 17 dB range in the crescendo. The ability to play softer with a mute is true for the Cup, Wah-Wah, Straight and Velvet and Harmon mute. The ppp (as soft as possible) sounds -5/-8 dB lower than with without mute. The chance to play fff (as loud as possible) is most reduced with the Harmon. The fff is 20 dB weaker than without mute. This explains why the Harmon mute is usually amplified when it is in use. The fff played with Cup, Wah-Wah, Straight or Velvet mute is 12 dB softer then without. The dynamic maximum of the Plunger depends very much on the gap size. Almost closed (1cm gap) the fff is about 6dB weaker than without mute.

3. timbre: The sounds produced by some mutes are very characteristic, others sounds similar. The physical reason for a certain timbre are changes in the spectrum. Mutes cause typical formants and above all antiformants. The FFT-Spectrum of the Trumpet without mute is shown in the graph (tone c1, blown fortissimo). The formant area is around 1.2-1.5 kHz. The intensity of the higher partials

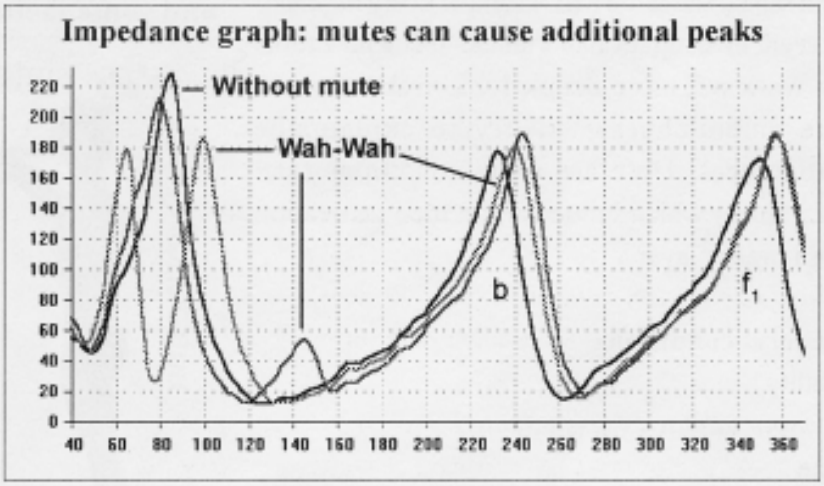


diminish gradually. The FFT of the Cup mute indicates antiformants at around 2.5 and 5 kHz. Also to be seen are the weakened partials over 10 kHz. The Cup prevents the radiation of wavelenghts shorter than the dimension of the mute. Very characteristic is the "Donald Duck" sound of the Wah-Wah mute. The FFT shows the alternating formants and antiformants. The foundamental is very faint. The strong partials around 1.5 kHz entail the nasal timbe. Some more examples for particular characteristics of the other types: The "classical" Straight mute has weak low partials, a formant around 2 kHz and an antiformant at 4 kHz. The Velvet has no antiformant or formant. It darkens the sound by attenuating the high frequencies. (The small wavelengths disappear in the cotton wool bucket).

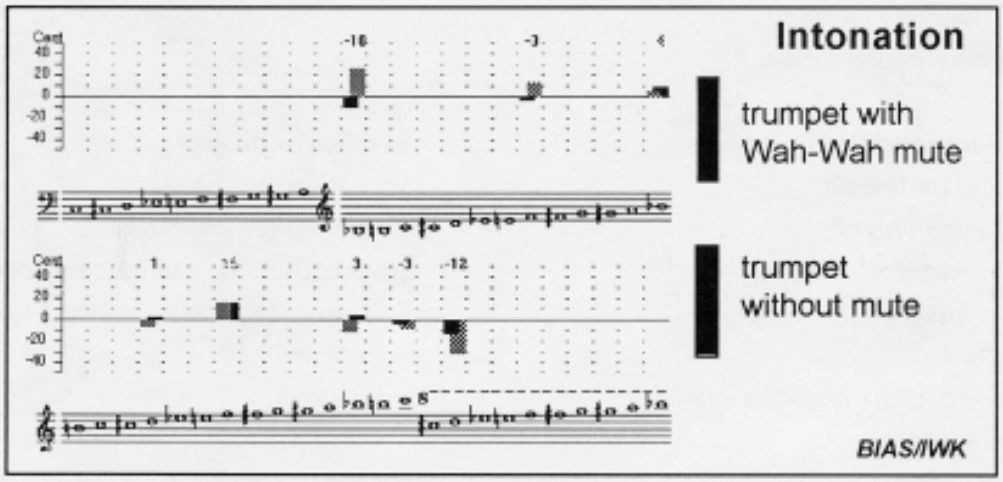
The Formants of some mutes correspond with vocal formants. This is why the Harmon sounds like"ee"(it nickname is bee) and the Plunger sounds in the closed positition like "oo" (doo-wah discribes the closed-open omnopoetically).

4. response: Impedance-measurements display the influence of the mutes on acoustical behaviour. All investigated mutes except the Velvet add a additional resonance peak to the curve. This peak causes a shift-effect on the other resonance peaks. The dimension of the shift depends on the positon

and magnitude of this additional peak. Good specimens of the Cup-, Straight-, Harmon,- Wah-Wah,- mute push the peak below the playing range of the trumpet, and the unintended shift is to a less degree. Bad specimens shift, and even suppress the resonances in the lower register considerable. The additional peak of the Plunger (closed position) lies in between the playing range and actual prevents the sound generation of a "correct" musical pitch. That doesn´t matter, because the Plunger is normally used for special "growl-technique".



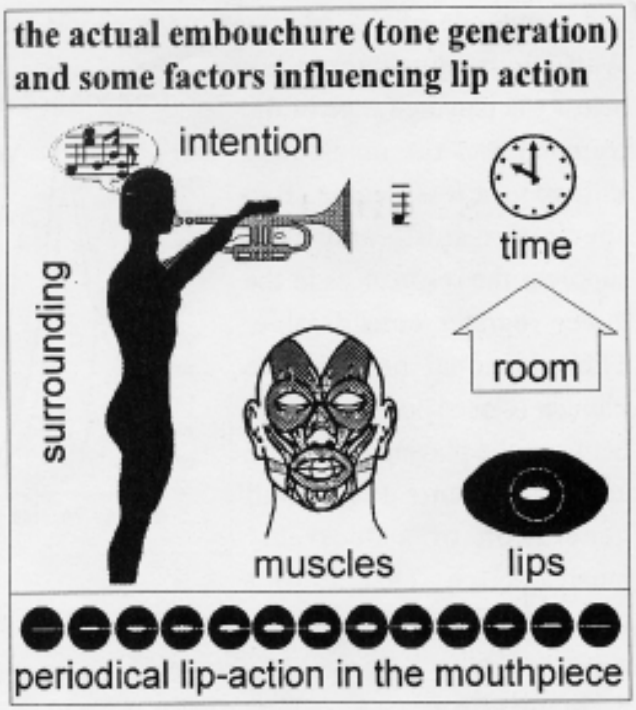
5. intonation: The described shifts of the resonance-peaks affect the intonation. The graph shows one sample. In the lower register the trumpet with Wah-Wah mute is much sharper than the trumpet without mute (28 Cent above equal temperature pitch instead of 10 Cent below).



II. ON EMBOUCHURES

The embouchure is the interface between the musician and the brass instrument. The term embouchure is used in two different ways. On one hand, it implies in a narrower sense the on-set of the mouthpiece on the lips and the actual tone generation of the lips. On the other hand there is the meaning of the word in the wider sense. Phrases like "I have no good embouchure today" or "Soft-drinks are not beneficial for your embouchure" indicate two aspects of parameters which affect the player. There are quite a lot of complex parameters influencing the "human-part" of the linked system "player-instrument". Scientific approaches on this subject have been done from pedagogical side and from the instrumental-acoustic side. The bridge is missing. In fact, the tone generation is determinated by the air flow and the lip action. The principle have been known for many years. What makes the differences between the same note, played with the same instrument (and even the same player)?

Brass player are no determinable machines who can repeat the same MIDI sample every moment. Recent investigation in Vienna - using new tools to work out more detailed informations about the embouchure- will try to explain the differences. Here are some conditions (and examples) which influence the tone generation of a brass player :



general conditions

ability
more talented / less talented
age
education level
pupil / student / professional
school / teacher
Vienna / German .....
teeth - constellation

more specific conditions

time (moment)
-day / night
-morning / evening
-hungry / not hungry
room
-unechoic chamber / church
lung capacity
surounding
-alone / in front of orchestra
cognitive processes
temperature
-cold / warm / hot
intention (music-context)
classic / jazz / else
auditory-system
hearing-ability

specific conditions

motivation
-sympathy / antipathy
lips-constitution (and mucous membranes)
"warmed-up / not "warmed-up"
wet / dry
endurance
-more pressure / less pressure
muscles
relaxed / forced
breathing (air-flow)
dynamic
register (upper / lower)
Instrument
response, intonation
quality, characteristic
feeling (used to mouthpiece and instrument ?)

References: - BACKUS, John. Input impedance curves for the brass instruments. (in: JASA, Vol 60, No2. 1976) - BERTSCH, Matthias. Der Einfluß des Dämpfers auf das akustische Verhalten und die Klangfarbe der Trompete.(Dipl.-Arb.,Universität Wien 1992) - KURKA, Martin. A study of the acoustical effects of mutes on wind instruments. (Chicago, 1961) - MARTIN, Daniel W. Lip Vibrations in a Cornet Mouthpiece (1942) - SLUCHIN, B. CAUSSÉ, R. Sourdine des Cuivres. (Paris, 1991)