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The basson-construction and specific sonority

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Abstract: *Observations regarding the behaviour of the instruments during sound exposure and upon the resultant proper of the aforementioned, the musical expressivity, were made over a period of more than 2000 years. The aim of these observations and research was to discover the most efficient sound articulation rules, necessary for obtaining the quality able to express, as convincingly and truthfully as possible. The bassoon finds its place in the orchestra of classicism, known as Mannheim School, in the Viennese composition trinity. The almost geometric expansion of a romantic orchestra, and especially the post-romantic one, enlarges the opportunities of complex manifestation of the bassoon.*

Key-words: *3 bassoon, instruments, styles, development, history*

1. Introduction

At the beginning of the 16th century, in the writings of Sebastian Virdung (1511), Martin Agricola (1529) and Othmar Luscinius (1535), there occur mentions on the dulcian, one of the ancestors of the bassoon. Nevertheless, most researchers believe that, underlying the construction of "phagotus", made by Afranio degli Albonezi (1480-1560), in Ferrara in 1536, there would be an older instrument called bombarda.

In 1536, in Ferrara, Albonesi was presenting an instrument called "phagotus", uniting through a bladder two older wind instruments called bombardas. This large-dimensioned "phagotus", difficult to transport and handle, had a very reduced ambitus. In 1619, in the chapter *De organographia*, Michael Praetorius was presenting the family of bassoons, known at that time, with drawings, explanations and the progress due to the improvements of the instrument. In 1692, the violin maker Jacques Hotteterre made an instrument with six apertures and six keys, on which one could play a larger ambitus. Only in 1827 in Paris, Frédéric Guillaume Adler and Carl Almenräder presented an improved bassoon, with an ambitus of almost three octaves, allowing for a chromatic array,

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and in 1831, Carl Almenräder and Johann Adam Heckel laid the foundations of Heckel's firm, that succeeded in making the most prestigious bassoon brand, improving the quality of sound and tuning.

2. The problem: the development of the bassoon

Observations regarding the behaviour of the instruments during sound exposure and upon the resultant proper of the aforementioned, the musical expressivity, were made over a period of more than 2000 years. The aim of these observations and research was to discover the most efficient sound articulation rules, necessary for obtaining the quality able to express, as convincingly and truthfully as possible, the background feelings of a musical work and which is also able to draw near the soul and comprehension of the listeners. Along the history of musical instruments, there was research regarding the sonority of instruments, that was not always carried out on scientific grounds, therefore the results were mostly random, fortuitous, carried out on a certain instrument, or by a certain instrumentalist, so having a singular, particular character. But in 1947, professor Bernard Hague presented his research entitled *The Tonal Spectra of Wind Instruments* to the Royal Musical Association in London [Hague, 1947]. For those interested in the science of acoustics applied to music and especially to wind instruments, this research represents a fundamental work, as herein the assertions are proved and scientifically grounded.

For every instrument, there is a source of production and supporting of the sound. In the case of the bassoon that is the reed held between the lips of the instrumentalist, and vibration is created by means of the air breathed out by him. The main principle is the same for each instrument: air vibration. The instrumentalist stores a quantity of air in his lungs. The trachea and the oropharynx contract, the soft palate and the uvula close the mesopharynx, preventing the air from escaping through the nasal cavity. Thus, a vibration is produced at the inferior end of the air column, resulting a stationary wave system, that moves inside the body of the instrumentalist. The air column can be (didactically) divided into two:

a) The air column inside the instrumentalist, having the diaphragm as a lower limit, and the lips as the upper one. While playing, this air column is moved as if it were a solid material (from the point of view of the laws of Physics). In the meantime, 100 muscles are working, the most important being those of the pharynx and the tongue.
b) The air column inside the instrument, the production of the sound and its resonance represent a dynamic couple. The resonator tube is predominant,

> and along with the air column in the instrument, where the efficient length is controlled through apertures, keys, pistons, valves etc., stabilises and determines the pitch of each musical sound produced.

This sound is facilitated by the large mass of the air column, tightly related to the source of sound production that is the reed. The tubes of the instrument display certain characteristics that allow the passing of and improvement of the air column, thus the chromatic scale of pitches is produced. For the bassoon, this occurs by means of lateral apertures. At the moment of gradual lifting, the air column shortens, allowing the air to escape, and thus the desired sound is obtained. A comparison with an organ's way of functioning is required; we recall that, for an organ, each sound of the scale has another tube, thus numerous tubes are needed, each with a role of its own in producing a sound (and different pitches). The tubes being dimensioned differently, and being made of different alloys, have certain properties with the role of influencing the timbre.

For the bassoon, first and foremost, it is necessary to master the articulation of the three and a half octaves that represent the ambitus of the instrument. One needs technical virtuosity in correctly handling the positions (grids) on the instrument, technical abilities consisting of a large array of techniques for controlling respiration and artistic (musical) thinking, for highlighting the expressive and semantic background of an interpreted work. In other words, 42 sounds must be obtained from a wooden tube fitted with keys; using eight fingers and two thumbs, the entire chromatic scale along the ambitus of the instrument needs to be accessed and controlled. Sound B ♭ in the low register requires a length of the tube of 2.59 m, the instrument being divided into 5 segments: tenor joint, bass joint, boot, bell joint and bocal.

The bassoon is a continuous conical tube and over time, this shape (conicity) was constantly modified, improved. The most important component of the instrument is the bocal and the side upon which it is mounted. The bocal was described by the German newspaper *Die Seele* as the soul, the heart of the instrument. There is a wide range of bocals, each with its advantages and disadvantages. Each instrument, with its own particularities, can combine with one bocal or another. Some of them can help the instrument render an easier emission for the high-pitched and super-high-pitched register, while others can provide a soft sonority or a more open, bright one.

In the case of the other wind instruments (such as flute, oboe, or clarinet), they have six apertures covered by fingers, at comfortable distances, allowing for using and placing fingers naturally.

To render sounds from B ♭ in the low register to F in the medium register, we use 18 apertures of tone and semitone. Starting with F in the medium register, the other sounds will be rendered with the help of a higher pressure of the air column, in a harmonics regime *F♯- G - G♯- A* – B ♭ *- B - C - C#*. Then, compromises made in the positioning of the apertures may lead to considerable differences in intonation and timbre quality. These differences can be compensated by the auxiliary fingering (false positions) of the two construction systems: German and French. Normally, the sound apertures will be open or closed depending on the number of free fingers left. Today possibilities of research assisted by computers, and the possibilities of listening to the array of instrumental sound timbralities, impress and highlight how important choosing and studying timbralities proved to be in the history of human civilization.

The possibility of controlling timbrality and using it in the most advantageous ways, with a view to processing sonority, are achievements of the 20th century. Thus, through adjusting and changing the initial data of a musical recording, with the help of computers or in a laboratory, incredible performances of interpretation can be obtained and also their storage on media with everlasting temporal properties.

The contemporary composer and interpreter have the possibility to be informed and to compare the technical and artistic performance of work at a worldwide level. A concert or a cultural event can be transmitted simultaneously worldwide. Moreover, the same work can be listened to in a private environment every time one wishes, preserving sonority characteristics and technical data over the years. Benefits are not limited only to that because improvements of working technique have an impact on the professional background of the future interpreter. The desire for improvement of performance by each pupil or student, and also the professor’s marking out of the covered road, and the one that is left, in obtaining the parameters of instrumental technique, become easier to understand and quantify. The best proof for the interest that has arisen in the subject matter of timbrality and the improvement, based on it, of the artistic performance comes from the level attained presently with musical interpretation worldwide.

Performance hardware and software technology invented in the 20th century has become greatly appreciated by musicians. Through the many possibilities of sound recording, the interpreter has the chance to access the essence of sonority. Thus, he can remark on and compare details of each interpretation, analysing in detail the particular timbrality of a musical performance and visualising the evolution of his own sound frequencies. The interpreter can study more efficiently, in a shorter period of time, because he can control exposure more precisely and immediately.

He can also intervene immediately upon the sound result, improving it with the help of new techniques, both visual and auditory.

In the process of musicians' artistic performance, timbrality plays a very important role. Timbrality is the specific quality for each sound, which allows it to be distinguished from another sound, independently of its pitch, intensity or duration. Timbre is the most comprehensive sound quality. As Dorel Pascu Radulescu states (Pașcu Rădulescu 2000, 133): "trait of auditory sensation that allows for distinguishing different complex sounds with the same fundamental frequency and the same strength, but different spectral compositions".

As for determining the timber particularities and the way listeners would be impressed by the sonority and timber quality of woodwind instruments, we believe that the opinion of Nikolai Rimski-Korsakov is important, who considered that: "the sonority of the flute is cold in major and with superficial sadness in minor. The oboe displays a naïve joy in major and it's dubious in minor. The clarinet, joyful and flexible in major, dreamer and sad in minor. The bassoon, old-type and melancholic sonority in major, and sickly and sad in minor". By registers, due to its timbre, the bassoon can be dreary in the high and super-high pitches, low or melancholic in the medium one. The general ambitus of the bassoon lies between B $\flat_2$ at 58 Hz and F^1 at 692 Hz. The main formant is at 500 Hz, vocal colour O.

Tackling shortly the sonority of the bassoon, we have to envisage three factors equal in importance: man, with his physical and psychic qualities; the bassoon, the instrument in perfect working state; and the reed, as a source of vibration and rendering the sound that radically influences the colour and the quality of the sound obtained. The reed is a main factor in obtaining the sound. Quality traits of the reed, such as: clear and complete sonority; pure intonation; and comfortable sound rendering in all the registers of the instrument, as well as the ease of performing all articulation types, represent desiderata for all bassoon players in order to obtain a sonority as beautiful as possible and a special interpretation. Professional instrumentalists make the reeds by themselves, as small craftsmen, or they can appeal to professional builders and the instrumentalists make only the final finishings and adjustments. The reed contributes to the purity of the sound, intonation, it gives suppleness and quality to articulation.

A permanent and primary concern of wind instrumentalists with a double reed (oboe players and bassoon players), the reed ensures a dynamic array and marks the quality and colour of the sound. Designing and creating it according to the highest parameters for sound rendering requires deep knowledge about acoustic conditions in which the sound occurs when the reed vibrates. Through his experience and the control of respiration, the instrumentalist produces all the necessary frequencies with the help of the reed, which is necessary in order to obtain the sounds for the entire chromatic scale along the stretch of the instrument (over three and a half octaves). It is very important that professional instrumentalists make their own reeds, or at least they should know the techniques to finish them.

In the case of instrumentalists with a double reed (oboe, English horn, bassoon), the difficulty consists in balancing both superposed reed strips. No matter how well we master the manufacturing and construction process, the reeds will have different (specific) properties. These depend on the different quality of the reed (from the top, the stem or close to the root), on its draining process (drying) and on the details of workmanship. It is extremely important that the instrumentalist acquires the art of tempering, knowledge about choosing and preparing the wood, in order to obtain with the help of a balanced reed a correct intonation, to be able to create special timber colours, easily going through the entire ambitus of the instrument to obtain the fineness and refinement of musical expression.

We can firmly affirm that there is neither a standard way of constructing, nor a standard model for a perfect reed. One thing is certain, the more reeds that the instrumentalist makes, the more he will confront various situations and discover new things; he will gradually develop expertise. Professor Bernard Hague describes the bassoon as being an acoustic phenomenon of great complexity. This is due to the length of the resonator tube, its conical shape and the fact that aslant apertures represent a branch of the main resonator tube.

In the case of flutes, oboes, and clarinets, open lateral apertures stretch, respectively shortening the resonator tube, thus allowing for the rendering of lower or higher sounds. In the case of the bassoon, the air column is “limited” by a wooden “rigid wall” that has certain natural frequencies of its own. These elements together: the length of the tube (over 2 meters); the thickness of the walls; and lateral apertures (constituting auxiliary resonator tubes), in which the air column penetrates, confer the instrument the characteristic and behaviour of an acoustic filter. These construction parameters of the instrument represent its characteristic and a determining factor for its timbre. The normal length of the tubes of the bassoon needs to render the F sound, all its upper sounds are harmonics. Recent research has highlighted that the properties of sound spectrum, such as the number of harmonics, the nature of frequencies, and the intensity are factors that determine timbre.

Between the fundamental sound and its harmonics, there are certain specific relations of intensity. These relations are perceived by the listener under the form of impressions of aspects such as roughness, fineness, brightness, and ampleness. In general, the sound is bright when it has a great number of harmonics. In the ample sounds, the fundamental one prevails and its first eight harmonics. These characteristics of the timber of musical instruments, being studied at the highest level by acousticians, have led to combinations of sonorities unimaginable some time ago.

The history of the bassoon started in Italian music at the beginning of the Baroque, when *the dulcian* separates from its successor, a new instrument, present in the expressions for supporting the sound discourse (*basso continuo*), according to its "deep" technical possibilities, but also as a soloist. The bassoon finds its place in the orchestra of classicism, known as Mannheim School, in the Viennese composition trinity; it is the bass in the quartet of woodwind instrumentalists. In the orchestra, in Vienna, the bassoon serves different purposes: it is the ticking of the pendulum in the Clock Symphony by Joseph Haydn; or it performs short soloist fragments in *Symphonies* no 39, no 40, no 41 *Jupiter* by W. A. Mozart, and in *Symphonies* no 3 – 9 by Ludwig van Beethoven.

3. Conclusions, Proposals

The almost geometric expansion of a romantic orchestra, and especially the post-romantic one, enlarges the opportunities of complex manifestation of the bassoon. Thus, Johannes Brahms, Gaetano Donizetti, Giuseppe Verdi, Piotr Ilici Ceaikovski, Nikolai Rimski Korsakov, Dmitri Șostakovici, Maurice Ravel, and Igor Stravinski artfully use and give the bassoon a substantial place in their creation. Thus, the bass instrument of woodwind instrumentalists finds unimaginable resources in the creation of famous composers. Post romanticism exacerbates the orchestral apparatus to its "explosion" in the work of Arnold Schönberg, *Gurelieder*. "Due to its wonderful trait of adapting to any circumstance, the bassoon is, in the orchestra, what a knight is for the chess game".

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