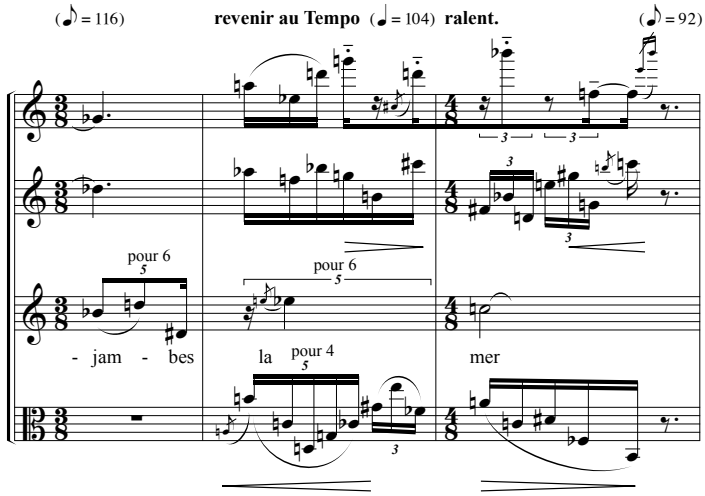


II.3 TEMPO

II.3.1 DEFINITION OF THE TERM AND ITS RELATIONSHIP TO METER AND RHYTHM – SPEED

Tempo expresses the relationship of a centric hierarchically organized (i.e. metrically structured) rhythm to *physical time* and it is given by the ratio of the BMU number to the amount of physical time. It is also possible to say that tempo is the motion-rate (resp. density) of the BMU. [050]

- It is important to note that in principle, we relate tempo to the BMU of the *real meter*, the one audible in the sounding musical structure and not only to the basic units of the notation in measures which, in many cases as already said, does not have to coincide with the real meter. The composer´s prescription by metronomic value does not always express the real tempo because the performer does not always choose the note-value as the BMU of his/her interpretation which the composer assigned in the tempo marking.

Tempo has the character of density, resp. motion-rate and therefore the same relationships are valid for it as for density (motion-rate):

$$\text{tempo [impulse/min]} = \frac{\text{number of BMU}}{\text{duration of the section [min]}}$$

For the same reason tempo is quantifiable in the same units as density, resp. motion-rate, i.e. impulse/min, resp. BMU rhythmic value / min – such as ♩ / min. Also the tempo markings of Maelzel's metronome are expressed in these units. [051]

050 Very often tempo is characterized as the speed of the musical motion. "Tempo means speed in which the composition is played." (Zenkl 1982, 38). "The marking L'istesso tempo... means that tempo (speed) does not change." (Janeček 1968, 26). We intentionally avoid these characteristics, firstly for its ambiguity but mainly because the term "speed" will be used in our following text in a different sense.

051 Mälzel's metronome – a mechanical apparatus designed to exactly measure musical tempo. It is based on the principle of shortening and lengthening a pendulum arm driven by a clock mechanism. The metronome was patented in 1816 by the Viennese machinist J. N. Mälzel.

- In practice several manners of tempo marking were established according to Maelzel's metronome: MM ♩ = 120 or MM ♩ 120, possibly only ♩ = 120 or ♩ 120. However, if taken strictly, only the 120 ♩/min type of tempo marking can be considered correct which corresponds with the mathematical expression of the tempo (as well as motion-rate) value as a ratio of the BMU number (number of impulses) to time. Then also the mathematical relation is valid
$$\frac{120\ ♩}{\text{min}} = \frac{60\ 𝅗𝅥}{\text{min}} = \frac{240\ ♪}{\text{min}}$$
and similar – as also is the case of mutually convertible motion-rate values (see section II.1.4.)

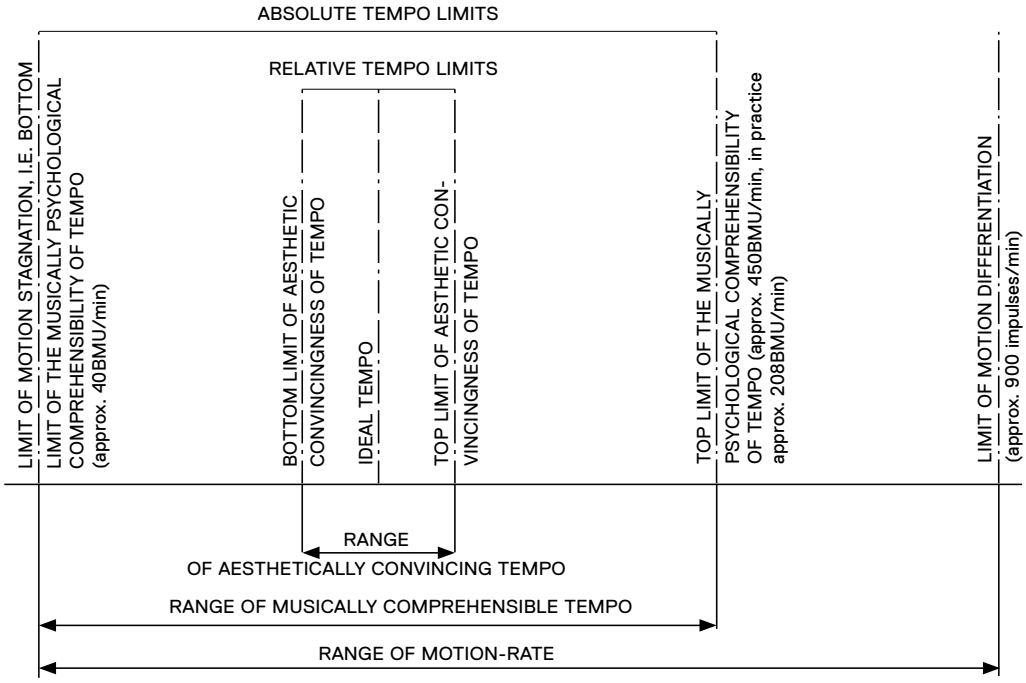
The tempo data can be converted to motion-rate data relating to lower as well as higher rhythmic values inherent in the given structure and vice versa, following the same principles as when converting the individual values of motion-rates (see II.1.4.).

With respect to the link of tempo and the flow of BMU, we can claim that there exists a bottom and top limit for a possible tempo which correspond to the maximal and minimal possible duration of BMU. Exact values of these limits (especially the bottom one) cannot be unambiguously determined.

- It is possible to deduce from practical experience that BMU should be still further divisible at least to two subordinate parts. If this condition is to be satisfied, the above limit of motion differentiation of 15 impulses/sec, i.e. 900 impulses/min, also implies a value of the top limit of tempo of *450 BMU/min.* The value of the bottom tempo limit should then correspond with the limit of motion stagnation, i.e. *40 BMU/min.* These values are theoretically possible. However, in practice we get along very well with the range of 40 BMU/min to 208 BMU/min which is the common range of Maelzel's metronome.

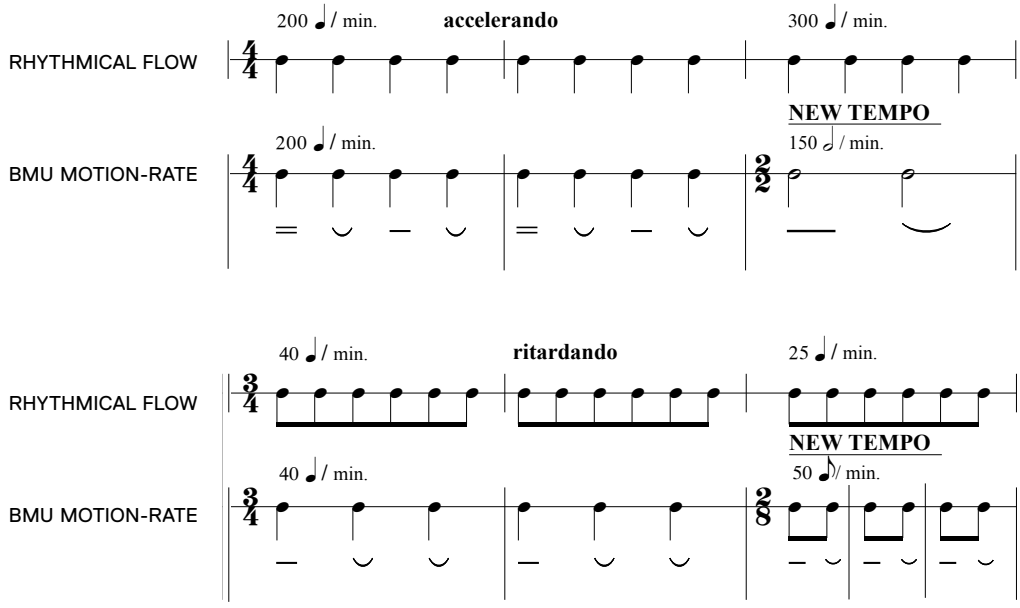
We will label the two described limits as *the top* and *bottom limits of the musically psychological comprehensibility of tempo.* They delineate the range of musically comprehensible tempo. As they are anthropologically given and they are practically constant from the viewpoint of the subject of our research we will consider them to be *absolute.*

For musical practice there are still other tempo limits of great importance. They result from the fact that in performance it is practically impossible (and from the artistic viewpoint even not desirable) to strictly mathematically adhere to the author's tempo marking. This marking has to be understood only as informative, instructional data describing the author's ideal image whose value should be essentially adhered to in the performance. Commonly however, deviations from this ideal value are tolerated in both directions if the performance subsequently gains force. Obviously this range is not too wide. When these limits are exceeded, the purely musical sense of the performed composition might not suffer but its aesthetic meaning is deformed (when these limits are exceeded, the interpretation has the impact of something like a caricature of the original). We will call the described tempo limits as the *top* and *bottom limits of aesthetic convincingness of a tempo.* This delineated range we then call the *range of aesthetically convincing tempo.* With respect to their variability and flexibility (they can be related to the most varying concrete values of the ideal tempo), we consider them to be relative. Relative tempo limits are always found inside the range of musically comprehensible tempo delineated by the absolute limits.



With respect to the limitation of tempo by the top and bottom limits of musically psychological comprehensibility, it is not possible to arbitrarily accelerate or attenuate beyond these limits. In the case that some of the presented limits are exceeded, the BMU function is taken over by another rhythmic value inherent in the structure (a longer one with acceleration, a shorter rhythmic value with attenuation; cf. lower the section IV.1.1.1).

As a consequence of change in the BMU value the tempo is also changed:



- In such cases a paradoxical situation occurs when the consequence of acceleration is a slower tempo and the consequence of attenuation is a faster tempo. In spite of this being completely true, it does not fully capture all the aspects of the described phenomenon because in spite of the stated attenuation of tempo in example a), the listener simultaneously feels an acceleration of motion as a consequence of the realized accelerando, and the opposite happens in example b). To comprehend this reality, we introduce the term of speed.

Speed, similar to tempo, expresses the relationship of a metrically organized rhythm to physical time but, in distinction from tempo, it does not have to be only dependent on the BMU flow. The term "speed" and the characteristic thus labeled makes sense when analyzing a structure with variable tempo in cases of tempo change where the consequence would be the described exceeding of the limits of musically psychological comprehensibility. Speed can be quantified either absolutely, i.e. in units of tempo, resp. density, motion-rate (number of impulses/min) or relatively, in the ratio of compared absolute values.

- Therefore in the above presented example a), as a consequence of accelerando the tempo is attenuated to 0.75 of the original tempo but the speed increases to a multiple of 1.5; in example b) on the contrary, as a consequence of ritardando, the tempo increases to a multiple of 1.25 of the original one while the speed is reduced to 0.625.

II.3.2 TYPES OF TEMPOS AND THEIR CLASSIFICATION

According to its course, similar to density and motion-rate, tempo can be classified as *constant* and *variable* and the latter then further as *fluctuating*, *ascending* or *descending*.

The tempo can be modified either for *agogic* reasons (fine ripples in tempo during the compositional flow primarily performed for reasons of expression) or *tectonic* reasons (more striking changes in tempo primarily for construction reasons following the intention to achieve contrast or gradation). Changes in tempo during the composition can also sometimes be connected with the occurrence of *free meter*.

In the case of a variable tempo, the *span* between the *minimal* and *maximal* tempos can be considered in its relation to the *length*, possibly *duration* of the section where the tempo change is distributed. A change in tempo is the more noticeable the bigger its span and the shorter the section within which the changes take course.

Constant tempo can be unambiguously metronomically determined. With variable tempo, only the values of *momentary* or *average* tempos can be metronomically expressed (cf. II.1.4. – momentary and average densities). Agogic ripples are not usually metronomically determined. When realizing them, the performer follows his/her feeling for the style of the performed composition.

- It is generally recognized that with compositions of a generally classicist style direction (Classicism but also compositions of the 19th and 20th centuries influenced by Classicism – such as Neoclassicism – and also fast motoric movements in Baroque music) there is the tendency to limit the agogic ripples as much as possible. On the other hand with compositions of a generally romantic style direction (Romanticism but also compositions of the 20th century influenced by Romanticism and many slow movements in Baroque and Classicist music) there is a tendency to emphasize