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NEW EXTENSIONS OF THE BEAUTIFUL CELLO TONE

Abstract

Extended playing techniques describe gradual extensions of well-known playing techniques as well as radical changes. While the Anomalous Low Frequencies consciously ignore the principles of producing a so-called beautiful tone (in terms of a Helmholtz motion), multiphonics deal traditionally with harmonics and flageolet nodes on string instruments. Both playing techniques are described in specialist literature, but need specification for cello playing as well as an enhancement of certain parameters, to which this study is contributing. Playing with scordatura expands the tonal range of the cello and reveals new overtone structures. The use of two bows increases the number of strings that are either played together or are newly combined. The process with current music is open, discussable and changeable. It incorporates the interaction between composer and interpreter in the same way as with free experimentation and improvisation.

Key words: extended techniques, beautiful cello tone, Helmholtz-motion, frequency analysis, Anomalous Low Frequencies (ALF), multiphonics, scordatura, 2-bows-techniques, curved bow, movement choreography, development process, sound experiment, improvisation.

Izvleček
Nove razširitve lepega tona na violončelu.

Nove tehnike igranja v pomenu angleškega strokovnega izraza „Extended playing Techniques“ pomenijo tako postopno razširjanje znanih načinov igranja kot tudi radikalne spremembe. Medtem ko je pri nenormalno nizkih frekvencah (ALF) zakonitost za izvajanje tako imenovanega lepega tona – v smislu Helmholtzovega nihanja – zavestno zanemarjena, pa multifoniki temeljijo na tradiciji ukvarjanja z alikvotnimi toni in nihajnimi vozli na godalih.

Obe tehniki igranja sta za violončelo opisani v specialistični literaturi, vendar so za igranje potrebna natančna navodila kot tudi razširitev določenih parametrov, k čemur pripomore pričujoča študija. Igra s skordaturo razširi tonski obseg violončela in pripelje do izraza nove strukture alikvotnih tonov. Uporaba dveh lokov pomnoži število strun, ki so igrane sočasno ali v novih kombinacijah. Proces pri sodobni glasbi je odprt, sposoben dialoga in spremenljiv. Vključuje

tako interakcijo med komponistom in izvajalcem kot tudi prosto eksperimentiranje in improvizacijo.

Ključne besede: razširjene tehnike, lep ton violončela, Helmholtzova nihanja, analiza frekvence, nenormalno nizke frekvence (ALF), multifoniki, skordatura, tehnika dveh lokov, ukrivljeni lok, koreografija gibanja, razvojni proces, zvočni eksperiment, improvizacija.

Introduction

Due to its pitch range and richness of sound as well as the size of the corpus and the frontal playing visible to the audience, the cello appears to be especially suitable as experimental ground for new sounds and playing techniques. This observation was already made by Bernd Alois Zimmermann in his essay *Über die neuerliche Bedeutung des Cellos in der neuen Musik* (Zimmermann 1968) and was implemented by Siegfried Palm and other distinguished cellists, who devoted themselves to the playing of contemporary works.

While we observe the effects of cello music of the 1960s-1980s in retrospect, though this is definitely about music by contemporary composers, my study is about cello music in the last 20-25 years, with still-unfiltered results.

A multi-dimensional observation of new playing techniques is required. It means that one or more suitable starting points need to be found to do justice to the events.

Extension and break-down of the beautiful cello tone

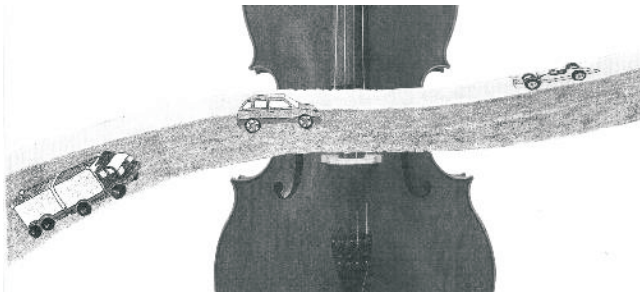
The generation of the so-called "beautiful cello tone" is based on the balance of bow-bridge-distance, bow velocity and bow pressure as main parameters of bowing. This observation is widely known among cellists and taught in cello lessons for students of all levels.

The pedagogue Walter Mengler has pictured these relations as tendencies in his cello tutor from 1995, which I would like to present as a short summary of common knowledge:

- High bow force has a tendency towards slow bowing near the bridge.
- Middle bow force has a tendency towards middle bow velocity on a middle bow-bridge distance
- Low bow force has a tendency towards high speed near the fingerboard.

The balance of these three main parameters helps us to keep the string oscillation within the range of traditional sounding.

Figure 1: The 3 traces of a highway



(Mengler 1995: 18)

The range of "beautiful tone" is synonymous with the generation of sustained Helmholtz motions. On the side of too low bow force, "surface sound" occurs and too much bow force, in relation to the bow-bridge distance, produces raucousness.

In connection with extended playing techniques, the borderline between "good sound" and "exaggeration" and the wide areas of surface sound and raucousness are most interesting. The borderlines are related to gradual extensions, pointed out in the question: "What would happen, if I were to change one or more parameters of my playing?"

The wide areas of surface sound and raucousness represent the idea of a complete break with the rules of traditional cello playing. The relevant question would be: "How to produce…such or such effect?"

Anomalous Low Frequencies (ALF)

The first extended technique I would like to discuss is initially experienced as an increase of the bow pressure. Crossing the borderline of noisy tone to raucousness, three categories of phenomena will appear:

1. The romantic Russian string schools, in particular, have developed exercises, such as sons filés, developing a manner of bowing "into the string" with a heavy stroke, in order to fill concert halls with a brillant big sound, which is then accompanied by an abundance of noise directly around the instrument. These noises are not sustainable; they do not spread around the hall, but they do give us information about the enormous strain put on the bow.

As Schoonderwaldt says, "the brilliance of the tone can be controlled via the bow force, providing an important expressive means to the player." (Schoonderwaldt 2009: 6-7)

Bow pressure is the most distinguished medium for controlling the quality of sound.

2. From there, increasing the bow force will lead to a sinking of the pitch. This sinking is due to a delay in the change of sticking and slipping. According to Schoonderwaldt (2009: 6 ff) the kink Helmholtz discovered is more a rounded corner because the velocity of string motion does not change abruptly from sticking to slipping and vice versa. There is a small delay in the reaction of the string when it tears off the bow or when the bow catches the string. This delay leads to a flattening effect on the pitch. Thus, the flattening effect is the indicator for a (too) heavy stroke. And the flattening effect is a quality limitation of bow pressure in traditional playing.

An increase in bow pressure can cause an elongation of the amplitude with a flattening effect. At the same time, it can evoke unusual modes of string vibration which lead to specific sound manipulations. The range of sound production is enlarged as long as the player and composer agree to include the borderline sounds in their repertoire.

3. Anomalous Low Frequencies (ALF) are not borderline sounds anymore. Their frequencies are far below the flattening effect. ALF were first described by violinist Mari Kimura.

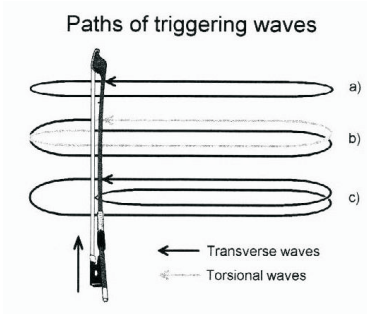
"One day nearly 20 years ago, violinist Mari Kimura was practicing a son filé exercise she'd long used to improve her sound on the E string, and on a lark decided to try it down on her G string. She drew her bow very slowly, and applied a bit more pressure than usual. Suddenly she heard a crunch and a scrape—and a G note a whole octave below what the violin is supposed to be able to play without changing the tuning. " (Reel 2009)

The most remarkable point is that Kimura specifies that she does not need too much pressure to obtain an ALF. For her it is a sensitive matter of finding the right grip via the bow. Since Kimura's range of ALF-pitches oversteps the octave below, the tone is for a semitone only. She uses both categories of ALF (torsional and transverse triggering, explained below) and probably also a combination of them. Kimura fills up the octave in a melodic way. We will see how far the violin grip can be adopted to the generation of ALF on the cello.

Increasing or changing the bow force even more leads to several categories of ALF.

In Guettler's diagram, different paths of prolongation are pictured:

Figure 2: Paths of triggering waves



(Guettler 2002: 23)

Guettler found two categories of ALF:

- ALF with torsional triggering
- ALF with transverse triggering

Unlike Helmholtz motion (path a), ALF with torsional triggering (path b) are caused by a medium increase of the bow force. Torsional waves, reflected by the bridge, help the string to tear away from the bow. In so doing, a period is created. The delay in slipping causes the lowering of the frequency.

The resulting tones in a simulation model (Guettler 1994: 12) show a prolongation of the period of about 20.4-29.3% with a sounding pitch of about a minor third below the periodicity pitch of the string.

With fourfold bow force compared to the normal bow pressure, ALF with transverse triggerring (path c) of nearly 100% prolongation occur. The resulting sound is about one octave below the periodicity pitch of the open string or fingering. (Guettler 1994: 13)

In this case, the prolongation is not due to a delay, but to the complete reflection of waves. The bow works as a perfect arrester barrier and reflects the waves towards the nut or finger. By the second attempt of the corner to slip under the bow, the transverse waves have increased enormously and make the tearing off possible. This time, of course, the moment of deliberation or slipping depends on the battle of these forces.

Approach to ALF for cellists and composers

On the cello the increase in bow pressure is much higher than on the violin. This is the reason why the composer Michael Maierhof, working with ALF, which he calls "undertones" UT, suggests a fist grip for the bow.

Up to now, ALF playing on the cello has not been specified systematically. Therefore my departure is from observational research, supported by frequency analysis and analysis of the playing manners resulting in ALF.

To start with general observations on how to play ALF on the cello, I noticed that:

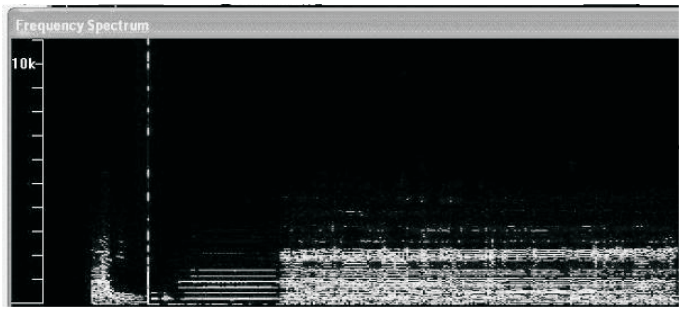
- ALF occur suddenly.
- The fundamental jumps one or more intervals below the original tone.
- The structure of partials changes immediately.
- ALF are very loud.
- The character of cello ALF is "hard edged".
- The fingering is not changed.
- The pitch depends on the amount of pressure and the bow-bridge distance.

Double stops of ALF and normal tones, as Kimura practices them on the violin, seem to be impossible on the cello because the ways of tone production are so different. The same problem occurs as soon as ALF on the cello are integrated into a melodic line: the tone production as well as the character of the sound is so different from the usual cello tone that ALF would disrupt a musical line.

Thanks to Prof. Kob, I had the opportunity to record ALF and multiphonics and to make frequency analyses at the Erich-Thienhaus-Institute for acoustics at the Detmold Music Academy, of which he is Head. I was invited to conduct a colloquium on those playing techniques with live demonstrations and live analyses, beamed on the screen for the students to watch the process (Biffio 2009).

On the figure below, the equal structure of the partial of a normally bowed tone is visible in the beginning; (after the click), it suddenly changes to a very dense partial structure with a lot of noise and the fundamental jumps below. The apparently chaotic structure of the partials changes in form. The high partials have a tendency to shift upwards.

Figure 3: Bbes3 – transition to ALF



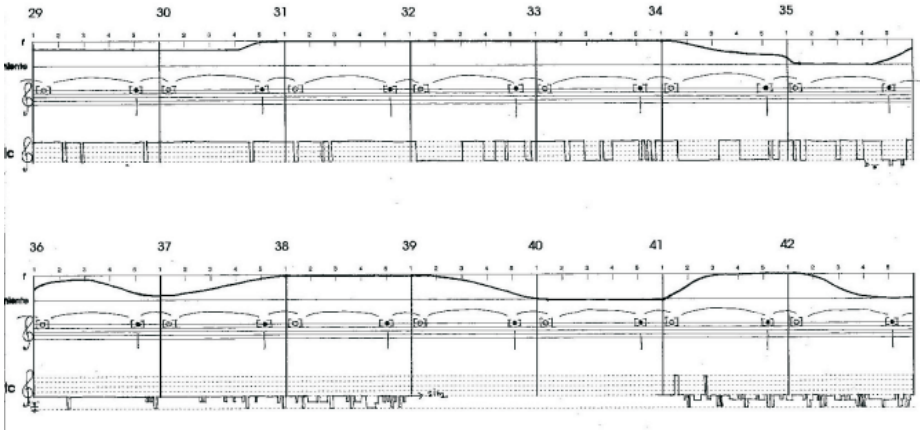
(Biffio 2009)

The Bbes3 was played in the 4th fingering position on the D-string. The resulting ALF extreme bow pressure was almost a Bbes2.

Maierhof's cello solo *splitting 14* (2003-05) on ALF starts with a long F5. That is why this tone was of special interest for me. I made frequency analyses and observed the playing conditions.

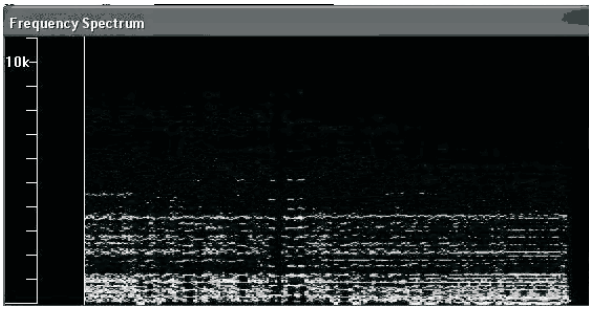
As indicated in the third line of his score, Maierhof demands jumps into three levels of ALF. To my surprise, he estimates a dynamic range from forte to piano, indicated in the first line.

Figure 4: Undertones of different levels



(Maierhof: 2003-2005: 2)

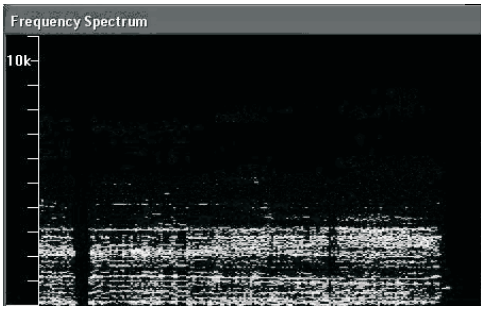
Figure 5: ALF under F5 with three leaps downwards



(Biffio 2009)

The figure above shows more than one ALF on a stopped note F5. On the bottom right hand side, one can see ALF on the third level below the stopped note with an instable pitch, drifting upwards.

Figure 6: ALF under F5 with change of bow bridge distance towards the fingerboard

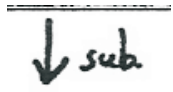


(Biffio 2009)

This figure indicates a change in bow bridge distance on ALF. The frequencies are heightened with the bow shifting towards the fingerboard. Once one of the ALF levels is reached, the deviations of pitch are in a microtonal or tonal range. A frequency glissando is possible.

Being a cellist himself, Maierhof is probably the most prominent composer writing ALF for cello as well as for string quartet. And still, the effect of jumping intervals beneath the stopped tone was already used in the 1990s by other composers e.g. Daniel N. Seel in *Skordaturen II* (1992-94). He notes the ALF-levels as arrowheads.

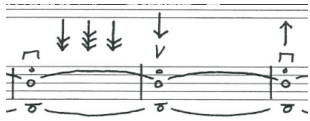
Figure 7: Increasing bow force



(Seel 1992-94: 7)

The vertical arrow indicates an increase of bow force. The result is a creaking noise.

Figure 8: First level and second level ALF



(Seel 1992-94: 7)

With progressive increase of bow pressure, ALF of the first level occurs (addition of a second arrowhead) and, further on, the ALF on the second level (addition of a third arrowhead). The arrowhead pointing upwards indicates the release of bow pressure back to the usual tone production.

Both samples are played on high tones on the A-string, which is the thinnest string, very much shortened by the finger. Almost violin conditions! Maierhof suggests using a damping finger to disturb the "normal" string oscillation. And Mari Kimura dicovered that old strings are better for ALF than perfect ones (Bundler 1999).

The playing of ALF works on the IV cello string as well. This time, the ALF is indeed abnormally low: far below the cello range. I do not know any cellist, including myself, who is able to play second or third level ALF on the C-string.

The pitches for ALF on the cello, according to my classification, are as follows:

- First level ALF: around an octave below the fingered note or open string
- Second level ALF: around an octave plus a fifth below the fingered tone or open string
- Third level ALF: around two octaves below the fingered tone or open string

The fundamental of the ALF jumps upwards at intervals that are reminiscent of the inversion of the overtone series. For that reason, the terms "undertones" (especially as used by Michael Maierhof) or "subharmonics" seem to be justified.

These terms feel right if an inversion of the overtone series is expected. But the real pitches differ up to a major third.

As Guettler outlined above, the length of the vibrating string is not doubled. The triggering is much more complex and the paths of triggering waves are multiple.

With respect to the non-linear system of triggering ALF, further research would probably lead to other factors, such as strange attractors or corpus resonance.

In addition to the frequency analyses, I find it important to report on some experimental series on ALF:

Table 1: ALF table

Stopped note	**String**	**Bow-bridge distance**	**Bow force**	**Resulting pitch**	**Sound quality**	**Remarks**
F5 A	A	**Ord. 0**	little supination	1. level: Fsharp4 + 50 ct	sustained and clear tone noisy	traditional bow grip
			increasing force	2. level: B3 - 20 ct		
			Limit of bow force in relation to the shortening of the string	3. level: Eflat3 + 20 ct	scratchy, pitch hardly identifiable	
F5	A	**Ord. – 1**	adaptation to weakness of the string near the fingerboard requested	1. level: G4	sustained	glissando possible via change of bow-bridge distance
F5	A	**sul tasto**	limit of bow force	1. level: Gsharp4 + 50 ct	unstable	bowing angle is difficult to find
Bbes3	D	**Ord. 0**	bow force more than fortissimo playing, slow velocity	1. level: B2 - 50 ct	sustained, clear	traditional bow grip
Bbes3	D	**Ord. - 1**	Cf. ordinario 0	B2 – 20 ct	sustained, clear	glissando possible

Bbes3	D	**Ord. + 1**	increasing bow force	Bes2 + 20 ct	sustained, clear	fist bow grip helpful, increasing bow velocity possible
C2	C	**Ord. - 1**	high bow pressure, slow velocity	Csharp 1- 50 ct	sustained, raucous	fist bow grip

Further research on ALF would need to be done with a team of cellist, composer and acoustician. For example, measuring the bow pressure with a plate under the bridge would give more precise data which could be tested with frequency analyses. Nevertheless, the ear and the kinesthetic sense of the professional musician cannot be replaced.

Multiphonics

With my next point, multiphonics on the cello, we enter the spectrum of high partials together with a breakable and split cello sound.

Marc Dresser states that "multiphonics are complex sounds generated from a single source. [...] It is the result of various conflicting messages being sent to the string at the same time." (Dresser 2009: 73)

It is important to note that these conflicting messages are coming from the left hand as well as from the bow. Two or more natural harmonics are triggered to form a cluster of partials, including or excluding the fundamental.

A deep understanding of the nodes, in other words contact points for natural harmonics is needed.

Figure 9: Nodes of the 5th partial

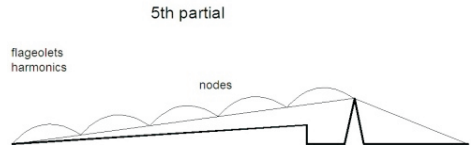
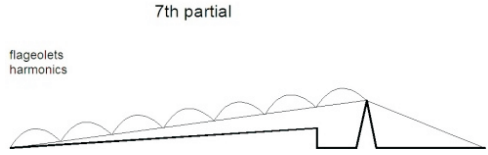


Figure 10: Nodes of 7th partial



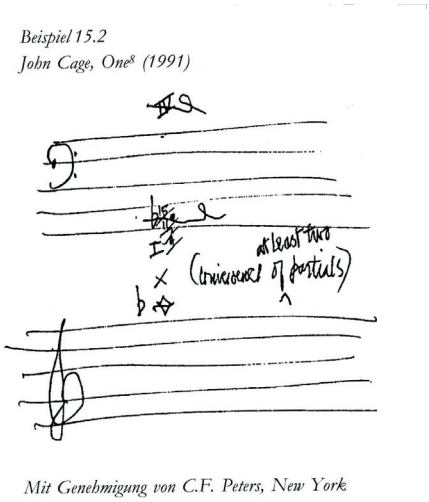
As can be seen on the figures, the string naturally vibrates as a whole. At the same time it vibrates in integer divisions, known as modes. By the time the finger touches the string on one of the nodes (= points which separate the integer divisions) it annihilates larger oscillations and triggers the division into certain partials: the frequency of the harmonic partial will be heard. Since the harmonic relates to the frequency of an unstopped string, the resulting harmonic is called a "natural harmonic", the playing technique used is known as flageolet playing.

When you overlap the nodes of several partials, you will see that in the middle of the string there must be a natural accumulation of nodes. The longer divisions are stronger than the shorter ones and with the "fat finger" technique the cellist is able to cover more than one flageolet point at the same time.

One famous example is the space around the tritone, which is densely populated with flageolet nodes, among which the 5th and 7th partials are dominant. Under certain circumstances of bow pressure, the fundamental of the open string will be added to the chord of partials. Michael Bach points out the occurrence of strong differential tones, characterizing the sound (Bach 1991: 32).

John Cage finds the beautiful expression "universe of partials" for the multiphonics in his cello piece *One8* (Bach 1991: 32), dedicated to Michael Bach.

Figure 11: Universe of partials by John Cage

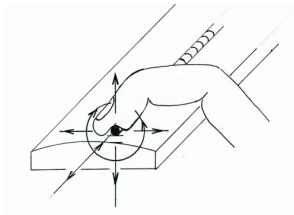


Mit Genehmigung von C.F. Peters, New York

(Bach 1991: 32)

Coming back to the left hand triggering, one should realize that the fingering touch is flexible in all directions.

Figure 12: Differentiation in fingering touch



Note: the space of a flat finger is not just covering a few nodes at the same time.

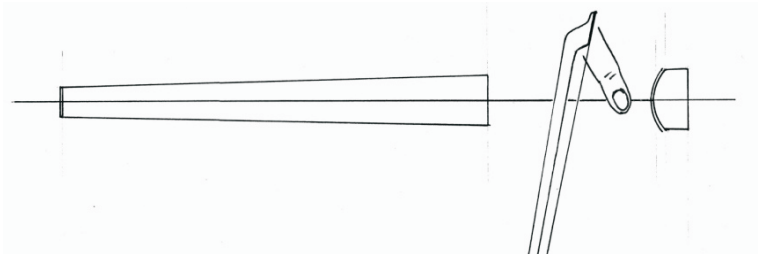
In addition, by adjusting the pressure, the finger will give conflicting messages to the string regarding the transmissibility of oscillations. It is important to know that even for stopped tones there is always an air corridor between the fingered string and the fingerboard. The enlargement of this corridor gives space for variation and differentiation in timbre and in triggering single harmonics.

Furthermore the bow itself can be placed on nodes and trigger harmonics. In general, a bow placement sul ponticello boosts the higher partials of the tone. Increasing the bow pressure makes it possible to play the partials series near the bridge without fingering. Therefore the bow needs to be tilted because the nodes are close to each other. Very high partials will sound at the bridge.

The most advanced technique of triggering harmonics with the bow (without the touch of left hand fingers) would be the placement of the bow on all nodes over the whole length of the string. The bowing of harmonics and the knowledge of nodes which can be reached by the bow is less widespread among cellists than among double bassists. Obviously, compared to the cello, the dimensions on the double bass and the playability of audible harmonics are more suitable. However, playing on the nodes of the string demands extra sensitivity for the string vibration and friction. With a view to these skills, Mark Dresser shows bowing exercises for double bass in *The Strad* issue of October 2009 (Dresser 2009). Starting from exercises to heighten the sensitivity of the bow hand, Dresser makes the bassist aware that sounding partials, triggered by the bow only, are one octave below placed partials.

The tromba marina effect with the flageolet finger between the bow and the bridge (see below) brings more freedom to the string vibration.

Figure 13: The tromba marina effect on the cello

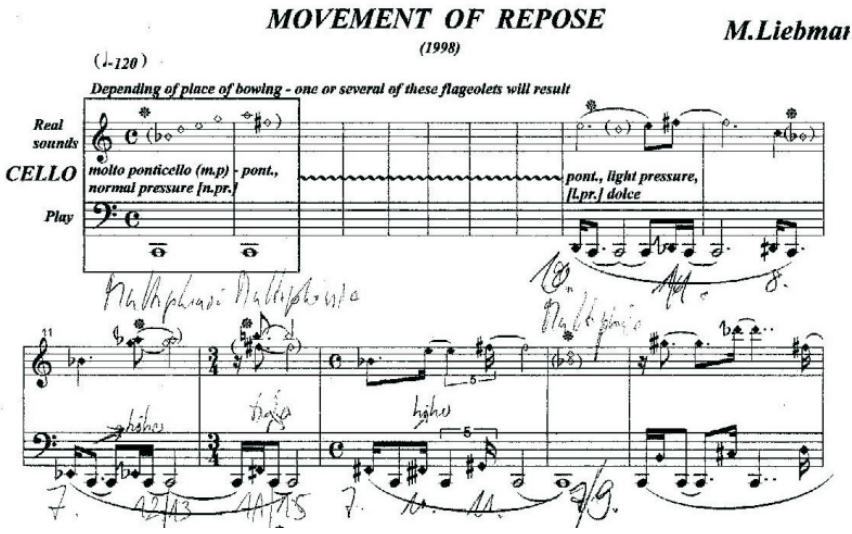


Guettler mentions two classes of multiphonics, depending on the bow placement. It is obvious that this bow placement has an emphasizing effect on single harmonics too (Guettler, Thelin 2010: 4). He notes that it is less practical on shorter-stringed instruments. The playing technique, proposed by double bass players Guettler and Thelin, seems to be less common among cellists. Still this extended technique is reasonable and effective on the cello too.

In his article, *Multiphonics – neue Möglichkeiten im Cellospiel* (Liebman 2004) in *Das Orchester* issue of October 2004, Michael Liebman was the first to analyze and review the state of the art in multiphonic playing on the cello, although he is not a cellist himself. Nevertheless Liebman experimented with a cello and he got advice from cellist friends. His research on multiphonics for cello led him, before writing the article, to the viola sonata Tremolet-Sonata (1997) and the cello solo Movement of Repose (1998), primed by Frances-Marie Uitti in Moscow. Unfortunately, his second solo cello piece with multiphonics, *Transmutations*, is not yet published. In January 2010 I was able to work together with Michael Liebman at the Jerusalem Academy of Music and Dance/Hebrew University.

Liebman took a lot of inspiration from woodwind multiphonic sounds such as frullato or whistle tones. Working together with him on his solo pieces, I realized that my tendency is towards a strict orientation on the nodes of a string. Instead of writing notes with lozenges my preference is for the (additional) indication of the harmonic.

Figure 14: Composition with multiphonics



The score of Liebman's *Movement of Repose*, here above, includes my own inscriptions of the partial nodes for the left hand. Based on my playing experience, the release of the open string is much too long compared to the flageolet tone, although it is true that, in general, flageolets continue sounding after the abandonment of the string. Singular effects which are possible in a rehearsal situation or figured out one-by-one are not necessarily reproducible in a concert setting.

The bow-bridge distances indications in cm, which will appear later in this piece, but also in Liebman's tables of chords, should, in my opinion be replaced by common cellistic terms. Liebman's argument that multiphonics should be produced by carefully following the instructions of the composer (Liebman 2004: 16) should be seen critically: the extreme complexity of multiphonics implies an interrelation between sensation and movement adjustment, which necessarily needs to be developed by the cellist.
The volume of multiphonics is achieved by bow velocity not by bow pressure.

Other composers describe the connection between right hand and left hand triggering of multiphonics in a more intuitive way.

Composer Robert HP Platz (Platz 1990: Book II), for example, is, by emboosting several partials, looking out for formants of a tone, which determine its color.

Matthias Pintscher (Pintscher 2000: 1) creates a smooth transition from the left hand to the right hand trigger and back. While the bow glides from estremo

vicino al ponte to ordinario, the fingers of the left effect a trill with loose fingers. The poco glissando of the left hand is accompanied by an enhancement of bow pressure, resulting in extreme pressure. His instruction to let as many harmonics as possible pass, charaterizes the whole multiphonic passage.

The exercises, I delevoped for multiphonics on cello:

- indicate an explicit orientation to the string nodes for the left hand
- train the sensitivity for fingering pressure
- train the ability and the sensitivity for bowing on the nodes, which is less developed among cellists
- train the sensitivity for small changes in bow force and bow bridge distance
- tend to develop a spontaneous connection between inner hearing of partials and small playing adjustments
- are open for surprises out of the "universe of partials"
- help to build up multiphonics by adding partials one by one

The enhancement in the tromba marina technique, which is also less common among cellists, does not only help to free the oscillation of harmonics. It also allows special effects such as soft rattling tones and others.

Multiphonics on the cello belong to the sphere of fragile tones which stimulate the inner hearing of both the cellist and the listenar.

Upside down

New playing techniques with obvious changes in material, such as 2-bows-techniques and the curved bow, certainly give an important visual effect to the audience, too. And radical changes of the tonal material, such as produced by scordatura tuning, turn listening expectations upside down.

2-bows-techniques

Diverse concepts of vertical playing will be shown on an instrument, which is mostly associated with melodic or horizontal playing.

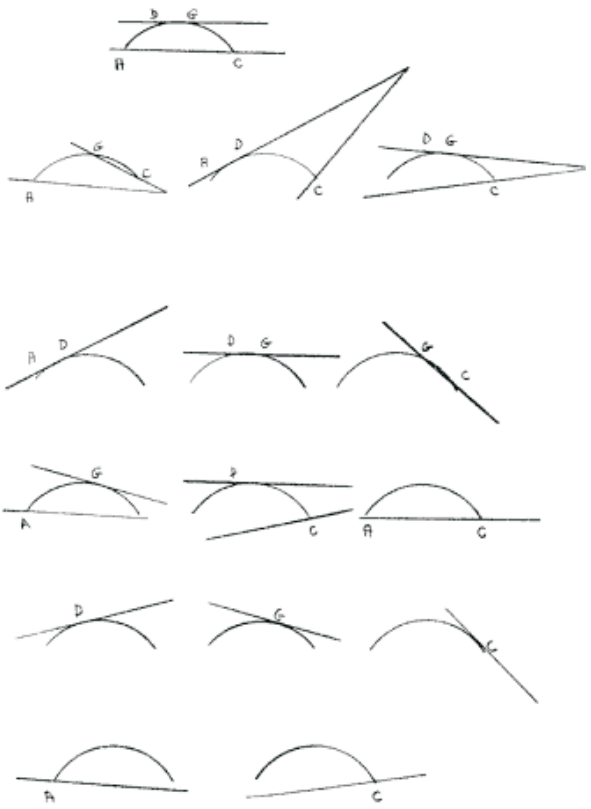
2 bows/1 hand

Showing the latest developments in playing with two bows would have been impossible without referring to Frances-Marie Uitti's achievements, even though she has already thoroughly documented them herself. Besides the fact that the innovations in playing techniques that she initiated in the 1970s have led to many outstanding compositions, her inventions have triggered other ones and have stimulated discussions and compositions of young composers, which emphasized interesting aspects of the 2-bows-technique.

Note that one bow is held above and the other one beneath the strings. The sketches from her website, given below, describe the various combinations of bows. Frances-Marie Uitti adds fingering charts for composers to these sketches which she has published on her website as well. It is hugely to her credit that she has not just developed innovative playing techniques in decades of research, but has also described them thoroughly and published them for public use.

The 2bows/1hand-technique has been adopted by many composers such as György Ligeti, Vinko Globokar, Richard Barrett, Fung Lam and others. It is especially fascinating to play strings together, which are not juxtaposed. That is how some strings can obviously be bowed both from, above and below. It is possible for each combination to lead to different conditions of playing techniques as well as different tonal results.

Figure 15: Two bows: chart



(Uitti)

The left hand stays free and is able to grip accords or tonal sequences on one or two strings.

Through this technique, the cellist is able to produce full chords, to combine strings which are not adjacent, to vary the number of strings he is bowing from one to four, generating different sound colors, depending on the bowing angle. And, he can use his left hand for gripping, which simply means for playing different tones and tone combinations.

Of course, there is a price to pay!
Analyzing the skills for the left hand, two new characteristic movements are found:

- Series of four-part chords without breaks.
- Simultaneous gripping on strings which are far away from each other in melodic lines.

Both skills are demanding for the cellist and need to be implemented carefully and consciously.

Long series of chords, since all fingers are constantly gripping, are exhausting for the hand. And also the finger combination matters: they will need to be changed at the same time from one grip to another.

In the case of two melodic lines on non-adjacent strings, the finger spread is going in all directions. Especially combinations of extension and flexion in one grip or even in one finger challenge the left hand to a significant degree.

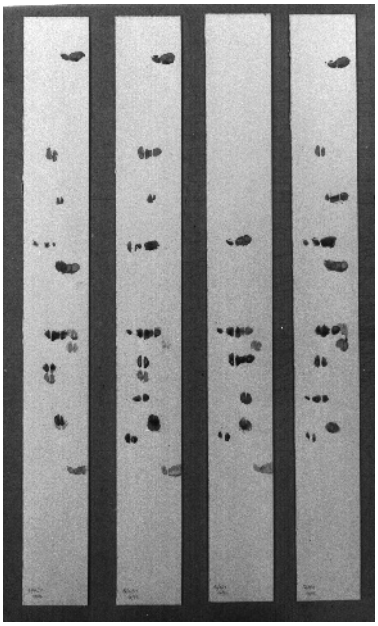
I am glad that I was introduced to the medical side of the musician's hand by piano didactics professor Ulrike Wohlwender, who assisted Prof. Christoph Wagner in publishing his standard book *Hand und Instrument* (Wagner 2005). She told me that research on the requirements of extended techniques is in demand.

Curved bow

The cellist who founded his cellistic approach on the possibilities and limitations of chordal playing on the cello is Michael Bach with his book *Fingerboards and Overtones* (1991) Bach had to solve the problem of chordal playing for his own invention of a modern curved bow, which allows him to play one to four strings together.

To make the possible fingerpositions available, he put Japan paper under the strings and colored his fingertips. The prints of his fingers left marks for all possible combinations, which you can determinate under a translucent tabulature of the fingerboard.

Figure 16: Extraction of Fingerboards



(Bach 1991)

Bach remarks that chord changes do need enough time for displacing all fingers. He does not recommend the use of the fourth finger because it does not enlarge the handspan. All recommendations need to be seen in the context of the conditions for the right hand playing a curved bow.

Figure 17: BACH.Bow[1]

1 With kind permission of Michael Bach given on 10.07.2009.

As to be seen, the BACH.Bow is playable on all four strings together as well as on one, two or three strings as long as they are adjacent strings.

Both techniques, the curved bow as well as 2 bows in 1 hand involve certain limitations with respect to the independency of the four voices, the response of the bow and the ability to play short notes and fast, especially saltato strokes. Both techniques are forseen for sustained notes, while the color of tones bowed from above and from underneath differ a lot.

Limitations can be turned into special expressive meanings, for example, by England-based Chinese composer Fung Lam who wrote a solo piece called *Caged* (2006). Here the melodic lines represent the narrow "caged" feeling, which is inserted in the bowing manner with two bows, playing partly from under the string.
The composer described the structure as follows:

- Frustrated, trying to break through but being restrained...
- Struggling, getting more emotional...
- Questioning...
- Being surrounded...
- Slower - gradually giving up...

2bows/2 hands

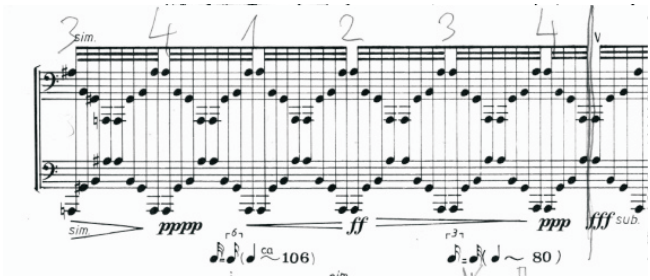
Bowing with one bow in each hand opens up freedom and independence to each bow. The price to pay, on the other hand, is the lack of fingering possibilities for the left hand as long as it is holding a bow. For most compositions using this playing technique, an extra chair is provided on which to place the left bow from time to time in order to liberate the left hand.

On the other side, all imaginable bowing strokes can be played simultaneusly from both sides of the instrument.

Uroš Rojko: *Ja* (1986/90)

The use of two bows is coherent with a score with two lines. In cases of mirror image moves of both hands, the notation expands in waves. The visual impression of wing beats corresponds in an ideal manner to the inner representation of the movement of the two arms.

Figure 18: Mirror image moves



(Rojko 1986/1990: 3)

Figure 19: The author, demonstrating the symmetrical playing technique in waves

The passage pictured above is introduced by the only word spoken by the cellist: an expanded "Ja" [= yes] as a statement for the enlarged space the cello takes up.

Rojko uses a very advanced form of seagull flageolet and established the "mute bow", lying on the string and disturbing the vibration the other bow is generating. This damping bow triggers uncontroled partials.

Carlo Forlivesi: *Pú Mesto (2003)*

Piú Mesto (2003) is an homage to Bartók's 6th string quartet, in which he uses the term "mesto" [= sad] several times to express his desolate feelings.

Carlo Forlivesi was given an award for his research on traditional Japanese music, which led him to long study visits in Japan. Forlivesi feels especially

attracted by the biwa because of its foreignness as well as its aggressiveness, due to its origin as a war instrument. In *Più Mesto* Forlivesi gives this expression over to the solo cello.

Figure 20: Benjamin Carat performing Carlo Forlivesi's *Più Mesto* for 2-bow cello[2]

(Photo: Mickaël Grefferat)

A very dramatic effect is achieved by a sudden intake of breath "as though choked" (bar 11) and the jerky lifting of the left arm with left bow up to the chin. The bow arm is quasi strangling the cellist before he starts scuttling down the fingerboard while exhaling.

Gesa Biffio: *Synchronisation* (2004)

Synchronisation was composed in 2004 for the art festival "Arte č Vita", which supported Potsdam's candidature for the title of "European Capital of Culture". The first performance took place on May 21, 2005 at Waschhaus (former wash house of the garrison and since 1993 a centre of culture) on Schiffbauergasse in Potsdam. Due to the acoustical and visual features of the wash house as an early

2 With permission of Forlivesi 9.4.2008

industrial building, the solo cello composition was conceptualised to fill a large hall with sound and to provide extra visual attraction, responding to the dimensions and the raw ambience of the building.

The 2Bows/2Hands technique was, in my opinion, the perfect choice for these skills. In my solo composition, *Synchronisation*, the alteration of large theatrical movement and small interference beats corresponds to the scordatura with large intervals between the outer strings and small intervals between the middle strings. The tuning is: Bflat3 – B2 – A2 – Aflat1. In fact, between string I and II we have a major seventh, between II and III a major second, between III and IV a minor none. Using this spread of intervals, the energy of the playing action, put into full chords on four strings, is audible as large and sharp sounds. Small timbre and pitch variations come naturally on the middle strings in second-tuning, reflected as small movements.

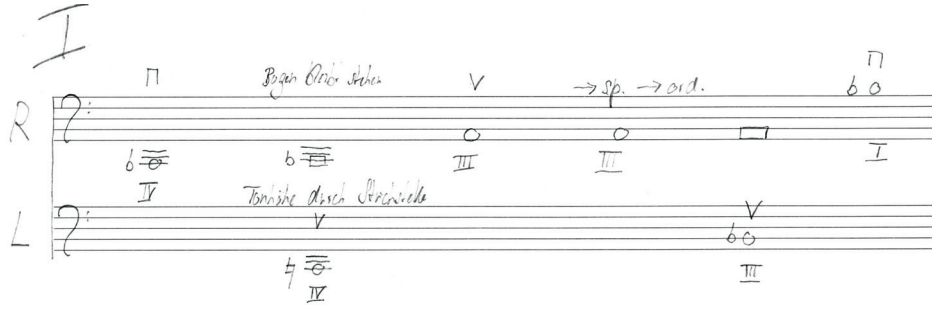
My composition was very much inspired by the solo piece *Ja* by Uroš Rojko, which I had been performing around that time.

Pitch alteration with two bows

A novelty, I have developed, is controlled chromatic pitch alteration using 2Bows, without fingering the notes. The mute bow changed into a flageolet bow and I developed certain techniques to control pitches, bowing on nodes and all over the string.

In the beginning of *Synchronisation* this idea is already introduced, presenting the tuning and a few bowing manners with 2Bows:

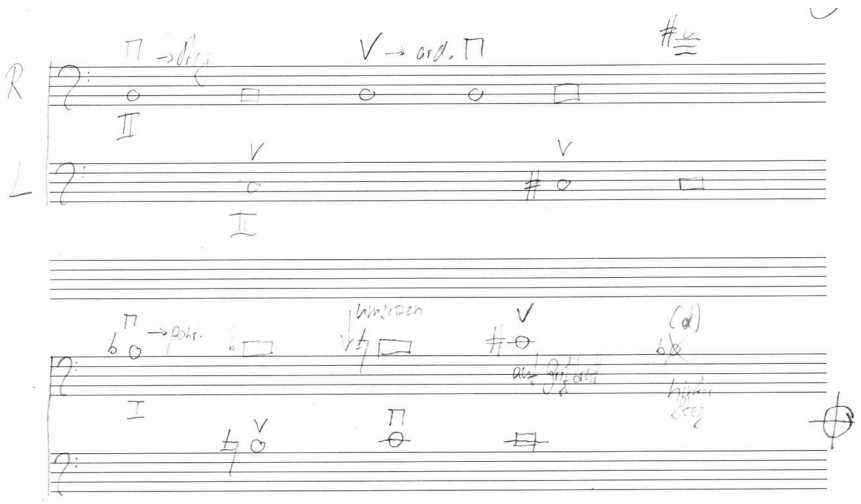
Figure 21: Presenting the tuning



(Biffio 2004: 1)

At the end of part A, a sequence of ten semitone intervals is generated through different playing techniques such as ordinary; “mute bow”; bowing in opposite directions; one bow standing on a flageolet node - pressed down or released; bowing with different bow velocities for each bow; conflicting bow-bridge distances; behind the bridge (example below).

Figure 22: Semitone intervals with two bows



(Biffio 2004: 4)

Figure 23: The author: First performance of *Synchronisation* on May 21, 2005

As described above, in *Synchronisation* the use of two bows is related to a dramatic predisposition of the cello's tuning. Apart from the consequences of the tonal material, the enormous increase of string tension for the up-tuned strings and the decrease for the down-tuned strings has an important impact on the playability and sound quality of the strings.

Hereby, the critical point is in the middle of my scordatura: in order to attain a major second between the strings II and III, the G-string is heightened to an A2. The heightening for a major second comes near to the breaking point; whether the string or the instrument's body might be affected, depends on their quality and age.

Scordatura

Through noticeable tuning up, the inner layers of the string construction will be weakened. The string loses its sound quality for normal playing in standard tuning as well. For this reason, most cellists prefer using extra strings put on a second cello, in case the whole setting is provided for scordatura. Obviously the scordatura implies practical problems.

From the point of view of playability, the differences in tension provoked by tuning up or down (sometimes on the same instrument), make an adaptation of the bowing hand necessary.

Since the strings have been constructed for a certain defined pitch, with the whole set of strings in balance, each change of tension causes a loss of the playing features. On the other hand, playing on detuned strings with different modified tension and friction forces gives a fresh sensomotoric stimulus to the performer.

Creation of a prototype scordatura string

Discussions about the sonority and playability of strings in scordatura led to Laurits Larsen at Larsen Strings and to the measuring instruments of his company in Denmark.

i.e. ordinary A-string changes in tension approximately according to the following scheme:

Table 2: The tension of a detuned A-string

C4	13,4 kp
B3	**11,9 kp**
Bflat3	10,6 kp
A3	9,4 kp
Aflat3	8,6 kp

The breakage problem is obvious. For the down-tuned C-string, playability was the focus. As an experiment, we created a prototype string on Aflat1 and compared it with the quality characteristics of a C-string, lowered to Aflat1, which we usually do with scordatura. Larsen manufactured the prototype and we discussed all the steps of this creative process while I was trying out each experimental string on my cello. With Larsen's generous permission, I was able to use this prototype Aflat1-string in concert for my solo *Synchronisation* and to compare it to a down-tuned C-string under concert conditions.
The result of my observations could be represented schematically as follows:

Table 3: Observations on a prototype scordatura string, compared to a normal de-tuned string

	C- string, down-tuned to Aflat1	Aflat1-string prototype
tension	13,4 kp on C2, with scordatura ca. 11 kp	11 kp
volume	inhibited	full sound
timbre in piano	snarling	warm
timbre in forte	dashing against the fingerboard	brilliant
playability	sluggish, delayed	quick response
touch	loose	comfortable

Discussion

At first sight, the evaluation of a normal de-tuned string, compared to the new construction, is negative. The newly constructed string, which fits perfectly to its pitch, conforms to our requirements. Does it? Is not the de-familiarization of sound and timbre part of the scordatura an effect? Is the strange sound also desirable or is it only accepted, being the price to pay for the change of the pitches?

Movement choreography

My last point is the collaboration between composer and cellist on the process of generating a cello piece. I will discuss about a very quiet piece called *Morgenlachen* (1997). The German composer Friedemann Schmidt-Mechau and cellist Matthias Lorenz tend to transfer the dual nature of "chronos" and "kairos" into all layers of his composition. Both of these elements are attributes of time. In addition the order of tones and the notation are also incorporated into the

complexity of the compositional process. The central point for interpretating the paradoxical nature of time is its realization in motor activity.

While the motor skills meld with each other and form new visible elements, the tone intervals are in a state of suspense: exclusively in the beginning and at the end of the activity the pitch is hardly recognizable.

Schmidt-Mechau has developed nine motor activities for the cellist, which can function independently or be combined in a counterpoint manner:

Right hand activities:

- tangential movement across the instrument (pizzicato, down- and up bow)
- concentric movement (string crossing)
- longitudinal movement along the string (bow glissando and hand glissando from the pegbox to the endpin, wiping)
- vertical movement (battuto, bow pressure, Bartók-pizzicato)
- turning around the centre line (ordinario, col legno)
- turning around the cross axis (bow angle on the string)

Left hand activities:

- vertical movement (stopped notes, flageolet, tapping)
- longitudinal movement along the string (shifting, glissando, wiping)
- transversal movement (fingering on adjacent strings, pizzicato, pitch bending)

These movements are worked out in a "quasi serial counterpoint" (preface by Schmidt-Mechau). The resulting movement intervals are related to tone intervals from minor second to major seventh, up- and downwards. To my question concerning the choice of the cello Schmidt-Mechau answered via email on September 28, 2009:

„The possibilities of the instrument are, first of all, a question of perception to me. Thereby I keep on discovering novelties, often as a result of 'faulty' or 'incorrect' play. The cello is an instrument of almost limitless possibilities. […] The cello's material nature is of a much greater interest to me in this context. You will have seen in my biography that I worked as a carpenter for 15 years. Matthias refers to that, which he then expresses as: 'To Friedmann the cello is always just a wooden box as well.'"(Email Schmidt-Mechau 29.9.2009)

With a genuine sense of humor in his pointed remark, Schmidt-Mechau refers back to Lachenmann's "instrumental musique concrčte" (Lachenmann 1996: 381) in *Pression* (1969), which left its impression on many contemporary compositions. Above all, Lachenmann experienced all the effects for *Pression* on

the cello, as he was able to produce them by himself. In a workshop he held at the Münster Academy in June 2009, I was able to see Lachenmann demonstrate all the techniques he demanded from the violinist, the cellist and the pianist.

Schmidt-Mechau's concept is broadly open to all kinds of results with respect to the sound. Lachenmann notates the action but knows the result, which only differs marginally from player to player. Schmidt-Mechau, by contrast, opens up a palette of expressive meanings. Therefore he decided not to give me any recording of his works. According to him, each performance has a completely different outcome. He comments: "My expectations are focused on the cellists, whether and how they grasp, use and control all the ranges of their instrument." (Email Schmidt-Mechau 29.9.2009)

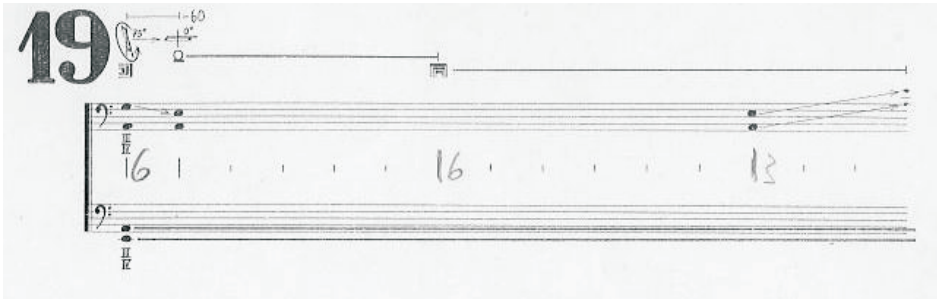
The cello player, interpreter and dedicatee Matthias Lorenz describes his work on Morgenlachen as follows:

"[…] Thereafter three things especially are uncommon:
The orientation alongside the moves instead of sounds: One knows bit by bit only, how a certain part is supposed to sound, the way there is rather abstract with respect to the musical-phonetic aspects. Afterwards one can stick to the sound as usual.

The extension of moves beyond their usual limits: The turn of the bow, for example, reaches from a 75° down- and upwards rotated tip, the contact point for stringing in the peg box reaches via the cords up to the endpin.

The exact designation of the bow's position above the fingerboard. The bow's position is indicated here as a tone pitch on a certain chord respectively (like in the sample notation). Even if the orientation is a bit difficult here at first: This is especially easy to hear. With legno battuto anyway, but also the stringing on the simple overtones of the tones creates a very distinct sound." (Email Lorenz 27.9.09)

Figure 24: Bow position above the finger board



(Schmidt-Mechau 1997: part 19)

As Schnmidt-Mechau says, "*Morgenlachen* was inspired by the playing of the Canadian violinist Malcolm Goldstein […] who developed an unusual movement repertoire by improvising." (Email 29.9.2009)

Discussion: Working process

The process of creation makes clear how open-minded the composer's and interpreter's attitudes are with respect to the exploration of sound and movement. They do not consider either sound or movement as an end in itself. However the need to isolate elements triggers discoveries and inventions of movement variations as new musical material. This arrangement itself has, in turn, brought things to light, which they could not foresee in advance.

It is worthy of note that the cellist works from outside to inside. The reading and practicing of movement indications makes him discover a specific sound, which he needs as a mark for reproduction. On the other hand, the composer is very much fascinated by the diversity of movements on the cello and he takes the way via movement to sound differentiation.

Conclusion and perspective

Anomalous Low Frequencies as a complete break with the rules of bow pressure and velocity have been analyzed in frequency analyses and in practice. Different ways of building up mutiphonics are outlined in the context of expanded knowledge of flageolet playing and bowing on the harmonic nodes of the string.

Visible innovations have been made in the field of chordal play. On the one hand, there is the entrance of two bows held, to some extent, in one hand, to some extent played with two hands or the curved bow. On the other hand, diverse scordaturas considerably extend the range of the cello, especially downwards, and turn the conventional pitching upside down.

Their documentation supports the process of understanding as well as the conveying of these techniques and therefore their reproducibility at any place.

Still the genuine artistic aspect of intuitive creating and finding of sound is not supposed to stand back because the artist has his imagination, inner hearing and proprioceptive at his disposal which are linked in a direct circuit.

In the New Music medium the "player-composer-composition" triangle is enlarged by another factor: the dynamic of an unfinished developmental process.

This experience of developing contemporary music in an exchange together with living persons is an important experience for every student and musician. It also affects the interpretation of concluded works and music of past times.

Meanwhile didactics of traditional cello playing manners is very advanced, the handling of contemporary works often appears as a confrontation with an overabundance of unfiltered information and complex connections. And still, it is

possible to advance from the easy to the complex or from known to unknown fields respectively.

The term of „extended techniques“ is to be taken in a literal sense! For example the production of multiphonics requires the play and comprehension of natural and artificial harmonics as well as a differentiated prospect of string vibration modes. However, they can be inserted at an early stage of the training appropriate to the student's age. They especially need to be a part of the teacher's education and training.

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