Acoustic musical instruments, a concise sonological exploration

Pitch, loudness and timbre

From the perspective of perception we can attribute three rough psychological labels to sound: *pitch*, *loudness* and *timbre*. A low soft sound with a hollow character can give a tone of a clarinet or a tone of a panpipe. In everyday life, the character of a sound is often described by a corresponding imitating term. For example: the big drum does bom-bom. Also in the naming of musical instruments we find these sound imitations: *fl*ute, *fl*auto and *Fl*öte. For example, an electric guitarist knows of a *wah-wah* pedal. In both examples, substantial observation characteristics are expressed in the naming.

Interaction

The dynamic sound is inextricably linked to the biological and mechanical-acoustic sound generators. The reason for this lies in the fact that these instruments form physically so-called 'coupled systems': a combination of interactive elements.

Driver and Resonator

Roughly we can distinguish a dichotomy: a driver and a resonator connected to it. Some examples. With a violin, bow and string together form a forced oscillating system. The sound box is the resonator. In a brass wind instrument, the player's lips form the driver oscillator and the instrument itself the resonator with a high degree of feedback to the lip oscillator. A marimba shows a small amount of coupling between the driver, the vibrated bar (a damped oscillator) and the coupled tube resonator. If you disconnect this tube resonator, the bar vibrations will be less charged, so that it will sound longer, but less loud. The resonator so to speak 'steals' energy from the bar oscillator. Listen: https://www.yamaha.com/en/musical_instrument_guide/marimba/mechanism/mechanism002.html The degree and complexity of the interaction between driver and oscillator can be different, but is always present.

This interaction forms an essential distinction with the early *electronic musical instruments* (from electronic organ and Theremin to Minimoog), which can be regarded as decoupled - feed forward only- systems'. In the latter case we are talking about a system whose component elements do not interact.

Characteristics of acoustic musical instruments

An important characteristic of mechanical-acoustic musical instruments is their shape. They therefore seem simple, which soon leads to the prejudice, that you also understand its working. An example: the ney, an open flute from Arabic, Persian and Turkish culture. This instrument appears to be very simple. Just a cylindrical tube with six finger holes and a thumb hole. Nothing else. No special blowhole such as on our flute, no air duct with labium as with the recorder.
Listen: Itzhak Ventura, Ney https://www.youtube.com/watch?v=Evs9os_cjmQ

An experiment with a recorder
Suppose you want to simulate this instrument real-time as a physical model in a computer. First we have to make a formal, mathematical, description of the system. However without making use of mathematics, we nevertheless can conceive the complexity of the real thing.

We do this through an experiment. All you need for this is a (soprano) recorder. It consists of two parts: the head piece and the tube with finger holes. Take only the head piece and start blowing so softly that sound is created. Then gradually increase the air force. You now hear that the pitch depends in part on the wind pressure, the driving force. This also applies to the timbre. Yes, the loudness also increased; the amplitude of the vibration will therefore have become greater.

Then we try to blow a fixed airflow that is as constant as possible. Meanwhile, we slowly, with one hand, squeeze the end of the head piece, which is, as it were, extended by the tube that we form. The pitch drops! Apparently, the connected tube exerts influence on the head piece.

Once again the experiment gradually increasing the breath power. Now, however, with the entire recorder with all the finger holes closed. We hear the pitch rise, the sound becomes more pronounced and louder. Then a strange vibration arises, as if the system is in doubt: what will I do now? Then the pitch jumps, which has now become one octave higher. Then we hear the sound become even sharper and louder, then skip over again, a fifth in this case. Now we have arrived at a pitch an octave and a fifth higher than we had at the beginning of the experiment.

Another experiment
After this experiment with the recorder that was an example for a system with a high degree of coupling and complexity, another example from the real world. Now a system with a very low and simple form of coupling. We will therefore use what everyone has in the kitchen: a metal cooking pot and a wooden spoon. Hold the pan with one hand on an ear and let it hang down. With the spoon in the other hand, gently beat the middle of the bottom. Then hit very hard. That was clearly distinctive in both cases. With soft beats a soft sound, hard beating and loud sound, but also the character changed, it seemed as if even new tones were added.

A rule of thumb
With our two experiments we have discovered a rule of thumb that applies to all biologically and mechanically-acoustic generators:

excitation > waveform [timbre], > vibration amplitude [loudness]

(in which > means, affects)

In cases of systems with a high degree of coupling, for example in wind instruments, similarly applies to a lesser or greater extent:

excitation > frequency [pitch]

Listen: Catalina Vicens, Portative, Rondeau C. Cooman
https://www.youtube.com/watch?v=Uk4iVold0eU
Listen: Horst Rickels, Part 4 of Partita for Variable Air Compression
https://www.youtube.com/watch?v=4ZIR8j_9TDg

Sometimes this is also the case with systems with a lower degree of coupling. You can pluck a thin string so hard that you increase the string tension at the moment of striking. You hear the pitch at the beginning of the sound higher and slide to lower, after which the pitch remains. In fact, due to the large driving force, we change the system conditions: the string tension becomes greater.

Free oscillating systems and self-oscillating systems
In our two tests we have become acquainted with the two fundamentally different physical models. On the one hand, a system that, after a pulse-shaped driving force, spontaneously reaches free decaying vibration: damped oscillation. On the other hand, a complex coupled system that comes and stays in vibration under the right conditions, with a constant driving force: self-oscillation or forced oscillation.

A mechanical-acoustic instrument can be classified in both categories depending on the form of excitation. You can drive a double bass string continuous by bowing, but also by striking, initial excitation. Similarly, you can bow the marimba bars instead of striking.
Listen: Renaud Garcia-Fons Double Bass https://www.youtube.com/watch?v=ZQsd2tAIgUE
Tatiana Koleva Marimba & Loop Station https://www.youtube.com/watch?v=KVtRc5ojWmY

Fine-structure modulation
The internal interaction in the system is responsible for the dynamics of the vibration produced. These distinctive peculiarities are a fact of the instrument in question and determine the sounding identity of the instrument to a large extent. Such fluctuations of amplitude, vibrational form (waveform) and frequency, which mainly occur at the beginning when vibrating and to a lesser extent at the end when the tone is stopped, are called internal *fine structure modulation* by Tempelaars (1982).
Listen: Pierre Charial, barrel organ https://www.youtube.com/watch?v=Sjv2R6O_-a0cvghb
In addition to *internal* fine structure modulation, we also have *external* fine-structure modulation. This is a direct consequence of the influence of the player: the variation in excitation.
Listen: Görkem Sen, Yaybahar https://www.youtube.com/watch?v=iQEgSDuijVs
https://www.youtube.com/watch?v=DcQ17f4Tnmc

The sound generation principle as a classification criterion
The sound generation principle, and the degree of mutual coupling of the constituent parts, is of great importance for the final sounding identity of a musical instrument. It is the most important delineation framework for the sound (s) that can be formed.

Mahillon, von Hornbostel & Sachs
In 1914 Erich M. von Hornbostel and Curt Sachs published their 'Systematik der Musikinstrumente' in the 'Zeitschrifft für Ethologie' (Heft 4 u. 5). In this classification of the musical instruments, two classification criteria are central: firstly the sound generation principle and secondly the mode of playing. It is a musical instrument classification that builds on the classification of Victor Mahillon from 1888. This formed the foundation on which he based his catalog of the collection of the Brussels conservatory museum. Mahillon can therefore be regarded as the first to see the importance of the sound-generating principle with regard to the resounding individuality of the musical instruments. This division into four groups therefore forms the basis of the Hornbostel / Sachs system (HS):

1. Idiophones
2. Membranophones
3. Chordophones
4. Aerophones

Ranking of the groups
The order of the four groups seems anything but randomly chosen. From a mechanical-technical perspective, it reflects a line from simplicity to complexity. From the physical model point of view, we find a line of increasing degree of coupling. This means that the constituent parts of the sound generation principle interact with each other. The first two groups, the idiophones and membranophones (as well as the tonal and excited chordophones) can be regarded as systems with a lesser degree of coupling. The following groups, the chordophones (the applied variants) and the aerophones can be regarded as systems with an increasing degree of coupling and complexity.

Considering the most common methods of excitation, it is striking that the first two groups can then be classified as belonging to the 'free damped vibration systems' (damped oscillation), the last two groups, bowed chordophones and aerophones, belong to the 'self-vibrating systems'. (forced oscillation).

It is also interesting to consider the order of the groups from a psychological point of view with perception as the starting point. We then find a line that we can consider as running from complicated to simple in terms of pitch sensation.

Idiophones and membranophones
The idiophones and membranophones often form sounds that do not produce a clear or unambiguous pitch experience for our perception. Often in the sounds of these instruments we can observe multiple pitches at the same time. This is in contrast to the vibrations of the string and wind instruments, which provide an unambiguous, indivisible pitch sensation for perception.

This is related to the system's vibration mode. The idiophones and membranophones produce aperiodic (irregular) vibrations in which no, little or hardly any periodicity can be detected.
The systems with a high degree of coupling provide periodic (regular, repetitive) vibrations. More accurate, however, appears to be a quasi-periodicity. That is not surprising, of course, as we have discovered in the test with the recorder. The frequency of the vibration is also determined by the degree of excitation. However, blowing with a stable wind pressure is only possible in theory.

Physical quantities	***Psychological qualities***
frequency, periodicity	*pitch*
amplitude	*loudness*
waveform	*timbre*

Above is the relationship between objective physical quantities and subjective psychological qualities. The relationship between frequency-pitch and also the amplitude-loudness relation shows a non-linear relationship. With a linear increase in pitch and loudness, there is an exponential increase in physical quantity.

One generator, multiple pitches
The heading above this paragraph already indicates that we now consider a single sound generation principle (generator) and the way in which it is possible to produce different pitches with this one generator. This can be realized in a number of different ways.

Aerophones
With the aerophones, by varying the effective length of the vibration column. For example with a sliding mechanism like the trombone or a valve mechanism as with most brass instruments. With the woodwind instruments, the effective vibration column is shortened by opening one or more holes.

Chordophones
Let's take a one-string musical instrument as an example. We can change the string tension, which is directly related to the vibration frequency. For example by pressing in the string behind the comb with more or less pressure. We thus increase the tension and can thereby continuously vary the pitch to a small extent. A so-called single generator with pitch area. We have then tacitly defined the pitch as a limited pitch continuum.

The fretless fingerboard
A more practical way is to change the effective vibration length by shortening the string. For example, as with a violin: the string is simply shortened by pressing it in any position on a wooden key. In this way we have a so-called pitch continuum over the entire key length. Between these extremes all imaginable pitch nuances can be realized.

The fingerboard with frets
We can also make it a little easier with regard to intonation by providing the key with frets, transversely placed, usually metal, rods.
You only have to press the string somewhere between two frets and thus obtain the desired pitch. You can achieve the right pitch with much more ease, but you will therefore have some options. Especially if step-by-step shortening works via a mechanism such as a nyckelharpa. The pitch steps are then literally steps, which can no longer be varied. If this is done manually by pressing the string between the frets, then variations in pitch are possible depending on the string tension.

Frets and string tension manipulation
A definite example of this is the 'solid body' electric guitar. The string tension on this instrument is relatively low, so you can easily push the string - as it were stretching and thus increase the tension. This has a glissando, a gradual pitch bevel, as a result. Of course this can also be done the other way around: starting from a stretched string and then letting the string return to its normal tension. That results in a glissando down. In other words, with an electric guitar, each individual string forms a single generator with a series of pitch ranges.
Between every two successive frets we actually have a limited pitch continuum available. This is in contrast to the nyckelharpa where we only have a fixed pitch range, a series of steps with unchangeable pitches. Finally summarized the fundamentally different ways of pitch selection with a single tone generator.

A sonological classification:

1. *Generator with fixed pitch*
2. *Generator with limited pitch continuum*
3. *Generator with fixed pitch range*
4. *Generator with a series of limited pitch continuity*
5. *Generator with one extensive pitch continuum*

Expression with monophonic instruments
If we look again at the diagram above, we see that almost all expressive monophonic instruments fall within HS categories 4 and 5. This mainly concerns the string and wind instruments. By means of blowing power and embouchure on the one hand and bowing speed and pressure on the other hand, the player can manipulate loudness and sound color. Due to the lack of a fixed pitch scale, they offer the possibility to realize nuanced pitch bends to the experienced player.

These pitch bends have a direct relationship with what we experience as emotional charge. In itself that is not surprising when we consider that in a similar way we provide our speaking voice with such pitch modulations, which so often say more than the formal message itself. During the sounding of a tone or multiple tones in a phrase, a musician can influence the frequency [pitch], amplitude [loudness] and waveform [timbre] by physical intervention. No wonder then that these instruments are so suitable for an expressive melodic function.

Polyphonic instruments and expression

Polyphonic instruments include a plurality of generator models as indicated above in "A sonological classification". For example, we can say that a violin is composed of four tone sources (generators) according to category 5 and thus a quadruple polyphonic instrument, in practice - by curving the comb and the key - only two neighboring strings can be simultaneously applied. These two strings are then 'controlled' from one driving mechanism, the bow. So this two-part interpretation already means surrendering possibilities of expression in comparison to playing just one tone. Polyphony controlled from a single mechanism, is referred to in the world of (electronic) musical instruments by the term paraphony. Another example of this is the accordion: the bellows is the single mechanism that controls several tones at the same time.
Listen: Emy Dragoi Accordeon https://www.youtube.com/watch?v=trq8UcRjxUY

It is therefore not surprising that we find the most polyphonic instruments in group 1: a multiplicity of generators with fixed pitch. The pitch is fixed, we do not have to worry about that anymore, the builder or tuner has already done so. If such instruments are then initially excited, whether or not the driving force is passed through a 'switching' mechanism, we can fully focus our attention on timing and initial force (carillon) or tone duration (organ).
Listen: Tom Van Peer Carillon https://www.youtube.com/watch?v=JE6wG9eN4_o

The quality of the sound is now entirely determined from the instrument itself. For example, in the pipe organ with electric traction, the organist activates an electromagnet which opens the valve and thus allows the wind supply to the pipe. Only the builder determines the tone by the internal fine structure modulation. From the point of view of monophony-polyphony, we can discover the following rule of thumb for the mechanical-acoustic instruments:
As more tones can be played at the same time, the degree of expressive tone forming decreases.

Internet

Further reading

Hornbostel-Sachs classification of musical instruments
https://en.wikipedia.org/wiki/Hornbostel%E2%80%93Sachs

Revision of the Hornbostel-Sachs Classification of Musical Instruments by the MIMO Consortium
http://www.mimo-international.com/documents/Hornbostel%20Sachs.pdf

Yamaha Musical Instrument Guide
https://www.yamaha.com/en/musical_instrument_guide/

Further listening on YouTube

Idiofonen

Gary Burton Vibraphone, Chega de Saudade https://www.youtube.com/watch?v=rHR3F7vp1uc

David Friedman Vibraphone, Almost blue
https://www.youtube.com/watch?v=hBbgv1dsLEU

Doug Perry Vibraphone, Mourning Dove Sonnet
https://www.youtube.com/watch?v=DRPqWCWufN8

Marco Bianchi, Vibraphone, improvisation
https://www.youtube.com/watch?v=KSEvGWEslUk

Joe Locke, Vibraphone, 'SwordOf Whispers'
https://www.youtube.com/watch?v=1HiM-VSehEU

Ed Smith, Malletech LoveVIbe, Neptune
https://www.youtube.com/watch?v=MVfJW0lqaqY

Leigh Howard Stevens about Malletech OmegaVIbe & LoveVibe
https://www.youtube.com/watch?v=b-vfEDOmg_4

Joe Locke, Vibraphone, 'Available in Blue'
https://www.youtube.com/watch?v=6sRqs3ql1WY

Tatiana Koleva, Marimba, 'Way Home'
https://www.youtube.com/watch?v=KVtRc5ojWmY

Eusebio Sanchez, Marimba, Caprice by Leigh Howard Stevens
https://www.youtube.com/watch?v=xXUlDEAU5J0

Geoff Stradling, Celesta & Keyboard Glockenspiel
https://www.youtube.com/watch?v=URkens-9izw

Tom Van Peer, Carillon
https://www.youtube.com/watch?v=JE6wG9eN4_o

Vladiswar Nadishana, Halo handpan
https://www.youtube.com/watch?v=t68QcWqXyek

Thomas Bloch Crystal Baschet
https://www.youtube.com/watch?v=STBjUHPmiDk

Petr Spatina, Glasses
https://www.youtube.com/watch?v=NgShlrKzNFQ
https://www.youtube.com/watch?v=BjD07oJrFZw
https://www.youtube.com/watch?v=dcpHcoOAaO4

UK Gamelan Network, Basic playing techniques for Javanese gender
https://www.youtube.com/watch?v=AILyFuGuYKM

Pak de Giyanto, Gender Pelog (Pelog)
https://www.youtube.com/watch?v=Rp_gvm5oa8Y

Wang Li, Jew's Harp
https://www.youtube.com/watch?v=lCDdXR2uCPw

Valentinas Krulikovskis and Viaceslavas Lukjanovas, Jew Harp
https://www.youtube.com/watch?v=4SpWuseQGys

Anoniem, Mbira
https://www.youtube.com/watch?v=tKbfUEhjuH4

Anoniem, Klimba
https://www.youtube.com/watch?v=tg24k7tzIc0

April Yang, Kalimba, Canon Pachelbel
https://www.youtube.com/watch?v=RWWfhzsvetg

5-octave Array Mbira
https://www.youtube.com/watch?v=Z3b1bz_9gEo

Membranofonen

Glenn Velez, Frame drum
https://www.youtube.com/watch?v=fB0hE-YlfzQ

Solis Barki, Bendir
https://www.youtube.com/watch?v=WijPkznVNEY

Shawn Turbochicken, Djembe
https://www.youtube.com/watch?v=qdfN5FWH1-E

Giovanni Hidalgo, Conga
https://www.youtube.com/watch?v=L6V8S8U9iLs

Zakir Hussain, tabla
https://www.youtube.com/watch?v=6kNLb6aOn1A

Ruben van Rompaey, Darbuka
https://www.youtube.com/watch?v=CronUnQW6L0

Chordofonen

Kristian Bezuidenhout explain the fortepiano
https://www.youtube.com/watch?v=M2JqEKncsyM

Kristian Bezuidenhout, Fortepiano, W.A. Mozart Fantasie in d (KWV 397)
https://www.youtube.com/watch?v=3Xl5AzB9nhg

David Schrader, From the Clavichord to the modern Piano
https://www.youtube.com/watch?v=4uCCw_hmILA

Mathieu Terrade, Harpejji
https://www.youtube.com/watch?v=Wr87Z7rZiWE

Renaud Garcia-Fons, 5-string Double bass, “Bajo de Guia’
https://www.youtube.com/watch?v=OjosyL8X460

Renaud Garcia-Fons, 5-string Double bass & Derya Türkan, Kemençe
https://www.youtube.com/watch?v=wyPMS_nm-gQ

Katica Illényi, Violin, ’Schindler’s list’
https://www.youtube.com/watch?v=UCXCd5_-Uc8

Ramesh Misra, Sarangi, Alap in Raag Durga
https://www.youtube.com/watch?v=XrpXKB74ujQ

Ranjit Singh, Diruba, Alap in Raag Puriya Dhanashree
https://www.youtube.com/watch?v=DVigHVgl2pU

Derry Türkan, Kemençe & Erkan Otur, Classical Guitar
https://www.youtube.com/watch?v=VPbOJJ-l6Fg

Xiao Bai-Yong, Erhu
https://www.youtube.com/watch?v=Fz1YMjLwExE

Aytaç Dogan, Kanun, 'Gözüm & Kulagım'
https://www.youtube.com/watch?v=FR1E1Tn5vvs

Tommy Emmanuel, Flat top still string guitar, Amazing Grace
https://www.youtube.com/watch?v=niT2q0ElP4g

Enver Ismailov, Tapping guitar, improvisations
https://www.youtube.com/watch?v=D2LzBKJLUWA

Amjad Ali Khan, Sarod
https://www.youtube.com/watch?v=BjY20Lsu-TQ

Simon Shaheen, Oud, Makam Nahwand
https://www.youtube.com/watch?v=KyNXeCfPB2U

Mariano Martin, Guitar & Amir John Haddad, Oud, Bulerias
https://www.youtube.com/watch?v=t6jlx6jAb-Q

Amir John Haddad, Bouzouki, improvisation
https://www.youtube.com/watch?v=-FJNiQaYbWE

Ismail Tunçbilek, Baglama
https://www.youtube.com/watch?v=ciLeRmhhpEQ

Jimi Hendrix, Electric guitar
https://www.youtube.com/watch?v=cJunCsrhJjg

Giani Lincan, Cimbalom, Niccolò Paganini, Caprice No. 5
https://www.youtube.com/watch?v=-WYFK8oOOK8

Marius Mihalache, Cimbalom, Fantezie
https://www.youtube.com/watch?v=vfbcVwJcGwY

Kálmán Balogh, Cimbalom
https://www.youtube.com/watch?v=hRdXFvJ55c4

Ion Miu 1, Cimbalom and Alexandre Cellier, Accordion, Bösendorfer grand & Panflute
https://www.youtube.com/watch?v=U5yzIYG28Ps

Ion Miu 2, Cimbalom and Alexandre Cellier, Accordion, Bösendorfer grand & Panflute
https://www.youtube.com/watch?v=JO0ntryHPSM

Shivkumar Sharma, Santoor
https://www.youtube.com/watch?v=QvHrBaqkxZs

Russell Cook, Hammered Dulcimer
https://www.youtube.com/watch?v=HAaaDlOaHPA

Mark Wade, Hammered Dulcimer, Garage Band & iMovie
https://www.youtube.com/watch?v=-xkXo8Z2UnA

Chris Foss, Demystifying the hammerd dulcimer
https://www.youtube.com/watch?v=9Uur6fj7mj8

Bing Futch, Mountain Dulcimer
https://www.youtube.com/watch?v=vjU6bSNh9qo

Dulcimers in the Heartland - America's Heartland
https://www.youtube.com/watch?v=UurHbXwVo04

Anushka Shankar, Sitar, Voice of the moon
https://www.youtube.com/watch?v=RzoO756PvL8

Bei Bei, Guzheng
https://www.youtube.com/watch?v=Uf3h0JLg3j4

Kazue Sawai, Bass koto
https://www.youtube.com/watch?v=7YGDgQZhMJg

Kumada Kahori, Biwa and Vocals
https://www.youtube.com/watch?v=bnt4CSZVJy8

Liu Fang, Pipa
https://www.youtube.com/watch?v=JtrthXXmKgA

Guilhem Desq, Hurdy Gurdy
https://www.youtube.com/watch?v=ypuaJLHK_LQ

Griselda Sanderson, Nyckelharpa
https://www.youtube.com/watch?v=LgbMVIYv57I

Eldrim, Taglharpe
https://www.youtube.com/watch?v=muRr8WqrU48

Aërofonen

Wang Li, Hulusi
https://www.youtube.com/watch?v=TuNq82S7ek0

Erik Bosgraaf, sopraanblokfluit 'Doen Daphne over schone Maagd', Jacob van Eyck
https://www.youtube.com/watch?v=G1xqiiylsHU

Jörgen van Rijen , Trombone solo and loop station, 'Slipstream' by Florian Magnus Maier
https://www.youtube.com/watch?v=J2dqO5PQGTE

Delfeayo Marsalis, Trombone, What a Wonderful World
https://www.youtube.com/watch?v=xN--yTnS45Q

Tine Ting Helseth, Trumpet, Concerto Eb major, Joseph Haydn
https://www.youtube.com/watch?v=FCcZ90NWHZM

Chet Baker, Trumpet, Almost Blue
https://www.youtube.com/watch?v=z4PKzz81m5c

Gordon Hudson, Demonstration of the difference between Trumpet, Cornet and Fluegelhorn
https://www.youtube.com/watch?v=ZhfGM19bsmM

Hüsnü Senlendiriçi, G-Clarinet solo, improvisation
https://www.youtube.com/watch?v=YWQhi4Mligk

Catalina Vicens, Portative
https://www.youtube.com/watch?v=z5qWsMzZdfs

Martin Erhardt, Portative
https://www.youtube.com/watch?v=AO6Hsf3xeuM

Christophe Deslignes, Portative with stopped pipes
https://www.youtube.com/watch?v=wW0sVik8lgI

Tomas Flegr, Regaal, Pieces from the Linzer Orgeltabulatur
https://www.youtube.com/watch?v=M87JII5UN8U

Balint Karosi, A short demo of stops on the oldest
playable organ from 1442 in Rysum Germany
https://www.youtube.com/watch?v=w0c9ask5zy4

Emy Dragoi, Accordion & Loop Station
https://www.youtube.com/watch?v=trq8UcRjxUY

Oleg Fateev, Bayan, Prelude and Fuge for organ in c-minor J.S. Bach (BWV646)
https://www.youtube.com/watch?v=5JCpjzfJYW8

Nestor Marconi, Bandoneon and Juan Pablo Navarro Double bass, Oblivion, Astor Piazzolla
https://www.youtube.com/watch?v=Z0cfLPKminY

Davy Spillane, Uilleann Pipes, Caoineadh Cu Chulainn

https://www.youtube.com/watch?v=Mwxga8udlio

Winne Clement, Overtone flute, improvisation
https://www.youtube.com/watch?v=unX-em53pGk

Winne Clement, Fujara, improvisation
https://www.youtube.com/watch?v=R1_lBpN4AGw

Wine Clement, Low D# Overtone flute & Zeger Vandenbussche, Bb-Clarinet
https://www.youtube.com/watch?v=GtOftFfLW8Y

Wine Clement, Double kaval
https://www.youtube.com/watch?v=X88fTwb2Jmk

Wine Clement, How to make an overtone flute in 5 minutes
https://www.youtube.com/watch?v=-dB8DDjCU14

Kyiv Ethno Trio, Overtone flute Telinka
https://www.youtube.com/watch?v=QPby01qNro8

Theodossi Spassov, Bulgarian kaval improvisation
https://www.youtube.com/watch?v=-p4r7Synuxk

Kazushi Matama, Shakuhachi
https://www.youtube.com/watch?v=BEJQ8jBcsnI

Hariprasad Chaurasia, Bansuri
https://www.youtube.com/watch?v=3oSavdHwr5Q

Pauline Oostenrijk, Oboe and Enno Voorhorst, guitar
https://www.youtube.com/watch?v=YMY7VAP1ewA

Francisco González Sánchez, Bassoon, Fantasia para fagot solo
https://www.youtube.com/watch?v=sT2wkQV2wPo