MODARTT

presents

PIANOTEQ 4

Welcome

Congratulations on your purchase of **Pianoteq** – the starting point of a brand new generation of pianos, developed from mathematical research done at the Institute of Mathematics of Toulouse at INSA Toulouse, France, and offering unique possibilities to make the piano behave and sound just the way you like.

For support issues and latest news about our products, please visit our website at www.pianoteq.com. If you have any questions or comment, let us know. We always listen to our customers.

Contents

1 Introduction

1.1 The fourth generation of pianos

The first generation of pianos, starting in 1698 with Cristofori's *pianoforte*, came to maturity at the end of the XIX century with the acoustic grand concert piano. It was followed in the XX century by electro-acoustic pianos, and then by digital sampled pianos. Now, at the beginning of the XXI century, **Pianoteq** is the first instrument of the fourth generation of pianos, based on a true physical modelling and offering extraordinary playability and expressiveness.

With **Pianoteq**, you can adapt the piano sound to your own taste. Unique parameters that model the behaviour of real pianos result in great realism, until now only to be experienced on real acoustic pianos.

Using 32-bit internal computation, the calculated piano sound is free from quantization noise. True dynamic timbre results, from the faintest *pianissimo* to the strongest *fortissimo*, for all 127 MIDI velocities available for each note played.

Everything that characterizes a real piano is there: the mechanical noises (optional), the complex sound of pedals and strings in interaction, the percussive impact on *staccato* play (short notes), and of course, most importantly, **the beauty of the piano sound**.

The second generation brought innovative sounds (such as the Fender Rhodes, Wurlitzer, Yamaha CP, and others), whereas the third generation only reproduced recorded samples. Based on an effective physical model, **Pianoteq** allows you to adjust and stretch parameters, resulting in new sounds and performance styles. **Pianoteq** is both a way to emulate existing pianos and an innovative tool for music creation.

Pianoteq is in fact the first **virtual piano factory**: it can produce new brands as well as copies of historical instruments, from harpsichords or pianofortes to more recent electro-acoustic pianos.

Other instruments of the percussion family are regularly added to the **Pianoteq** collection. Visit our website www.pianoteq.com and discover our latest creations.

1.2 What makes Pianoteq outstanding

- It is the first of a new generation of pianos, issued from an outstanding breakthrough technology based on physical modelling, which is foreseen as the technology of the future. Notes are really played ("constructed" in real-time, like on a real piano), not just read from the disk or the memory. This explains why **the sound is alive, not static: it is not a simple recording, it is as genuine instrument that responds to the pianist's finest interpretation**.

- It has been developed in the prestigious *Institute of Mathematics of Toulouse*, at the *Institut National des Sciences Appliquées* in Toulouse, France. Two specialists from this laboratory have been working hard to create this beautiful instrument. Conception of the physical model is from Philippe GUILLAUME, piano tuner, musician, and mathematician whose "Grail" is finding the equations for the "piano soul." Implementation is from Julien POMMIER, engineer and mathematician, who implemented the physical model to work in real time.

- It is light: it does not require storing huge data involving a whole collection of DVD's, since it only needs an up-to-date CPU for computing all sounds in real time. It loads easily into RAM, and installation is instantaneous. No problem using it on a modern laptop.

- It can handle ultra low latencies with good audio drivers on a recent CPU.

- It offers a beautiful collection of stunningly alive instruments: pianos, rare historic harpsichords and pianofortes, electro-acoustic and electric pianos, chromatic percussions, etc.

1.3 Pianoteq versions

Pianoteq is available in three versions:

- **PIANOTEQ STAGE** (formerly PIANOTEQ PLAY) is for musicians who want to plug it in and play without tweaking the physical model. It includes standard features such as velocity curve, dynamics, action settings, EQ, tremolo, wah-wah, chorus, compressor and other effects.
- **PIANOTEQ STANDARD** offers in addition powerful tools to tweak and adapt the physical model, as well as the positions of the microphones.
- **PIANOTEQ PRO** goes even further. Its Note Edit feature allows those who require complete freedom in note shaping to edit the parameters note-by-note.

All versions offer the same sound, instruments and playability but differ in the range of features and settings. The table below summarizes the main differences between the three versions.

	PIANOTEQ STAGE	PIANOTEQ STANDARD	PIANOTEQ PRO
Grand pianos D4 and K1	✓	✓	✓
Commercial add-ons [1]	✓	✓	✓
KIViR instruments (free)	✓	✓	✓
Preset (fxp) loading [2]	✓	✓	✓
Audio effects	✓	✓	✓
Piano model tweaking		✓	✓
Microphones setting		✓	✓
Note Edit (note-by-note editing)			✓

[1] Commercial add-ons are sold separately and can be loaded in any **Pianoteq** version.
[2] In **PIANOTEQ STAGE**, preset loading is limited to parameters that are present in the interface. Presets built with **PIANOTEQ PRO** can be loaded in **PIANOTEQ STANDARD** without any limitations.

This manual describes the general features that can be found in **Pianoteq**. Depending on your version, some of them may or may not be present.

1.4 Features in short

Pianoteq is equipped with all of the features you could dream of:

- Continuous velocity from *pianissimo* to *fortissimo*, with progressive variation of the timbre: that makes exactly 127 velocities! A sample-based software program would in theory require hundreds of gigabytes for all these velocities
- Complex resonances that only a model can reproduce in all its richness:
  - Sympathetic resonances of all strings, both without and with sustain pedal
  - Duplex scale (the undamped string parts which come into resonance)
  - Damper position effect when key is released (variable overtones damping)
  - Other specific effects like *staccato* and sound continuation when pressing down the sustain pedal a short time after key release (re-pedalling)
- Extended key range to 105 keys for some grand pianos (D4, K1, YC5, etc.)
- Timbre modification of repeated notes, due to the hammer striking strings which are already in motion instead of being still
- Four pedals:
  - Progressive sustain pedal, allowing the so-called "half pedal," but also quarter or tenth's pedals if you want! [1]
  - *Sostenuto* pedal, allowing you to hold some notes after release without pressing down the sustain pedal
  - Harmonic pedal, allowing you to play *staccato* while maintaining the sustain pedal resonance
  - *Una corda* pedal, also called the soft pedal, modifying the sound quality or *timbre* by shifting the piano action to the right (on grand pianos)
- Variable lid position
- Natural instrument noises including action key release noise, damper noise at key release (bass notes) and sustain pedal noise: pedal velocity dependant "whoosh" produced by the dampers rising altogether from the strings or falling down
- Choice of microphone position and multichannel mixing (up to 5 mics, 5 channels)
- Microtuning and *scala* format files import
- Keyboard, pedal and note-off velocity settings
- Sound control via equalizer and dynamics
- Built-in convolution reverberation, allowing you to import WAV impulses
- Standard effects including delay, chorus, flanger, tremolo, wah-wah, amplifier and a compressor
- Original hammer bouncing feature, interesting for chromatic percussions (marimba, xylophone, cimbalom…).

[1] If your piano supports a fine enough MIDI progression when using the sustain pedal.

2 Installing and starting Pianoteq

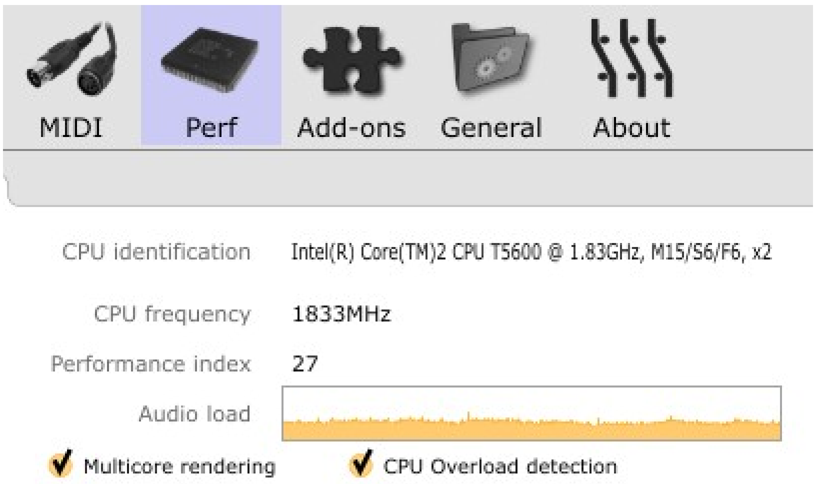
Pianoteq works on computers equipped with Windows XP or later, Mac OS X 10.5 or later (Universal Binary) and Linux (x86). You can use the stand-alone version or use **Pianoteq** as a VST, Audio Units or RTAS instrument. We recommend visiting www.pianoteq.com, where you will find the latest information and a detailed FAQ.

2.1 Installation for Windows

Execute the installation program file pianoteq_setup.exe. Activation is required when launching **Pianoteq** for the first time. Just follow the on-screen instructions. ASIO drivers are necessary for obtaining a low latency. If using a soundcard that is not distributed with its own ASIO drivers, you can download ASIO drivers at www.asio4all.com.

Optimization

If you experience pops and cracks when playing, watch the audio load and CPU frequency in *Options* ► *Perf*:



Red bars in the graphic indicate an overload. In that case, look at the displayed CPU frequency. If this frequency varies or stays below the normal frequency of your CPU, it comes from the Power Management setting of your computer which should be set to “High Performance”.

2.2 Installation for Mac OS X

Click on the **Pianoteq** package and follow the instructions. Activation is required when launching **Pianoteq** for the first time. Just follow the on-screen instructions.

2.3 Using Pianoteq stand-alone

Using **Pianoteq** stand-alone is very simple. Launch **Pianoteq** and specify your audio and MIDI *Devices* settings in the dialogue box: you are ready to play.

2.4 Using VST hosts

Pianoteq can be loaded by any VST host. You will need to specify, inside the VST host, your MIDI device and the driver you are using.

Warning

Most VST hosts save your modifications and reload them when you restart. If you hear some strange sounds, make sure that all parameters are at their default values. Check, for example, if the velocity and equalizer curves are correctly defined.

2.5 Hardware requirements

Pianoteq can be used with any MIDI compatible keyboard. We recommend a touch sensitive keyboard, such as one with full weighted keys simulating the hammer response of a real piano. See tutorial section 12.4 for adapting **Pianoteq** to your keyboard in the best way. For half and quarter pedalling, a progressive sustain pedal is required.

The requirements for using **Pianoteq** successfully are:

- Recent CPU (dual/quad core recommended)
- 512 MB RAM
- ASIO compatible sound card and drivers (Windows users)
- Internet connection (however installation on a computer that is not connected to the internet is possible. See our FAQ at http://www.pianoteq.com/faq)
- Windows XP or later, Mac OS v. 10.5 or later (Universal Binary), Linux (x86).

2.6 Adapt Pianoteq to your hardware

When you click on the *Options* button, a window containing the following sections appears:

The *Devices* section (in standalone mode only) lets you select your keyboard, audio device and related driver (Audio device type), output channels, sample rate and audio buffer size.

In the *MIDI* section you can:

- Assign MIDI controllers to **Pianoteq** parameters (experienced users only — may produce unexpected sounds with MIDI files containing special instructions)
- Unassign all controllers except pedals and Pitch Bend by choosing *Current MIDI Mapping: Minimalistic* (recommended for starting)
- Transpose notes by 3 octaves.

Pianoteq computes all notes dynamically (that is, in real time). Thus a fast CPU is required. The minimum requirement is a 1.5 GHz CPU. Be aware that bass notes require more computations than treble, because they contain many more overtones. The *Perf* section allows you to select from among the following features:

- *Multicore rendering*. You should usually enable this feature.
- *CPU overload detection*. Under certain circumstances (a slow CPU, very fast music), the CPU may be overloaded by the number of required computations. *CPU overload detection* might be useful for real time processing, for example when 10 seconds of sound require 12 seconds of CPU computations. Some computations are then by-passed.
- *Internal Sample Rate* affects the internal sampling rate of **Pianoteq**. A lower frequency requires less computation. Thus the lower the capacity of your CPU, the lower you should set this sample rate.
- The *Polyphony* is the number of individual sounds (notes, sympathetic resonances…) that are played simultaneously. The lower the capacity of your CPU, the lower you should set the polyphony. Alternatively, you can choose *Auto (Pessimistic or Optimistic)* for an automatic polyphony setup.

2.7 Quickly loading fxp, ptq and MIDI files

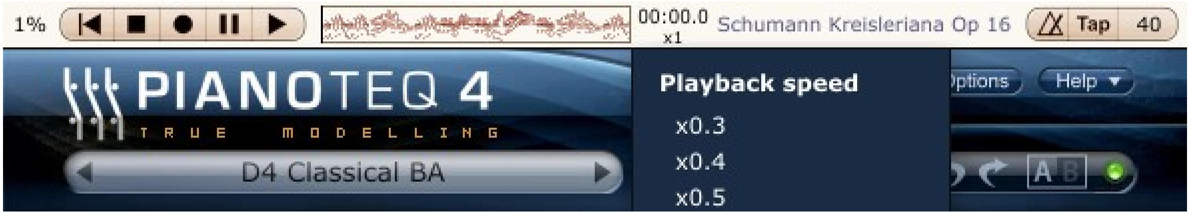
You can drag *fxp* and *ptq* files (and MIDI files with the stand-alone version) from the file manager, email client, web browser, and drop them onto the **Pianoteq** interface.

2.8 MIDI file player (stand-alone version)

The **Pianoteq** stand-alone version is equipped with a MIDI player that lets you play and record MIDI files.

2.8.1 Playback speed

You can adjust the playback speed by clicking on x1 ("times 1"). A menu will appear where you can choose another value or enter any value between 0.1 and 10. Alternatively, click on x1 and drag the mouse to get the value you want.



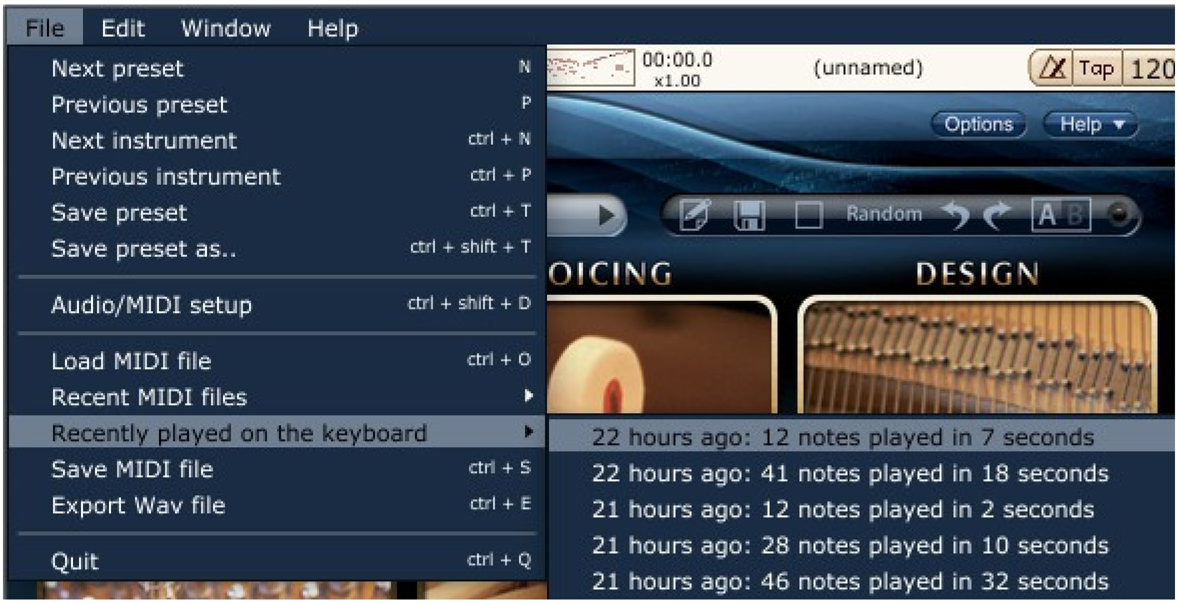
2.8.2 Record and Save your performance

Click on the *record* button to start recording your performance live.

Save your MIDI file by opening the *File* menu. There you can also export your recording to an audio WAV file.

2.8.3 Brilliant performance lost?

At any time, you can retrieve your recent performances via *File->Recently played on the keyboard*. Particularly useful when after a brilliant performance you think "too bad I didn't record this"! Well, **Pianoteq** did it for you: just load the latest *Recently played on the keyboard* and save/export it to a regular MIDI/WAV file. It's as simple as that!

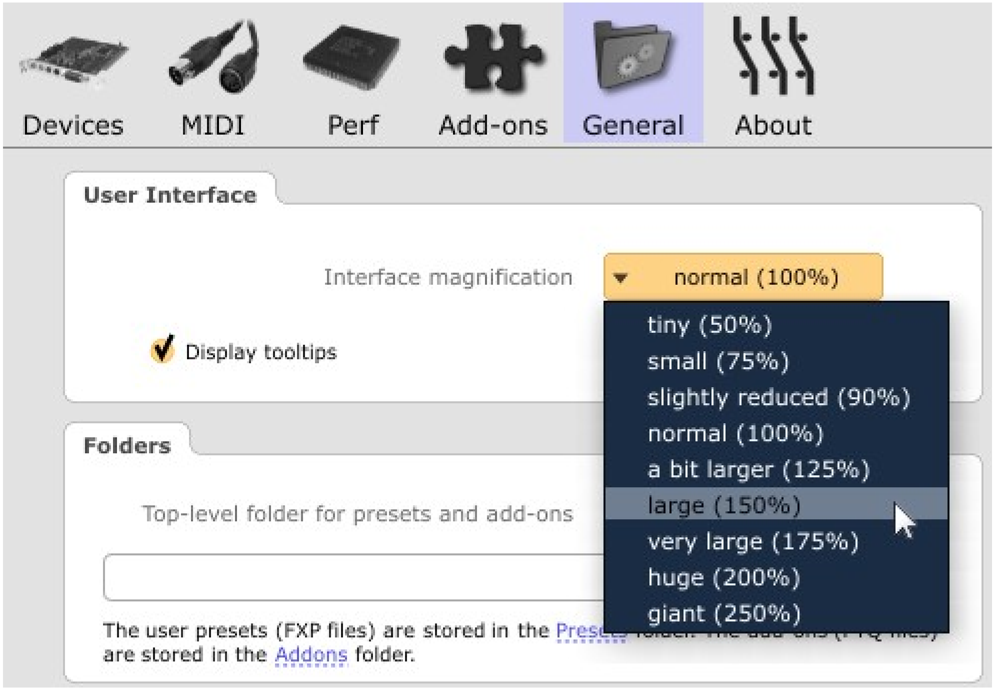


2.8.4 Step by step in your MIDI file

In the standalone version, for exploring your MIDI file step by step, forwards or backwards, use the right or the left arrow to play single notes or chords.

2.9 Interface magnification

Since version 4, the **Pianoteq** interface is resizable, making it comfortable to work with any display size. Click on *Options* ▶ *General* and select the size in the *Interface magnification* menu:



3 Overview

We come now to a brief overview of **Pianoteq**. Its interface is divided into two sections:

- An **Instrument section** containing innovative features presented in three panels called *Tuning*, *Voicing*, and *Design*. Each panel opens with a single click.

The three Instrument section panels

- An **Audio Engineering section**, which offers you a unique feature available through the *Output* menu: microphones positioning and mixing. The section also offers features like velocity curve, volume, dynamics, action and mallet settings, equalizer, reverberation, chorus, flanger, compressor and other effects.

The Audio Engineering section

Adjusting any of the parameters is easy. But you can also simply choose your instrument from the instrument menu on the top left.

3.1 Instruments

Pianoteq instruments are based on physical modelling — which simulates the way the sound is generated and how it propagates in space — coupled to a mathematical analysis of original instruments.

The commercial add-ons are included in demo mode in **Pianoteq** for your evaluation. You can download free add-ons from the user area at www.pianoteq.com.

3.1.1 Acoustic pianos

Pianoteq 4 brings a new virtual grand piano: the **D4**. A Steinway D from Hamburg has served as reference. Its characteristics have been used for feeding the physical model from which the D4 is issued. The secret of its sound quality lies in the refinement of the soundboard model and its acoustic radiation computed via a structural analysis model coupled to integral equations. Moreover, each note has been adjusted in its finest detail, just like in a real factory. This new piano has many presets with various recording perspectives that can serve any style of music. Of course, these are only a few among the infinite number of perspectives that you can create yourself by choosing your own recording settings: microphones placement, mixing, etc.

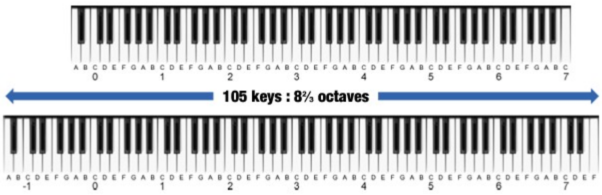
The grand piano **K1**, while keeping in the medium range the nice and warm sound of the previous version from **Pianoteq 3**, has been equipped with new bass strings.

The **YC5 Rock add-on** is provided as a commercial add-on. It is developed to meet demands for a specific pop/rock piano. Its bright and vivid tone cuts through in pop/rock oriented mixes.

The grand pianos C3 and M3, which were included in **Pianoteq 3**, can be downloaded for free from the user area (V3legacy.ptq).

Keyboard range extension

Our grand pianos D4, K1 and YC5 benefit from an unprecedented keyboard range extension from 88 to 105 notes (8⅔ octaves):



3.1.2 Electro-acoustic pianos

The **electro-acoustic add-on** offers two amazing electro-acoustic pianos from the seventies. Each instrument (*Rhody* and *Wurly*) is provided with several variants. Using the rich interface features, you can customize them to your own taste.

3.1.3 Clavinet

The **clavinet add-on** is modelled after the well-known D6 electric clavichord. Thanks to the powerful technology provided by physical modelling, it offers, in contrast with the original instrument, a sustain pedal, an extended range from C0 to C6 (original range F0 to E5), a variable mute bar and continuous pick-up mixing.

3.1.4 Vibraphones

The **Vibes add-on** offers two beautiful vibraphones. *V-M* is a virtual copy of a Musser vibraphone that belongs to the famous French vibraphonist Dany Doriz. *V-B* is a virtual copy of a Bergerault vibraphone that belongs to the Condorcet studio in Toulouse (France). The bars are made of metal.

3.1.5 Xylophone and Marimba

The **Xylo add-on** includes a xylophone and a marimba. The xylophone virtual copy is modelled after a modern 3½-octave French brand and the marimba virtual copy is modelled after a modern five-octave French brand. In contrast with the vibraphone, the bars are made of wood instead of metal.

3.1.6 Celesta and glockenspiel

The **Celeste add-on** includes a celesta and a glockenspiel. The celesta resembles an acoustic upright piano but houses metal plates struck by felt hammers resembling piano hammers. The virtual celesta is modelled after a modern five-octave German brand. The glockenspiel has also metal plates but they are struck by hard metal mallets held by the musician. The virtual glockenspiel, modelled after a modern French brand, has been slightly extended to cover four octaves.

3.1.7 Prestigious historical collection

Virtual copies of historical instruments can be downloaded from our website at www.pianoteq.com. We currently offer **free add-ons of a cimbalom, harpsichords, pianofortes and acoustic and electro-acoustic pianos**. Some of these instruments are presented in their current state. Their age has caused imperfections, such as some voicing irregularities, which we have kept intact. We will continue to enrich this collection.

3.1.8 Other add-ons

Other add-ons, such as church bells and tubular bells, are available for download on our website at www.pianoteq.com. Subscribe to our newsletter for the latest information.

3.2 Managing instruments and presets

You can load and save instruments from the *instruments menu*:

This menu lets you choose from a list of built-in *instruments* and *presets*, additional add-on instruments (files with extension .ptq) or presets (extension .fxp) that you have saved in your Pianoteq folders. More details are provided in section 3.4.2.

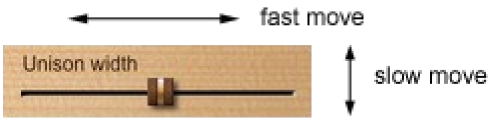
3.2.1 Difference between "instrument" and "preset"

The physical model contains a great number of parameters, but only a small part of them are available through the user interface. When only the user interface parameters are changed, then we say that it is still the **same instrument** but a **different preset**. Hence presets are understood as variations of a given instrument.

For example, *D4 Spacious* and *D4 Player Jazz* are the same instrument, as the difference lies in the microphone position which can be defined by the user himself. On the contrary, *D4 Spacious* and *K1 Close Mic* are two different instruments because it is impossible to obtain one of them by modifying the user interface parameters of the other.

3.2.2 Instrument modifications

You can change any parameter of the current instrument or preset by moving the corresponding slider with the mouse. Moving the mouse cursor *perpendicularly* to the slider will make the slider move slowly.



Each time you modify parameters in **Pianoteq**, a few computations are needed to update the instrument (physical model).

Once you are done, the *edit* and *save* buttons to the right of the *instruments menu* allow you to edit and save your new preset.

Also have fun trying the *Random* button, which changes all settings randomly!

3.3 Hints

3.3.1 Creating your own instrument

Generally speaking, you will find it more interesting to make adjustments, large and small, in several parameters instead of making a single large adjustment. Moving a single slider to the left may throw the weight of the sound onto other parameters that you may want to adjust. Moving a slider to the far right may obscure the contribution other parameters make to the sound, or make their small contribution seem too strong. Moreover, the parameters that interact may be in separate panels, since each panel has controls that modify the way in which a single physical component of a piano contributes to the sound, instead of controlling the sound in general. This manual often touches on these adjustments. Further experimentation will let you experience the ways in which the parameters interact. Make a small adjustment in one parameter and a large one in another. Make large and small adjustments everywhere. You can create almost any sound that a piano can create, and more.

3.3.2 Brilliance

Brilliance is an important sound quality for achieving good realism. You may want to adjust it whether you are staying close to the loudspeakers, or listening at low volume levels, or using headphones. You can for example change the hammer hardness from the *Voicing* panel, or use the EQ from the lower panel.

The keyboard velocity itself plays a crucial role in the sense of brilliance. Visit the **Pianoteq** user forum http://www.forum-pianoteq.com/ where users provide velocity curves for many types of keyboards. See also the tutorial in section 12.4.

3.3.3 Using reverberation

Listening through loudspeakers usually requires significantly less reverberation than through headphones. The reason is simple: when using loudspeakers, the sound is naturally reverberated by the room in which they sit. We thus recommend that you reduce the *reverberation mix* when using loudspeakers.

Moreover, it is worth mentioning that bypassing reverberation in **Pianoteq** does not have the same effect as bypassing reverberation in a sample-based instrument. In the latter case, unless recording was done in an anechoic chamber, there is a natural reverberation present in the recorded samples which may not be perceived as reverberation because the note release cuts the reverb tail itself, whereas in **Pianoteq**, there is no reverberation whatsoever when you switch it off. In that case, the sound loses an important part of its natural quality and may sound strange or synthetic, particularly with headphones, because in the real world we never hear sounds without some reverberation. Hence, we recommend bypassing reverberation only when using an external — or natural — reverberation.

3.4 General commands

3.4.1 Playing with the parameters

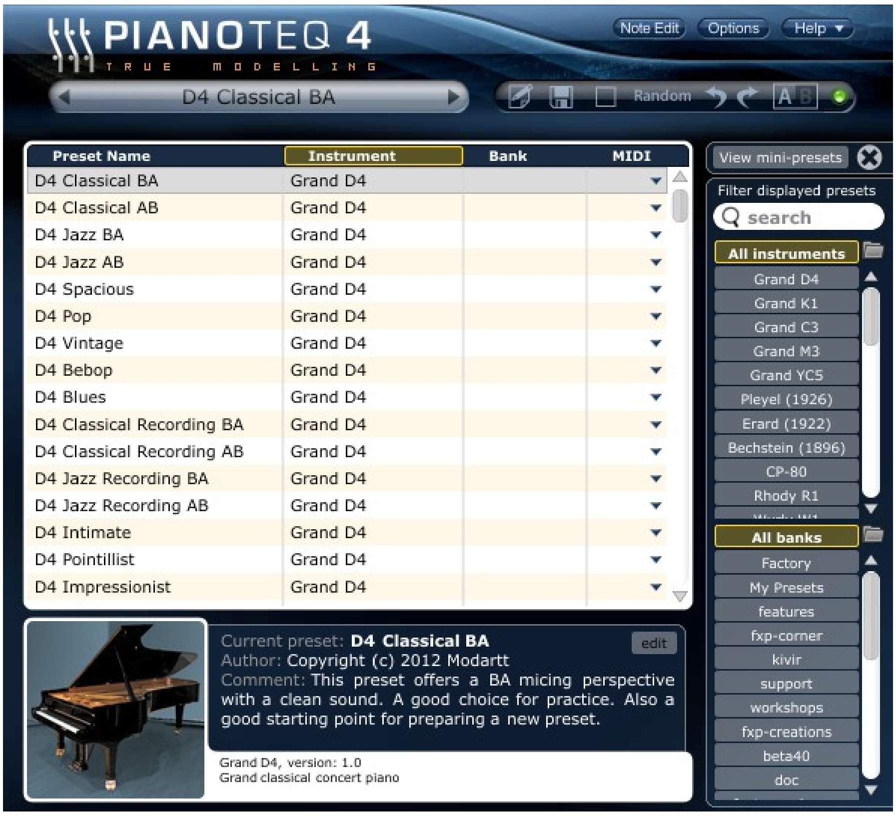
In **Pianoteq** you can modify and create your own presets, save them and share them with other users. The following commands are located at the top of the interface.

- The **edit** (pen) and **save** buttons allow you to edit and save your new preset.
- The **freeze** checkbox allows you to select the parameters that you want to keep unchanged when changing instrument or preset. This is a very convenient feature for “transporting” settings from one instrument to another.
- The **random** command allows you to randomly change *tuning*, *voicing*, and *design* parameters. Parameters located in the Audio Engineering section are not affected by the random command.
- Using the **undo/redo** commands, you can at any time undo and redo the changes you have made: up to 100 undos are possible. A right click on the button shows you the last modification.

- The **AB** button allows you to switch between two presets A and B, one being in the foreground while the other is in the background. The *led* beside them is lighted as soon as A and B are different. Clicking on the led copies the foreground preset into the background preset. A right click on the AB button lists the differences between A and B. A and B presets have their own undo/redo stack.

3.4.2 Managing and sorting presets

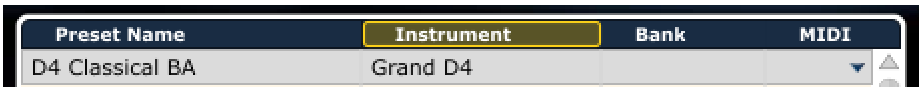
When you click on the edit button, the following presets manager appears:



It lets you manage the instruments and presets from the instruments menu. You can sort them, filter them (see some part of them), rename them, etc.

Sorting

The way presets are sorted can be chosen by clicking in the appropriate column: *Preset name*, *Instrument* or *Bank*.



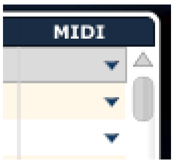
A *bank* is a set of presets that are located in a given folder, except the *factory* bank which contains built-in instruments and add-ons provided as ptq files located in the *Addons* folder.

Filtering

You can select the instruments and presets that are visible in the instruments menu through three different "filters" located on the right side of managing window: *search*, *All instruments*, *All banks*. You can also click on individual instruments or banks.

Renaming presets

A double click on a user preset name allows you to rename it. You can also open the contextual menu by clicking on the small arrows in the *MIDI* column.



The Pianoteq folders

The easiest way to find the **Pianoteq** folders is to click on the little folder images to the right of *All instruments* and *All banks*. The **Pianoteq** folder contains two sub-folders:

- *Addons*: this is where to store the add-ons provided as ptq files,
- *Presets*: this is where to store the user defined banks. Each bank is itself a folder that contains presets with fxp file format.

Importing fxp files

There are two ways of importing fxp files:

- Drag and drop the file into the interface,
- Copy the file into the appropriate folder.

Saving presets

After you have created your new preset, you can save it by simply clicking on the save button; a popup window will ask you for a preset name and a bank name (default bank is *My Presets*). Each time you click again on the save button, you will save the new values with the same preset name. You can access backup copies with a right click on the preset name (if there are some).

3.4.3 Assigning a parameter to a MIDI controller

You can assign **Pianoteq** parameters to MIDI controllers such as those that may be on your keyboard. Select the parameter slider that you want to assign (right click on the slider and click on *MIDI->Assign MIDI Control*) and move the knob of the MIDI controller that you have chosen for this parameter. Pianoteq will automatically assign the parameter to the controller. More sophisticated possibilities are provided in the *Options/MIDI* section.

Any MIDI control may be assigned except the following ones: MIDI controls 6, 38, 96-101 which are used for RPN and NRPN MIDI parameters; controls 120 to 127 are reserved for various reset operations ("all notes off" etc.); controls 32 to 63 are reserved for 14-bit precision controllers.

3.4.4 Instrument controls table

The following table summarizes **Pianoteq** main controls that are associated with instrument features and will be discussed in the next sections.

Feature	*Controls*	*Action*
Pitch	Diapason	Changes A (above middle C) frequency
Tuning	Temperament	Chooses among standard temperaments
	Unison width	Frequency variation within each unison (group of three strings)
	Octave stretching	Stretches octaves
Sound length	Direct sound duration	Modifies the direct sound duration
	Soundboard mechanical impedance	Modifies the global sound duration: raising impedance yields longer sounds
Timbre	Spectrum profile	Modifies individual intensity of the first eight overtones
	Hammer noise	Modifies the hammer noise level
	Strike point	Changes the overtones level
	Soundboard cut-off frequency	Raising cut-off frequency enriches high frequencies of each tone
	Soundboard Q factor	Raising Q factor shortens high frequencies duration
	String length	Controls sound "acidity" (inharmonicity)
Brilliance	Hammer hardness	Enriches the high frequencies: the harder the hammer, the brighter the sound
Resonance	Sympathetic resonance	Controls the amount of sympathetic resonances of all strings (the harp)
	Duplex scale resonance	Controls the amount of Duplex scale resonances (undamped string parts)

Warning: when adjusting the parameters to extreme values, one may create instruments having unusual or even unrealistic properties. Hence one can create sounds that do not correspond to known instruments.

4 Tuning panel

Pianoteq allows you to perform all of the tuning operations usually done by a piano tuner. The *Tuning* panel contains the following controls:

4.1 Diapason

The standard diapason (A above middle C) frequency[2] is 440 Hz, but you can change it to other values by clicking on *diapason*.

4.2 Temperament

The *temperament* defines the way the scale is tuned. By clicking on *temperament*, you can choose from among the following temperaments (see appendix):

- *Equal*: the standard tuning
- *Zarlino* (circa 1558): sometimes called the "physicians scale", based on harmonic thirds (ratio 5/4) and fifths (ratio 3/2)
- *Pythagore* (VIth A.C.): based on harmonic (pure) fifths except for one (the so-called "*quinte du loup*"). Can you hear which one it is?
- *Mesotonic, Well-tempered* and *Werckmeister III* (XVIIth): unequal temperaments used in baroque music
- *Flat*: octaves ratio is strictly 2, for use in certain circumstances, for example with synthesizers.

A unique feature of **Pianoteq** is that tuning does not follow a pre-computed frequency table (except for the flat temperament), but *takes into account the inharmonicity of the strings, in the same way a piano tuner does with acoustic pianos*. Hence, the consonance of the notes is improved and the chords have a fuller and richer sound.

---

[2] Frequency is the number of oscillations per second.

For other temperaments, you can enter the microtuning panel by clicking on the *"mu"* button 

 and there import your own *scala*[3] files or keyboard mappings via the *scale* and *keymap* menus:

4.3 Unison tuning

As very few people know, the three strings of each piano unison (the strings hit by each hammer) are not tuned at exactly the same frequency. To change the *timbre* or *colour* of the sound, a skilled piano tuner introduces small tuning differences between these three strings. Experiment yourself by gently changing

- The *unison width*, that is, the difference between the lowest and the highest frequency produced by the three strings of a single note.

4.4 Octave stretching

It is quite usual to stretch *octaves*[4] in a piano, but how much should they be stretched? Well… this might be a matter of taste! Adjust it to your own taste by modifying

- The *octave stretching* parameter. The main effect will be observed in the treble notes.

When the *octave stretching* parameter is set to 1, the stretching follows the natural inharmonicity of the strings (depending on the string length), so there still is a slight stretching. If you want no stretching at all, then use the *flat* temperament.

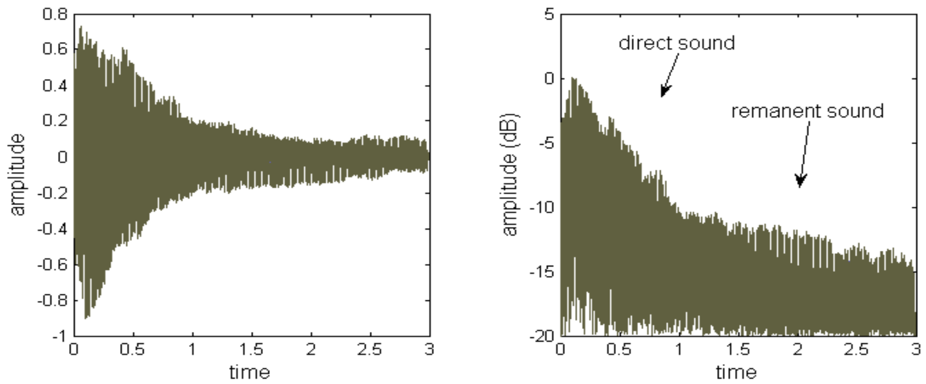
[3] For more information, see http://www.huygens-fokker.org/scala/

[4] The musical interval between the two closest notes with the same name (e.g. A3 and A4) is called an octave. The theoretical frequency ratio between two such notes is 2, but in practice it is slightly stretched because the ratio between the fundamental and the second overtone of a real string is slightly greater than 2 (cf. also Design Panel).

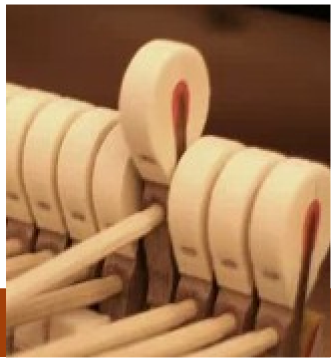
4.5 Direct sound duration

One consequence of modifying unison frequencies is that you change the direct sound duration. The same thing happens when reshaping hammers. If you prefer, you can act directly on this duration by changing:

- The *direct sound* duration.



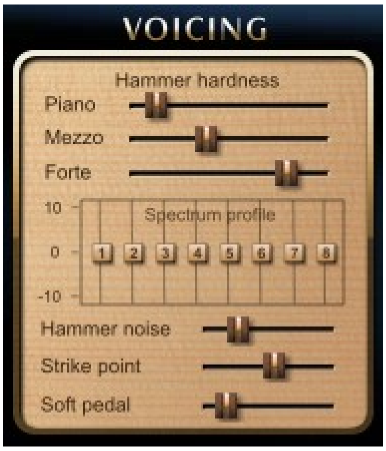
Time representation of a piano sound decay, natural scale (left) and log scale (right). Fast decay at the beginning (direct sound), slow decay after (remanent sound).



5 Voicing panel (acoustic)

The strings of a piano are struck by the hammers, small wooden pieces covered with hard felt. For a piano tuner, *voicing* consists in “shaping” the sound according to the pianist’s taste. This is done by working on the hammer felt, giving it the desired shape, hardness and elasticity.

Pianoteq allows you to perform this same voicing operation. The voicing panel offers you the following controls:



5.1 Hammer hardness

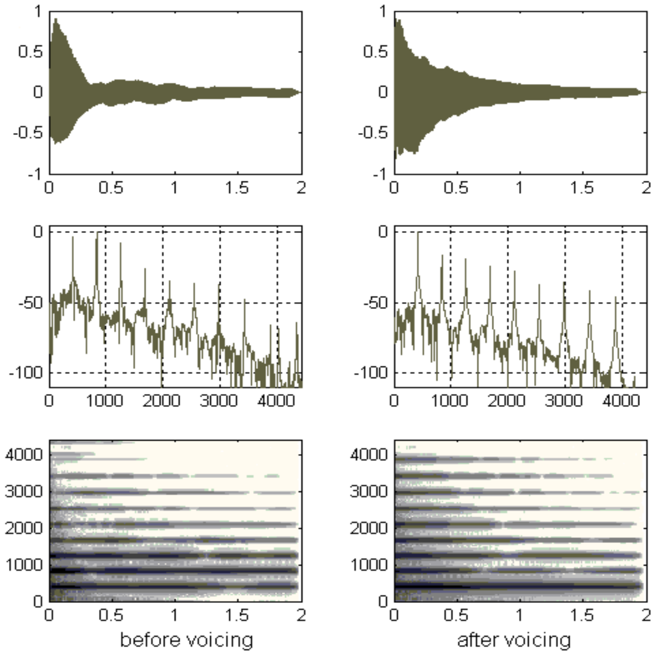
Here you can choose the hammer hardness at three different velocities:

- *Piano*, corresponding to MIDI velocity 32
- *Mezzo forte*, corresponding to MIDI velocity 64
- *Forte*, corresponding to MIDI velocity 96.

The harder the felt, the more brilliant the sound becomes. Of course, the louder you play, the harder the felt should be, unless you wish to try some original playing effects!

5.2 Spectrum profile

Here you will find small sliders that allow you to adjust the individual intensity of the first eight *overtones* (cf. section 8.2). Experiment with it by increasing the weights of all *fundamentals* (the first overtone is called the fundamental) by raising the first bar. Depending on the piano brand, the seventh, eighth or ninth overtone is usually weaker than the other overtones : the strength of the overtones is related to the hammer strike point defined by the piano manufacturer.



Time, frequency and time-frequency representation of a note, before and after voicing. Here, among other things, the first overtone intensity has been increased.

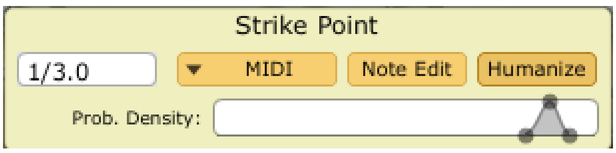
5.3 Hammer noise

You can adjust the *hammer noise*, that is, the weight of the hammer percussion sound. With a loud hammer noise, you will feel as though you are standing close to the piano.

5.4 Strike point

The *strike point* slider allows you to choose the position where the string — or the bar for percussion instruments — is struck by the hammer or the mallet.

A special *humanization* feature allows the strike point to vary as if it was played by a human musician. This feature is particularly suitable for the chromatic percussion instruments. Right click on the *strike point* slider and select *humanize*. You can adjust the range of the random variation on both sides of the mean strike point.

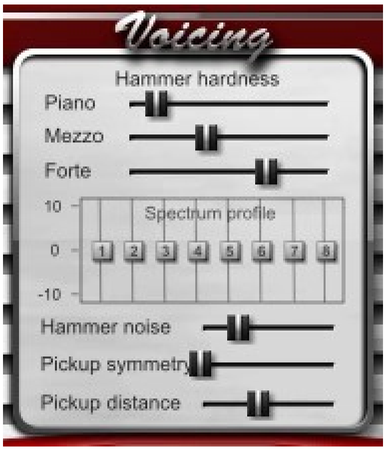


5.5 Soft pedal

Here you can control the smoothing degree of the *una corda* pedal, also called the *soft pedal*. Despite its name, the una corda pedal usually lets the hammer strike the three strings, but with a softer part of the hammer felt.

6 Voicing panel (electro-acoustic)

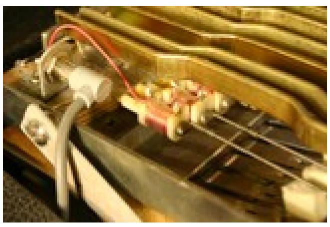
The tone sources (reed, tine, bar) of an electro-acoustic piano are struck by hammers or mallets whose hardness can vary, depending on the material that is used. Here again, as for acoustic pianos, **Pianoteq** provides a voicing panel that offers the following parameters:



Hammer hardness, *spectrum profile* and *hammer noise* work in the same way as with acoustic instruments.

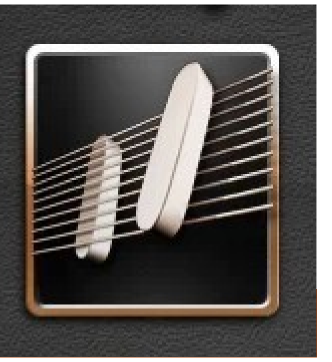
6.1 Pickup symmetry

In an electro-acoustic piano, the pickup is not exactly in front of the tone source at rest. When it is exactly in front, due to the symmetry of the device, the note jumps one octave higher than the normal tone. Moving the Pickup symmetry slider from left to right makes the pickup move from an unsymmetrical position to a symmetric position, providing thus a wide range of timbres.



6.2 Pickup distance

The pickup distance slider sets the distance between the tone source and the pickup. When the pickup is moved closer to the tone source, the sound becomes more distorted and the timbre variation between soft and loud sounds increases.



7 Voicing panel (clavinet)

The clavinet works much like a clavichord. When a key is depressed, a small rubber tip strikes the string and presses it on to an anvil. It contains two sets of pickups, positioned above and below the strings, and is usually electronically amplified.

The voicing panel of the clavinet lets you choose among the four standard pickups settings:

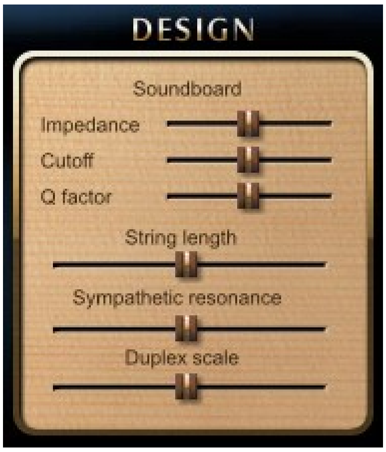
- A-C: **L**ower pickup
- B-C: **U**pper pickup
- A-D: both pickups
- B-D: both pickups but out of phase.

Even more, it lets you make any continuous change between these four settings by using the **U**pper pickup and **L**ower pickup sliders.

Hammer hardness, *spectrum profile* and *hammer noise* work in the same way as they do with acoustic instruments.

8 Design panel

This panel offers controls over piano design parameters such as string length or soundboard characteristics (the soundboard is the wooden plate which transmits the string vibrations to the air.)



8.1 Soundboard

On a real piano, you cannot change the soundboard mechanical impedance[5]. With **Pianoteq**, it becomes very easy: it is just one of the design parameters. You can control:

- The soundboard mechanical *impedance*: the greater the impedance, the longer the sound becomes.
- The soundboard *cut-off frequency*: the higher you set this frequency, the more high overtones will be present.
- The soundboard *Q factor*: the greater this factor, the faster the high overtones will decrease.

8.2 String length

Each piano note produces a complex sound, mainly composed of *overtones* with approximate frequencies *f, 2f, 3f…* where *f* denotes the *fundamental* frequency.

A parameter which greatly affects the timbre (and the tuning) is the so-called *inharmonicity*: the more inharmonic the strings, the more the overtone frequencies of each string are driven away from their theoretical values *f, 2f, 3f…* and the more the piano sound will resemble a bell.

Inharmonicity decreases very rapidly with string length. Experiment by changing the *String length*. The difference will be most evident in the bass range. You can choose up

[5] That is, how the soundboard resists the string vibrations, and thus amplifies the sound.

to a 10 meter long piano! At such a size, there is almost no inharmonicity. People say that piano manufacturers dreamed of producing pianos without inharmonicity…

8.3 Sympathetic resonance

The *Sympathetic resonance* parameter controls the weight of the strings' sympathetic resonances. It is used, for example, in the famous piece *microcosmos* by Béla Bartók. The sympathetic resonances depend on the position of each individual damper, and consequently on the position of the sustain pedal: it is longer when the sustain pedal is down, for dampers do not touch the strings.

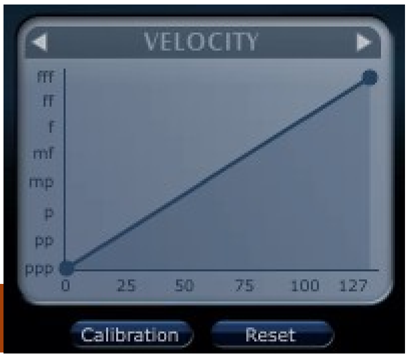
Experiment by pressing down a few keys very slowly so that they do not produce any sound, and then, without pressing down the sustain pedal, play a few notes *staccato*. You will hear the resonance introduced into the first depressed notes. If you release these notes, the sound will stop.

You can also do the "opposite" experiment. Play a note loudly and hold it, press silently another note, and release the first note: it continues resonating in the second note.

8.4 Duplex scale

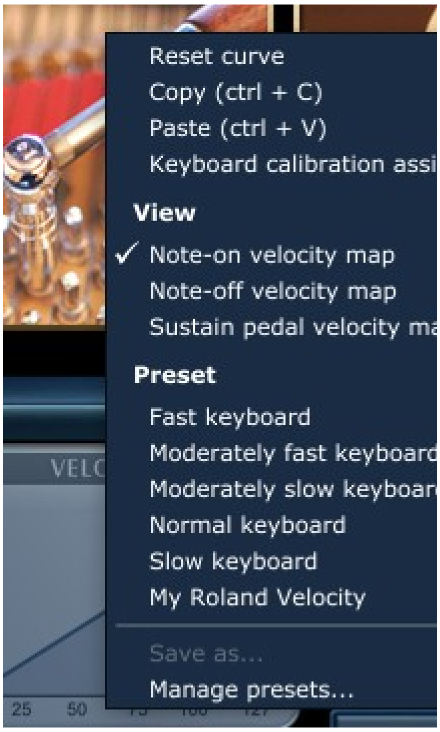
The *Duplex scale* parameter controls the weight of the duplex scale resonance, issued from the undamped string parts located between tuning pins and frame (front scale) and between bridge and frame (rear scale). This invention was patented by Steinway (who consulted with the physicist Hermann von Helmholtz) in 1872 and enriches the harmonic content of the notes.

9 Velocity panel



On the left side of the Audio Engineering section, you can find a *velocity* control curve, allowing you to adjust **Pianoteq** to your keyboard. You can add or remove control points (double click to remove) and modify the curve by moving them with the mouse. The upper menu lets you separately adjust *Velocity*, *Pedal* and *Note-off* velocities.

A right click on the velocity graphic opens a menu where you can select and manage velocity presets.



The *calibration* button opens the *Keyboard calibration assistant* which will help you adjust **Pianoteq** to your keyboard and pedal and to your own playing style. We highly recommend that you follow that procedure at least once. See also tutorial 12.4.

The *reset* button resets the displayed velocity curve to the default curve.

10 Output panel

In the middle of the Audio Engineering section you will find:

- A menu that allows you to choose from among four modes: *stereophonic*, *monophonic*, *sound recording* and *binaural*. The *sound recording* mode lets you set **microphone** positions for acoustic instruments. The *binaural* mode includes a **head model** and is mostly intended for use with headphones. The *stereophonic* and *monophonic* modes are used with electro-acoustic instruments and also allow compatibility with previous Pianoteq versions. Click on *save as* for saving your mic settings.
- A volume VU meter, equipped with a *limiter* than can be turned on/off by a simple click. By reducing high amplitudes, the limiter is intended to avoid casual cracks that appear when the amplitude is too high (in such a case, the clipping led to the right of the vu-meter shows up).
- The sound *volume*. You can adjust it note by note via a double click on the slider.
- The sound *dynamics*, which controls the loudness level between *pianissimo* and *fortissimo*. Since it is applied to each note, it can be seen as the **ideal compressor** for it allows you to adjust the dynamics without any distortion. In particular, the attack and decay of individual notes are not modified.
- Four pedals, from left to right:
    - *Una corda* pedal, also called soft pedal. It moves the piano action to the right, so that the hammers strike the strings differently, changing the *timbre* of the notes
    - *Harmonic* pedal, allows you to play *staccato* while maintaining the sustain pedal resonance effect
    - *Sostenuto* pedal, allows you to hold some notes after release without pressing down the sustain pedal. Depress some keys, depress the *sostenuto* pedal, release the keys, and the sound of the notes will continue as long as the *sostenuto* pedal is down
    - Progressive sustain pedal, allows so-called “half pedals”, but also quarter or tenth’s pedals if you want! [6]

10.1 A sound radiation physical model

The **Pianoteq** instruments are based on a physical model of the soundboard and its radiation. It simulates the sound field generated by the instrument, and thus allows you to place **microphones** anywhere around the piano, or just above the soundboard, or even below the piano if you want. The sound pressure is measured at the place where you place the microphone, simulating a perfect omnidirectional microphone. However,

[6] If your piano supports a fine enough MIDI progression when using the sustain pedal.

for distant microphones, as the reverb process is decoupled from the sound radiation of the piano, turning the reverb off is equivalent to having a perfect directional microphone oriented towards the piano.

A **head model** is also provided: here, an additional treatment is applied to the sound pressure registered by the ears of the listener. It can provide an increased realism when listening with headphones.

10.2 Sound recording mode

If you have chosen the recording mode, you can drag a mic to any location around the instrument. You can detach the mic window by hovering the mouse cursor above the mic area and dragging it with the mouse.

The mix table allows you to mix the microphones into the different output channels. For each active microphone and each active channel, you can adjust the volume and the delay that you want to be applied by clicking in the corresponding cell. Which channels are active depend on your audio configuration.

10.3 Compensation

When switched on, *Level* compensation and *Delay* compensation compensate respectively for the level and delay on each line connecting a microphone to a channel. When switched off, the raw sound from the microphones is heard: the volume decreases with the distance from the piano while the delay increases. In both cases, level and delay that you adjust in the mix table are relative to the chosen configuration.

10.4 Stereo width and sound speed

Two other parameters can be adjusted in the sound recording mode:

- The *stereo width*. This parameter allows you to narrow or broaden the stereo image of the instrument,
- The *sound speed*. Since this parameter was present while we developed the model, we chose to make it available for you. Its effect is equivalent to changing the time unit. It modifies the travel time of the sound waves in the air.

10.5 Lid position

The *lid* can be raised or lowered. Hover the mouse over the top edge of the lid and drag the lid to raise or lower it. This feature appears in the same panel as the microphone position because it is part of the acoustic radiation model and thus directly influences the sound waves captured by the microphones.

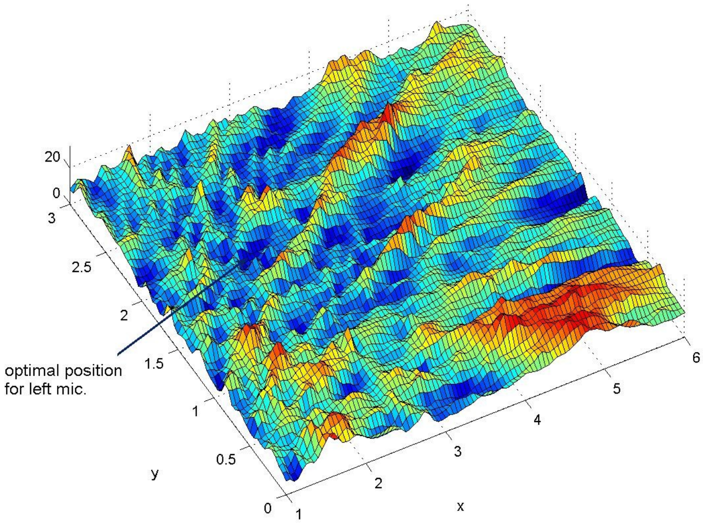
10.6 Binaural mode

If you have selected the *binaural* mode, you can choose the position of the listener around the piano. You can rotate the head in any direction, and you can even increase its size (for big headed people only).

10.7 About the microphones position

As is well-known among sound engineers, the microphone position has a dramatic effect on the resulting sound of the piano: for some positions, the sound is nicely balanced from low to high frequencies while other positions lead to a strongly coloured sound. There might be places where some frequencies are almost completely missing (wave nodes), and even the best position is far from rendering a purely flat response: recording always brings some additional colour, which makes sound recording a real art.

The next graphic gives an idea of how "flatness" can vary with the position: the lower a point of the surface, the flatter the response becomes.



11 From action to effects

The lower right panel gives access to the *Action*, *Mallet Bounce*, *Equalizer and Effects* settings. The buttons below it provide a shortcut for enabling/disabling the selected effects and the reverb.

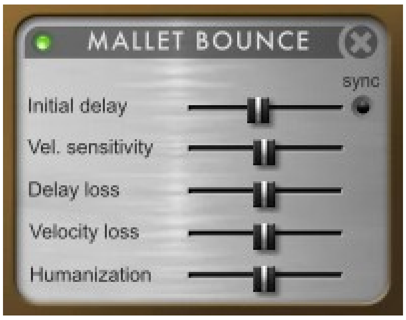
11.1 Action

Here you can adjust several parts of the piano action:

- *Damper position*: when a note is released, the damper falls back on the strings and each overtone decays more or less rapidly depending on the damper position. It is particularly noticeable in the bass notes when using partial pedals (and also with keyboards sending variable key release velocity),
- *Damping duration* (efficiency of the dampers),
- *Last damper*: all keys with MIDI note number greater than this value have no damper,
- *Mute*: makes the dampers more or less press onto the strings,
- *Key release noise*,
- *Sustain pedal noise*: “whoosh” when all dampers rise together, as well as when they fall.

11.2 Mallet bounce

This feature is particularly interesting for the chromatic percussion instruments, including the cimbalom.

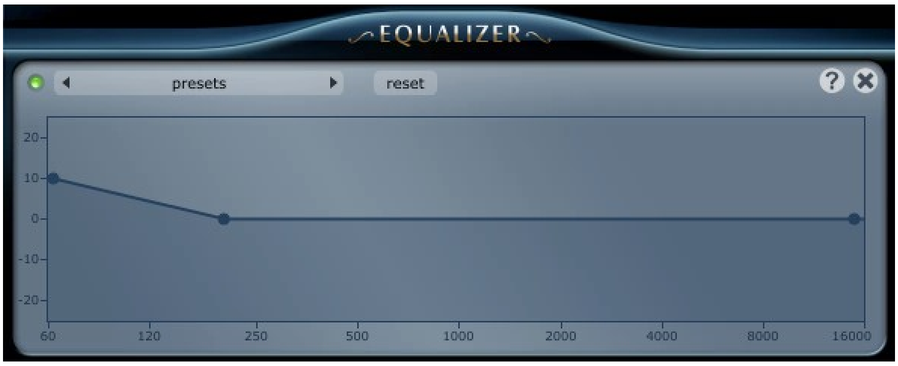


You can adjust the way the mallet bounces on the bar (or on the cimbalom strings):

- *Initial delay*: adjust the delay for the initial bounce
- *Velocity sensitivity*: the higher the sensitivity, the longer the first bounces at high velocity (the "drop height" has increased)
- *Delay loss*: adjust the amount of delay loss from one bounce to the next one
- *Velocity loss*: adjust the amount of velocity loss from one bounce to the next one
- *Humanization*: adjust the random variation of all these parameters.

11.3 Equalizer

The *equalizer* works in pre-processing (modifying the model *before* computing sound). The fact that it works in pre-processing allows automatic *volume compensation*: for example, when increasing the medium spectrum, it will increase the medium frequencies in each note while keeping the natural balance across the keyboard. In other words, the middle notes will not get suddenly louder than the other ones. Another advantage of pre-processing is that it allows very fine variation in the EQ curve, unlike on a standard 3 band EQ. You can add (click) or remove (double click) control points and modify the curve by dragging them with the mouse.



11.4 Effects

The effects panel lets you chain three effects that can be switched if wanted.

The effect menus allow you to select among the following effects: *Tremolo, Wah, Chorus, Flanger, Delay, Amp, Comp*.

The following controllers are shared by several effects:

- *Delay*: the length of the delay line in milliseconds
- *Depth*: the loudness variation in dB in the effect
- *Feedback*: the percentage of signal feedback in the effect delay line
- *Mix*: the ratio of the effect and the unprocessed sound
- *Mono* switch: changes the effect from mono to stereo
- *Rate*: frequency of the oscillator that modulates the effect
- *Stereo*: phase offset between the stereo oscillators
- *Sync* switch: its menu allows synchronizing the effect to the tempo
- *Tone*: simple tone control for the delayed signal.

In the *Wah* effect, the *Wah* slider itself is the direct controller of the *wah-wah* effect (right click on it and click on *MIDI* to assign it to a MIDI controller). In *Auto-Wah* mode, the *Wah* is modulated by the amplitude of the sound. Specific *Wah* controllers:

- *Sensitivity*: *Auto-Wah* is disabled when the slider is at the extreme left. The more you push it to the right, the lower the amplitude which starts triggering the *Wah* effect
- *Depth*: controls the upper limit of the frequency shift for the *wah-wah* filter.

The *Amp* effect simulates an amplifier equipped with the following controllers:

- *Drive*: amount of distortion introduced in the signal
- *Bass*: amplifier low frequencies boost
- *Midrange*: amplifier mid-range boost
- *Treble*: amplifier high frequencies boost.

The *Comp* effect is a standard compressor with the following controllers:

- *Ratio:* gain ratio input/output above the threshold
- *Attack:* the time it takes for the compressor to reduce the gain once the signal reaches the assigned threshold level
- *Release:* the time it takes for the gain reduction to end once the signal drops below the assigned threshold level
- *Threshold:* the level at which the compressor gain reduction starts
- *Gain:* the gain in the overall level after the compression.

11.5 Reverberation

A new convolution reverberation unit simulates acoustic surroundings ranging from Studio up to very long reverbs like Cathedral or Taj Mahal. It includes other types of reverbs such as Plate, Spring, Speakers, Broceliande... In **PIANOTEQ STANDARD** or **PIANOTEQ PRO**, you can even load your own reverb impulses via *Load WAV impulse* in the *reverb* menu.

The *reverberation* is controlled by the following parameters:

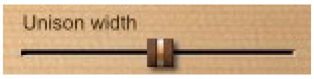
- *Mix*: the relative level in dB between reverberant sound and direct sound
- *Duration*: the length of the reverberant sound
- *Room size*: from 5 to 50m
- *Pre-delay*: the time between the direct sound and the reverberant sound
- *Tone*: a tilt equalizer that only affects the reflected sound, darker to the left, brighter to the right
- *Tail / Early reflections*: the relative level in dB between early reflections and reverberation tail.

12 Practice

And now, a few tutorials to help you understand how **Pianoteq** works. We will learn how parameters influence the sound. It is important to notice that **Pianoteq** also lets you produce new sounds which could never be obtained from a real instrument.

12.1 Tutorial 1: tuning

What is the difference between a "normal" piano and a "honky tonk" piano? Most of the difference can be found in the unisons tuning. Each note has three strings, except in the bass range. The honky tonk sound comes from the fact that these three strings are not in tune: they do not produce the same frequencies. You can obtain this effect by moving the *unison width* slider to the right in the *Tuning* panel:



Normal tuning

Honky tonk tuning

However, having the three strings perfectly in tune is not necessarily best. If you push the slider completely to the left, the three frequencies of each unison will match almost perfectly, but you will find that the sound becomes uninteresting. It sounds too "clean"; it lacks life. So, how should it be tuned? There is no universal truth in such an aesthetic matter. That is why **Pianoteq**, for the first time in a digital piano, lets you adjust the unison tuning to your own taste!

When changing *unison width*, you may also find it interesting to change the *direct sound duration*, reducing it if you have reduced *unison width* and vice versa. Observe that the closer the strings are to being in exact unison, the faster the direct sound will decay and the slower the remanent sound will decay.

Unison tuning is not the only feature that affects tuning: another question is how *intervals*, that is, the frequency ratio between two different notes, are tuned. The tuning of all the intervals within an octave is called a *temperament*.

Over the years, many different temperaments have evolved. The most commonly used today is the equal temperament, in which all semitones are equal. However, a few hundred years ago, people used many other temperaments, some of which you can choose in the *temperament* menu. Try playing them. You may find the difference not so evident when playing single notes, but much more prominent when playing chords, some of them having a nice consonant sound, whereas others having a quite harsh sound.

12.2 Tutorial 2: voicing

The main objective of piano voicing is setting the brightness of the sound by adjusting the hammer hardness. Different music may require different voicing. The *Voicing* panel contains three hammer hardness sliders. Try first moving the *mezzo* slider, which acts on the hammer hardness around MIDI velocity 64. Moving it to the left, you will obtain a softer sound, whereas moving it to the right yields a brighter sound:

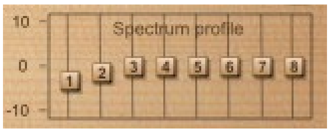
Normal setting

Bright setting

Once you are familiar with these sound changes, you can try the other two sliders acting at *piano* level and *forte* level respectively. You may also want to experiment with using the *hammer noise* parameter in conjunction with this *hammer hardness* setting. You can, for example, set the *hammer hardness* to very soft, but increase the volume of the hammer hitting the string using the *hammer noise setting*. In other words, reducing the hardness of the hammer doesn't mean that you have to lose the percussive sound of the hammer as you reduce the brightness of the sound. On the other hand, you may want to have hard hammers to make the timbre bright, but at the same time reduce the volume of the percussive knock of the hammer hitting the strings.

Another feature is *timbre* adjustment through the intensity of the individual overtones, which can be partially performed on a real piano by shaping or needling the hammers.

- Try moving the overtone sliders one by one in the *spectrum profile*, starting with the first overtone, also called the fundamental.
- Experiment by increasing the eighth overtone by 15 dB. A funny sound, isn't it?
- Next, try some more global shaping, raising or lowering, for example, the first three overtones:



Voicing is not independent from tuning, for shaping the sound during tuning can be considered as voicing. Do you want to obtain longer decay? Then you can:

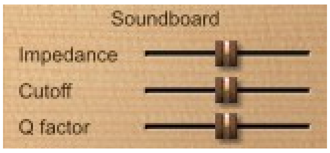
- Act directly on tuning by reducing the unison width in the *Tuning* panel,
- Act indirectly on tuning by increasing the direct sound duration,
- Act on design parameter by increasing the soundboard mechanical impedance in the *Design* panel.

12.3 Tutorial 3: soundboard design

Soundboard impedance plays a crucial role in piano design. What is the soundboard *mechanical impedance*? When a periodic force is applied to the soundboard, the wood oscillates with a certain velocity at the same frequency as the applied force. The soundboard impedes (resists) with its inertia, elasticity and resistance: this is the mechanical impedance, which has a ratio of *force / velocity*.

Typically, a high impedance results in a long sound because the energy is only slowly transmitted from the strings to the soundboard, and vice versa. High impedance yields long but weak sounds whereas low impedance yields strong but short sounds. Hence piano manufacturers have to find a compromise between sound level and sound duration.

With **Pianoteq's** solution, you are free to amplify the sound as much as you want. There is no more compromise. You can set the impedance, adapting it to the sound duration that you want:



- The first slider, *impedance*, acts globally on the impedance at all frequencies. Moving it to the right will result in longer sounds and vice versa.

The mechanical impedance depends on the frequency. The impedance is usually quite high below a certain frequency called the *cut-off frequency*, above which it drops down with a slope called the *Q factor*: the rate at which impedance is reduced and thus the rate at which the sound decreases in length. Higher frequencies decay more rapidly than lower frequencies. Hence:

- Moving the second slider, *cutoff*, to the right will increase the cut-off frequency, and thus increase the number of high overtones that are long.
- Moving the third slider, *Q factor*, to the right will increase the impedance slope, and thus decrease the duration of the overtones above the cut-off frequency. Moving it to the left will instead allow these overtones to decay more slowly, prolonging the initial bright sound just after the attack.

Example: if you like emphasizing the sound of the strings, you can reduce the *Q factor*. Alternatively, you can increase the *impedance* or the *cutoff*.

12.4 Tutorial 4: adapting Pianoteq to your keyboard

For demanding pianists, it is of utter importance to adapt **Pianoteq** to the keyboard in the best possible way.

- **Step 1.** If your keyboard has its own velocity settings, choose the one you like the best in general.

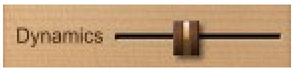
- **Step 2.** Use the Keyboard calibration assistant by clicking on the *calibration* button below the velocity window and follow the instructions step by step.

- **Step 3.** If necessary, make further adjustments of the velocity curve by moving the control nodes of the curve or adding new ones.

Further adjustments

Some further adjustments can be done that depend on the instrument you are playing:

- **Step 4.** Select the **dynamics** that you want to use, typically between 20 dB and 60 dB. Measurements done on acoustic pianos show a dynamic range of approximately 50 dB. In piano recordings, due to compression, the dynamic range is often much narrower. In **Pianoteq**, when changing dynamics, the *forte* volume remains constant while the lower amplitudes are raised or lowered.

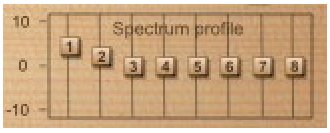


- **Step 5.** Choose the appropriate **timbre** when playing *piano*, *mezzo forte* and *forte* by moving the corresponding sliders in the Voicing panel.

You are now ready to play. Note that steps 3 to 5 can also be used to adapt **Pianoteq** to a given MIDI file in the best possible way.

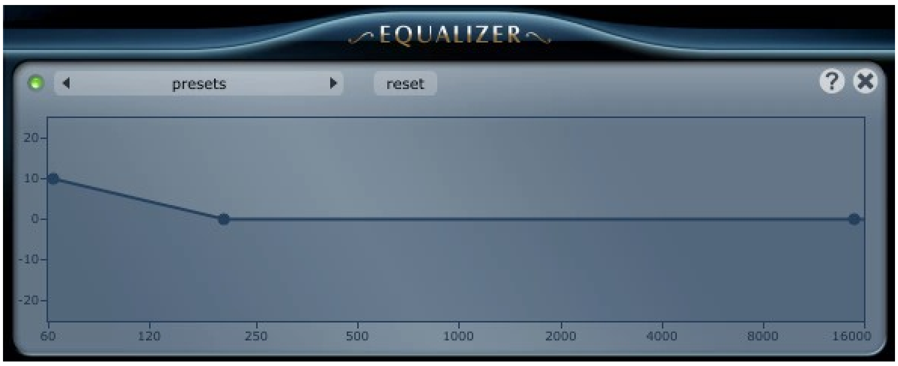
12.5 Tutorial 5: difference between spectrum profile and equalizer

What is the difference between the spectrum profile (see tutorial 2) and the equalizer? Let's look at an example. Open the *Voicing* panel and set the first two spectrum bars respectively to +6 dB and +3 dB:



What happens to the sound? **All notes** are modified: for each note, the fundamental has been increased by 6 dB and the second overtone by 3 dB. The piano sound has become globally softer because the higher overtones now have a lower amplitude relative to the fundamental and the second overtone.

Using several *undo's*, put the spectrum bars back to their original values, and now adjust the equalizer curve, increasing it from 0 dB to 10 dB when going down from 200 Hz to 62 Hz:



What happens now to the sound?

- For all notes with a fundamental **above** 200 Hz, that is, above G2 (the G just below middle C), **nothing** happens, because their overtones are all above 200 Hz, where the equalizer is a straight horizontal line.
- For notes **below** G2, **the first overtones** are modified according to the equalizer curve. For example, G1 whose fundamental is 98 Hz will have its fundamental frequency increased by 6 dB, whereas the other overtones remain almost unchanged (because they are above 196 Hz).

The resulting piano sound will have more bass, with an unchanged middle register and treble notes.

13 Pianoteq Pro

Pianoteq Pro is the advanced version of **Pianoteq**. It includes the following additional features:

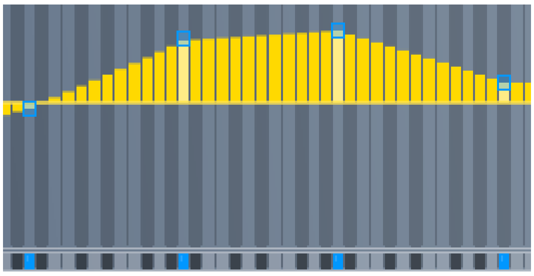
- Note per note adjustment for physical parameters: tuning, unison width, hammer hardness, strike point, string length, spectrum profile, soundboard impedance, damper position... This note per note adjustment is available in the Standard version only for tuning and volume.
- Sample rates available up to 192 kHz (limited to 48 kHz in the Standard version). Be aware that a high sample rate will generate a massive increase of CPU load.

13.1 Note Edit

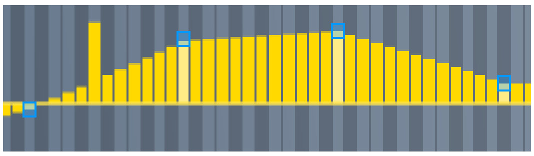
The *Note Edit* (note per note adjustment) of parameters is a very powerful tool that lets you adjust the chosen parameter for each note.

You access the *Note Edit* window by clicking on the *Note Edit* button or by double clicking on an "editable" slider. You can drag the Note Edit window anywhere on your screen and open several new windows, allowing you to work on several parameters at the same time as you can see in the picture above, where *Unison width* and *Direct sound duration* are being adjusted.

Observe the *handles* that let you perform some more global changes on the curve. These handles are located on specific *control notes* that you can select/unselect by a double click on the *control rail* below the graphic. These control notes are shared by all parameters except the special case of the spectrum profile which is described in the next section. For fine tuning, press the *Shift* key while moving a point of the curve.



Clicking outside a control note lets you modify any other note individually.



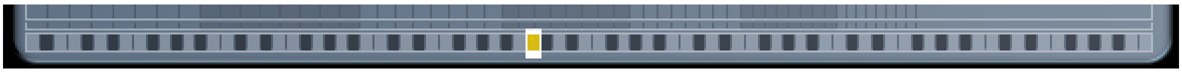
Convenient tools are provided that allow you to modify a given shape: *random*, *smooth* and *rescale*. Click and drag the mouse around the button to vary the degree of the effect (see also the tips that are provided on the interface). The *reset* button resets all parameters to the saved settings of the preset (contained in the fxp file on the hard drive).

13.2 Spectrum profile

The Note Edit of the *Spectrum Profile* works a bit differently from the other parameters, for you can adjust **each** overtone for **each** note! You can access it by a double click on any of the spectrum profile sliders.

Overtones can be modified individually, but also in different combinations called *harmonic*, *comb*, *major*, *octave*... Various draw modes named *simple draw*, *haircut* and *fill only* are also provided. All these features are grouped in the same menu on the right, labeled *simple draw* at first access.

The spectrum profile has its own set of *control notes* that you can select/unselect by a double click on the *control rail* below the graphic. They are independent of the control notes used by the other parameters.



Outside the control notes, the spectrum profile is linearly interpolated, and you can observe the intermediate values by clicking on the corresponding note on the control rail.

13.2.1 Example 1

If you set a single control note and increase its third overtone by 6 dB, all of the notes will have their third overtone increased by 6 dB:

With a single control note...

... all other notes are modified in the same way.

13.2.2 Example 2

Here — starting with a *reset* to clear everything — since we wanted only the middle C to be modified, we added 2 control notes on each side to prevent the interpolation from "propagating" to the other notes:

With three consecutive control notes...

... you can alter only the middle note if you want to prevent your edit from spreading to the notes above or below it.

13.2.3 Example 3

In this last example, we modified the middle C and the C below, and we observe how the intermediate notes are interpolated:

Profiling the middle C...

... and the C below ...

... results in interpolated values for the F between.

14 Appendix: temperaments construction

`MATLAB` programs for some Pianoteq built-in temperaments[7]. Inputs are equal tempered frequencies `f` (which may be stretched) and corresponding `MIDI` numbers.

```
%-------------------------------------------------------------------
function f = pythagore(f,MIDI)
%-------------------------------------------------------------------
delta = 3/2/2^(7/12);
ratio = delta.^[-3 -8 -1 -6 1 -4 3 -2 -7 0 -5 2];
f = f.*ratio(rem(MIDI,12)+1);
%-------------------------------------------------------------------
function f = zarlino(f,MIDI)
%-------------------------------------------------------------------
ratio2C = [1 25/24 9/8 32/27 5/4 4/3 45/32 3/2 25/16 5/3 16/9 15/8];
ratio = ratio2C./2.^((0:11)/12);
ratio = ratio/ratio(10); % leaving A unchanged
f = f.*ratio(rem(MIDI,12)+1);
%-------------------------------------------------------------------
function f = mesotonic(f,MIDI)
%-------------------------------------------------------------------
q = 5^(1/4);
ratio2C = [1 5*q^3/16 q^2/2 4*q/5 5/4 2/q 5*q^2/8 q ...
           25/16 q^3/2 4*q^2/5 5*q/4];
ratio = ratio2C./2.^((0:11)/12);
ratio = ratio/ratio(10); % leaving A unchanged
f = f.*ratio(rem(MIDI,12)+1);
%-------------------------------------------------------------------
function f = welltempered(f,MIDI)
%-------------------------------------------------------------------
q = max(real(roots([1 0 0 2 -8]))); a = (128/q^5)^(1/7);
ratio2C = [1 a^2*q^5/16 q^2/2 a^4*q^5/32 q^4/4 2/a a*q^5/8 q ...
           a^3*q^5/16 q^3/2 4/a^2 a*q^4/4];
ratio = ratio2C./2.^((0:11)/12);
ratio = ratio/ratio(10); % leaving A unchanged
f = f.*ratio(rem(MIDI,12)+1);
%-------------------------------------------------------------------
function f = werck(f,MIDI)
%-------------------------------------------------------------------
ratio2C = [1 256/243 1.1174 32/27 1.2528 4/3 1024/729 1.4949 ...
           128/81 1.6704 16/9 1.8792];
ratio = ratio2C./2.^((0:11)/12);
ratio = ratio/ratio(10); % leaving A unchanged
f = f.*ratio(rem(MIDI,12)+1);
```

[7] Some of these temperament definitions derive from “Der Piano und Flügelbau, Herbert Junghanns, Verlag Das Musikinstrument Frankfurt/Main, 1979”

15 Special acknowledgements

15.1 Instrument providers

- Michel Armengot, France (electric piano CP-80)
- Paul Badura-Skoda, Austria (pianoforte Walter)
- Robin Bigwood, UK (harsichords Grimaldi, Blanchet)
- Olivier Cussac, France (Rhodes MK1, Wurlitzer 200A, Clavinet Hohner D6)
- Luigi Gaggero, Italy (Cimbalom Balázs Kovács)
- Haendelhaus, Germany (pianoforte Schmidt)
- Monique Niebisch, France (grand piano Erard)
- Orchestre du Capitole de Toulouse, France (celesta, glockenspiel, marimba, xylophone)
- Gilbert O'Sullivan, UK (grand piano Bechstein)
- Daniel Parisot, France (grand pianos Fazioli, Steinway)
- Heinz Preiss, Austria (pianoforte Schöffstoss, Schantz, Graf)

15.2 Recording engineers

- Luc Filaretos (Studio le Graal, France)
- Laurent Minh (Ginkgo, France)
- Herwig Preiss (Austria)

Warm thanks to our beta testers, who helped us greatly in improving our instruments. Without their intensive participation, their constructive criticism and enlightening advice, **Pianoteq** wouldn’t have become the enjoyable instrument which you are playing.

Many thanks also to our customers and distributors for their engaging support and all others who supply us with valuable opinions and ideas.

Company

MODARTT is a company that develops and provides software, hardware and consulting services for artistic and technological applications. MODARTT also supports the KIViR project (Keyboard Instruments Virtual Restoration), offering digital restoration of historical keyboard music instruments in museums. Please visit our website www.pianoteq.com for further details.

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