Exhibit message

The acoustic piano is both a string and a percussion instrument. A complex series of levers from the key to the string allows the piano to respond to the player's slightest touch.

Quick Fact

'Piano' is actually an abbreviation for *pianoforte*. 'Pianoforte' comes from a combination of the words *piano* meaning 'soft' and *forte* meaning 'loud'. The pianoforte was so named because one of the most noticeable innovations of the piano was that the volume of each note depended on how firmly or softly the key was struck. The predecessor of the piano, the harpsichord, played each note at the same volume no matter how hard the keys were struck.

Graphic panel text

Is the piano more like a guitar or a drum?

Upright acoustic piano

The piano has strings, **like a guitar**. But instead of being plucked, the strings of the piano are struck with a hammer, **like a drum**.

For every piano note's key, a series of levers makes a hammer strike a string. This complex action transmits the player's slightest touch to the strings.

Digital piano

In a digital piano, sound comes from an electrical signal rather than a vibrating string.

Want to know more about how pianos work?

The pianoforte (abbreviated to 'piano') was invented by Bartolomeo Cristofori in 1709. The piano was vastly superior in terms of variability of response to touch to the harpsichord. The harpsichord basically reacts the same no matter how the key is touched. The main innovation that allowed the piano to vary the way a note could be played was that of the **hammer action**.

For every piano note's key, a series of levers makes a hammer strike a string. This complex action transmits every slightest nuance of the player from the key to the string.

Digital pianos are basically designed to be functionally equivalent to standard pianos, for example, they carry the most of the standard pedals of an acoustic piano. Aurally, however, digital pianos have some limitations, such as implementing the harmonic tones of an acoustic piano. In addition, digital pianos generally cannot implement the touch of a standard piano exactly. However, manufacturers continue to develop this technology and, for both tone and touch, quality and cost are associated.

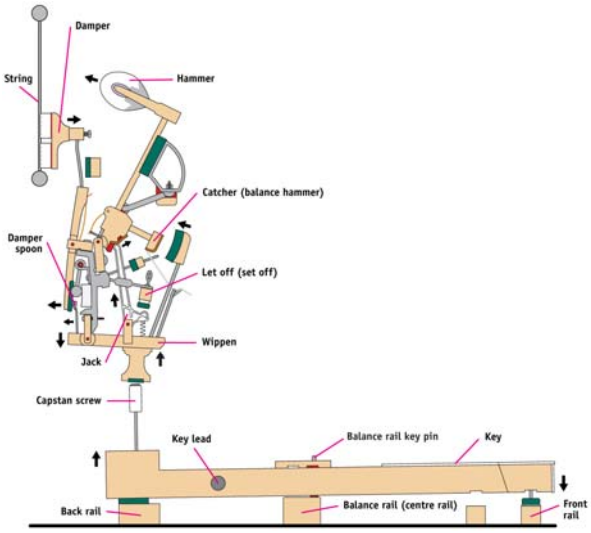
The main difference between a traditional, acoustic piano and a digital piano is that, instead of a series of levers causing a hammer to strike a string, the depressed key of the digital piano strikes computer sensors. In the digital piano sound doesn't come from the physical movement (vibration) of a string, but from a continuously changing (analog) or converted stream of numbers (digital) electrical signal.

Digital pianos have many mechanical mechanisms to make them behave as closely as possible to acoustic pianos. For example, good quality digital pianos can have wooden weighted keys to make them feel more like acoustic pianos, although they are generally still not as heavy as the hammer keys of acoustic pianos. In addition, in order to create

the responsiveness to differences in the player's touch of the acoustic piano, digital pianos have mechanisms to reproduce the acoustic piano's hammer **free fall**.

Extra for experts

How does the **acoustic upright piano** key action work? What happens when a player presses a key softly or with greater force, slowly or quickly?



1. **Key**: The player depresses a white or black key to play the corresponding note. The key moves like a 'see-saw'. When it is pressed **down** the other end of the key moves **up**. This activates all the levers inside the piano action and causes the hammer to hit the string.

   Balance rail (centre rail) and balance rail key pin: This is the pivot point of the key.

   Key lead: Balances and weights the key, making it easier or harder to depress. Lower notes have longer keys, and more leads make them feel the same weight as the shorter keys of higher notes.

2. **Capstan screw**: As the key is depressed the capstan screw is pushed up into the lower piece of the wippen (called the 'sticker').

3. **Wippen**: The wippen attaches to three actions – the **jack** which pushes up on the hammer, the **damper spoon** and the **back check**.

4. **Jack**: The jack is pushed up by the wippen, and in turn pushes the padded butt of the hammer. The wippen continues to push the jack up into the hammer until the jack slips off the hammer butt and the hammer continues the rest of the way on its own inertia and momentum. This allows the hammer to bounce freely or 'escape' and is the key to the great sensitivity of the action. The arc and centripetal force of this action means that as a key is hit harder its weight actually increases, and therefore hits the stings differently.

5. **Hammer**: The hammer is the component that actually strikes the piano strings. It is pushed by the jack during a full stroke and pushed by the catcher during light or rapid strokes. There is one hammer and string for every key and note.

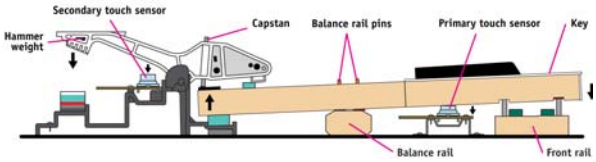
6. **Let off (set off)**: When the hammer is almost at the string, the let off (set off) catches the heel of the jack and, as the wippen keeps moving upwards, the jack pivots and slips off the hammer butt. The hammer continues the rest of the way on its own inertia.

7. **Catcher and back check**: The catcher is caught by the back check and remains there while the key is depressed. The catcher pushes the hammer during light or rapid strokes (once the jack has slipped off the hammer butt).

8. **Damper spoon and Damper**: When the key is half pressed, the wippen pushes the damper lever and spoon to lift the damper off the string so that the string can vibrate freely. When the damper is on the string it dampens the sound by holding the string steady to stop it vibrating.

9. **String**: The string vibrates to cause the sound of the note. Longer, looser, thicker strings create lower notes.

How does the **digital piano** achieve similar results to the acoustic piano?



1. **Primary touch sensor**: Tells the computer that the key has started travelling
2. **Secondary touch sensor**: Tells the computer that the key has stopped travelling

   The computer then measure the time interval and calculates the difference between the two sensors and extrapolates this to the appropriate volume and corresponding timbre in accordance with touch of key (to give similar response as an acoustic piano)
3. **Hammer weight**: This acts in the same way as the hammer in a acoustic piano reacts once 'escapement' has occurred. This enables the digital piano to mimic the responsiveness and sensitivity of the acoustic piano.

Further information

We would like to give our special thanks to Christopher Davis from Davis Wheeler Music for information on the action of the acoustic and digital piano, and to Yamaha and Davis Wheeler Music for their generous donation of the digital and acoustic piano key actions.

Pianos – General:

✪ Wikipedia: *Piano* http://en.wikipedia.org/wiki/Piano

Upright piano action:

✪ *How an upright piano functions*. The Blue Book of Pianos website. http://www.bluebookofpianos.com/acton.htm

✪ Concert Pitch Piano Services (image of the inner workings of one note in an upright piano) http://www.concertpitchpiano.com/UprightActionModel.html

Grand piano action – in action!

✪ *Music Play.com*. K W Land, 1998. http://www.musicplay.com/action/action.html

Digital pianos and electronic keyboards:

✪ *Keyboard: Electronic Keyboard Basics*. Indie-Music.com, 2002. http://www.indie-music.com/modules.php?name=News&file=article&sid=1630

✪ Wikipedia: Digital piano - http://en.wikipedia.org/wiki/Digital_piano