Goldmund White Paper

MECHANICAL GROUNDING

Since the Goldmund T3 tone arm and the Goldmund Reference turntable, all Goldmund products have been studied with extreme care for their mechanical parameters. Our lines of amplifiers and preamplifiers are mechanically built using the same principle:

The Goldmund Mechanical Grounding principle.

Developed by the Goldmund research engineers by analogy with the electrical grounding laws, this technology aims to a perfect suppression of spurious mechanical resonance in audio components by connecting rigidly their structure to a perfect mechanical ground: the earth. Just like electrical grounding, experiences have proven that only earth can sufficiently absorb vibration potential to secure the vibration level to zero.

An Interesting Experience

To easily explain the principle of the Mechanical Grounding, Goldmund usually presents the example of the electrical razor.

When you hold an electrical razor, you perfectly feel the vibration of the unit. If you want to cancel those vibrations, you may try to damp it by applying soft, absorbing material around the razor. But wrapped in rubber or soft towels, the razor still vibrates, even if you do not feel it as strongly: the damping isolates the vibration, it doesn't suppress it. Now, if you gently press the wrapped razor on the side of your tub, and the tub is strongly sealed t the building, attached itself to earth, the vibration will be greatly attenuated, like "evacuated" to the earth by the rigid connection you established.

An Electrical Analogy

This phenomenon is absolutely similar to the electrical grounding. When part of an electrical component is floating, the noise, hum and DC offset is not stable. The chassis “vibrates”. By coupling the chassis to the earth, you stabilize it and avoid potential vibrations. The thicker the wire that connects earth to the chassis is, the better the grounding will be.

When the chassis is so grounded, any potential generated inside the unit, being relative to ground, is fixed, and the signals are much cleaner. In a similar way, small mechanical movements (such as the cartridge following the groove) are much cleaner in a mechanically grounded component. Drivers in a speaker do not loose part of their energy to make the enclosure vibrate; they have an “absolute fixed reference” and can provide much higher dynamics.

An Optical Analogy

To properly evacuate vibrations, the connection between the various elements of the mechanical structure must have certain properties. Vibrations can be “reflected” from one material to the other if some precise characteristics of the materials are not respected.

The optical analogy with light transmission in an optical system produces very interesting similarities:
When light travels from the air into a piece of glass, part of the light is reflected. Between two pieces of glass, the proportion of reflection depends on the surface and on the optical characteristics of the two types of glass. If the surface is finely polished and the two pieces are made of the same kind of glass (same refraction factor), the reflection is minimal. Light travels better from slow material (high refraction, slower propagation speed of the light) to fast material (low refraction).

In mechanics, vibrations also can be reflected and not transmitted depending of the surface and kind of material. Instead of refraction factor, mechanical engineers are talking about mechanical impedance. As for optics, a vibration is easily transmitted from a slow material (soft, with slow propagation speed), to a fast material (hard, fast propagation speed). The Goldmund cone material has been designed using this analogy, including the selection of its angle (the “limit refraction angle” in optics).

The Coloration in Audio Components

The intensive study of several kinds of audio components made by the Goldmund engineers have proved that most of the audio sonic colorations are due to mechanical vibrations.

If this effect is quite evident for components like speakers or cartridges, the recent research made by Goldmund on electronics mechanical vibrations is less known.
As for a speaker enclosure that “vibrates”, generating frequency emphasis by re-emission, and transient blurring by energy absorption, mechanical parts of an electronic circuit, including the components themselves, can vibrate and generate spurious signal and coloration (usually by microphonic effect).
The effect is very audible in electronic tubes. When the metallic parts vibrate (and they do when the voltage applied is modulated by the signal), the resonance of the electrodes themselves becomes audible, increasing decay time of the signal (the nice “spatial effect” of tubes), and coloring the signal in some frequency bands depending on the mechanical construction of the tube (difference between a “good” and a “bad” tube).

The effect has also been detected in the past years in capacitors. The so-called "sonic fingerprint" of capacitors is mostly due to internal vibrations generated inside the capacitors between foils. The stronger the mechanical assembly is (film and foil Vs electrolytic), and the more "euphonic" the material resonance is (polystyrene Vs polycarbonate), the "better" the capacitor is for audiophiles. Thicker dielectric (high voltage) sounds better than finer. Solid aluminum electrolytic components are used rather than liquid vibrating electrolytic ones, etc…

In an amplifier, the output transistors also generate high levels of vibrations and the Goldmund amplifiers have started isolating those mechanically from the input circuitry which can capture the vibrations by the microphonic effect of input transistors.
Mechanical grounding in speakers and turntables can also be improved by a more careful application of the same principles.

A Good Mechanical Grounding Design

Even if most of the technologies developed by Goldmund to mechanically ground its line of products are patented, the general principles to apply in order to obtain a good coupling with the earth are well known and used in other industries like in the big machine tools construction (a very important industry in Switzerland).
Again, they can be very easily deducted from the electrical and optical analogies.

First the mechanical coupling between the component and the earth must be very rigid (thick wire) otherwise the coupling material itself can resonate and act as a filter (un-damped cones). It will also transfer less energy (fine wire) and the evacuation of vibrations won't be perfect.
More, vibrations do travel better from slower material to faster material as we have seen. Proper selection of materials going from the slower to the faster ensures perfect evacuation and some limitation of vibration "re-entry" in the component. This effect has been called by Goldmund the "Mechanical Diode" effect. As seen in the optical analogy, the angles of the different mechanical parts attached together have some effect on this capability of directionality. It is interesting to notice that the cone is the shape used to represent a diode in electronics…

Conical feet, mechanical diodes, strong and heavy materials for all chassis and evacuation pods, damping of the materials where the vibrations are transmitted are obvious in the design of Goldmund products.

The Sonic Results of Mechanical Grounding

The two significant effects of a good Mechanical Grounding on sound are:

- Better dynamics.
- Lower coloration.

We have explained above that the Mechanical Grounding of any component is stabilizing its energy level relative to earth. Mechanically grounded speakers will use all the energy to move the cones in relation to the building (i.e. the listener). All available energy will be transformed into acoustical energy. Dynamics will be much improved. The same effect can be expected from a similar Mechanical Grounding design for an amplifier. Less internal resonance will produce a cleaner signal with a much more dynamic impact of the transients.
The lower coloration is less easy to detect for an inexperienced listener, but it can be the most important benefit of a good Mechanical Grounding design. Lower coloration is what makes an

audio component transparent and detailed. It allows a better distinction of subtle nuances and is also the key to good spatial phase accuracy.

Considering the level of improvement Goldmund has been able to achieve by only implementing Mechanical Grounding in its components, it should be no further doubt that components not built taking it into account cannot be sonically accurate.

Bibliography:

- *Daniel J Inman : Engineering Vibration*
- *James F.Doyle : Wave Propagation in structures*