# The sound exposure of paintings during transport

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## Introduction

Various sound sources can be observed during art transport. In the case of trucks, the large walls and the floor can act as sound radiators. In airplanes sound amplified by the walls of the tube and the sound emitted from the turbines can impact on paintings. The only means of protection from the possible adverse effects of this exposure are the crates the paintings are packed in. Generally, it is distinguished between airborne sound and structure-borne sound. When sound waves travel through the air and reach the wall of a crate, the wall begins to vibrate. These vibrations travel through the crate structure and internal packing where the waves will eventually hit the artwork. Since the material structure of paintings and objects can be much denser, it is possible that the sound waves are converted into structure-borne sound and the objects itself begin to vibrate. This effect depends on the wave lengths. This is vibration in addition to the vibration generated by the motor of the transport vehicle.

## Test objects

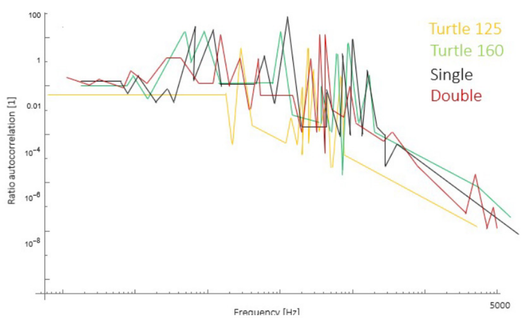
TURTLE 160

TURTLE 125

Double walled wooden crate

Single walled wooden crate

## Results




The diagram shows the ratio between the measured and averaged sound pressure levels inside and outside the crates in the frequency domain.

**Note:** The gap between lid and corpus was plugged with sealant to ensure the wooden crates perform similar to the crates made of composite material (i.e. the green Turtle crates).

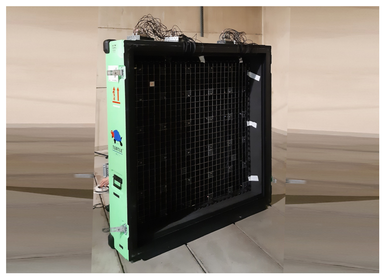
## Sound Measurements

In order to find out how effective transport crates currently available protect paintings from sound, experimental tests were carried out in a reverberation chamber.

### Excitation

Dodecahedron loudspeaker produced a diffuse sound field (white noise) over a wide frequency range up to 10.000 Hz. The amplitude distribution and frequency range were chosen according to [1].

### Response

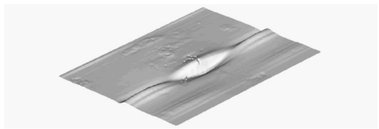


Inspired by standard methods for measuring sound insulation in buildings, the sound pressure level (SPL) was measured inside the box with 36 microphones and on the outside with two rotating microphones.

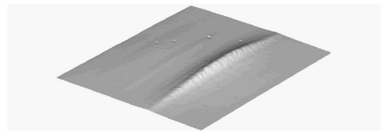
## Effect of Sound on Paintings

The response of a painting to sound depends on its structure on micro, meso and macro scale. KOEHLER also shows that that plane sound waves, spherical waves and diffuse sound do excite plate structures like paintings at their natural vibration modes, which is potentially damaging [2].

Research by the author (of this poster) revealed that each painting, depending on size, stretching, materials, condition, etc., has a very specific vibration behaviour [3]. Restoration and conservation measures can also alter the natural frequencies and the natural vibration mode as the following images show.



Before restoration, 1st nat. freq. 1,6 Hz



After restoration, 1st nat. freq. 3,6 Hz

## Summary and Conclusion

The results of this study show that crates made of composite material are quieter on the inside than the wooden crates. The gap between lid and body in wooden crates contributes significantly to a 'noisier' environment inside the crates. This increases the risk of additional structure-borne sound, i.e. resonance effects, impacting negatively on the painting.

This shows that the painting's response to sound is dependent on its specific vibration behaviour as well as its mechanical structure at different scales. Further investigation is required how sound affects paintings and if additional sound isolation is advisable.

**Literature**

[1] C. Thomas, H. Scheel: Kabinenakustik in der Luftfahrtforschung, DocumentID 480290, Deutscher Luft- und Raumfahrtkongress, 2018.

[2] I. Köhler.: Modellierung des Einflusses von Luft- und Körperschall auf die Anregung von Gemälden, BSc-thesis, TU Berlin, 2021.

[3] K. Kracht.: Die Untersuchung des Schwingungsverhaltens von Ölgemälden in Abhängigkeit der Alterung, Dissertation, TU Berlin, 2011.

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