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Editorial

Special Issue on Mechanics, Dynamics and Acoustics of Musical Instruments

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The mechanics, dynamics and acoustics of musical instruments concern scientists from different fields, such as physics, mechanics, acoustics, psychology, and music, as well as musical instrument manufacturers, who use these factors to not only understand and explain the phenomena that take place inside and outside of musical instruments as a result of the propagation of sounds, but also those related to the perception of the sounds produced by them.

This Special Issue collects and presents groundbreaking research on complex aspects of musical instruments based on numerical and/or experimental analyses, in combination with modern techniques for investigating traditional and new materials used for musical instruments. A total of six papers in the fields of the vibro-acoustic evaluation of a carbon fiber bouzouki, static and vibrational behaviors of the cello bridge, acoustic analysis and psycho-acoustic evaluation of violins, the modal behavior and the sound pressure level of a new guitar based on mechanical metamaterials of top plates and experimental and numerical dynamic analysis of triangles are presented.

Brezas et al. [1] showed that wood offers superior acoustics to those of the bouzouki compared to composites based on carbon fiber, with these results mainly proven via psychoacoustic tests, but the use of composites for certain component parts could be a good solution. Thus, the vibration analysis results indicate that the carbon fiber bouzouki behaved acousto-dynamically, being similar to wood, having frequencies of up to 1000 Hz. However, in order to optimize the bouzouki manufacturing process by minimizing production time and cost, the wooden bridge and bars can be replaced with carbon fiber. Starting from the hypothesis that different models of the cello product favor different sounds, Lodetti et al. [2] studied the influence of cello bridge geometry on frequencies' response function. Thus, it was found that the first two modes were not particularly affected by the leg modification, while in the frequency range 1500–3500 Hz, aside from the differences in the locations of the peaks, a decrease in magnitude is clearly noticeable from the model reference.

Nastac et al. [3] used two methods to evaluate the acoustic quality of violins—one was based on signal processing and the other was based on psycho-acoustic evaluation. From the perspective of acoustic signal processing, this study presents a set of acoustic models associated with violins with modified geometric parameters. From the point of view of psycho-acoustic evaluation, the study highlights the variability in acoustic impressions according to age, gender and musical experience, as well as the position of the sequence analyzed during the investigation.

Lercari et al. [4] studied the effects of mechanical metamaterials on guitar sound, as well as structural integrity under string tension and tone production. Thus, the novelty of the study consists in the simple use of guitar plates with a pattern of elliptical holes cut on the inside of the top plate, without penetrating the sound board. The effects of using these mechanical metamaterials have proven to be beneficial in terms of increasing the bearing

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capacity, but as far as the sound is concerned, the results are still not consistent enough, and the authors are going to deepen their research.

Malvermi et al. [5] propose and validate a new method for evaluating violins based on an extension of the multidimensional feature space (modal parameters and energy-based descriptors), having the possibility to highlight the similarity between FRFs in the low and medium frequency ranges. Stanciu et al. [6] made a valuable contribution to the study of the triangle made of different metallic materials based on the experimental and numerical modal analysis used. The study highlighted the differences between the time and frequency response obtained for different types of bent bars: two musical triangles with the same dimensions but made of different materials, as well as two musical triangles made of the same materials but with different dimensions. The material, due to its physical and elastic properties, the sizes of the sides and the geometry of the triangle, leads to the modulation of the emitted sounds.

Although submissions for this Special Issue have been closed, more in-depth research in the field of musical instruments will continue to be developed considering both the inter-disciplinarity of the field and the current trend of diversifying the types of materials, the investigation methods used, the use of artificial intelligence and the machine learning techniques employed.

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