

Form Finding Strategies for Acoustic Optimization - *Integration of acoustics and parametric design*

Alvaro Balderrama // MID-CD

Supervision: Prof. (i.V), Dipl.-Ing. M.Eng. Daniel Arztmann, Dipl.-Ing. David Lemberski, Dr.-Ing. Winfried Heusler

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Summary:

The increasing growth of cities contributes to various environmental problems including effects on the health of its inhabitants by being exposed to high levels of noise on a daily basis. The World Health Organization presents evidence of the health damage of noise exposure and recommends threshold values above which adverse effects on human health are observed. The European Commission stated that road traffic is the dominant source of environmental noise in Europe. By the year 2050, about 70% of the world population will live in urban areas; 6,5 billion people compared to 1 billion by the year 1950 and 3.5 billion by 2015 (Heusler, W. - Advanced Façade Design and Technology, 2015).

The importance given to sustainable design has notoriously increased in the past years, as it has become an architectural trend and has shown improvements for human health, productivity and comfort, as well as development for the construction industry and the real-estate market. The development of technology has given architecture more possibilities than to only provide shelter, but to influence the health of its occupants (even if it's not intended by the designer). Some environmental conditions such as energy consumption, CO2 emissions, water efficiency, thermal comfort, wind energy, among others are nowadays well understood and regulated by international standards, local construction codes or environmental laws, but the field of acoustics, even when being deeply studied and understood, is not applied in the vast majority of architectural designs.

The main goal of this research is to establish strategies to solve architectural challenges focused on improving the acoustic environment. These methods should aid the designer to find creative geometrical solutions by providing multiple options with ease of adaptability. In architectural design the problems encountered can be complex and the exact same approach is rarely suitable for new design scenarios, reason why this research aims to create parametric models that can be interconnected to the other design processes of an interdisciplinary project. The methodology is composed by two case studies, an urban street canyon (environmental acoustics) and a music hall (room acoustics), with the objective to generate graphic representations of sound through specular reflection in order to make informed decisions on how to optimize the building geometry and materials, improving the acoustic properties of the space. The case studies were developed in the 3D modelling software Rhinoceros in combination with its parametric plugin Grasshopper, and the acoustic simulations were performed by the plugin Pachyderm Acoustic. The results present improvements in the acoustic measurements required for each case (sound pressure level, reverberation time, loudness and clarity).



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Hochschule Ostwestfalen-Lippe
University of Applied Sciences
Detmolder Schule für Architektur und Innenarchitektur
Master of Integrated Design

Alvaro Balderrama

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