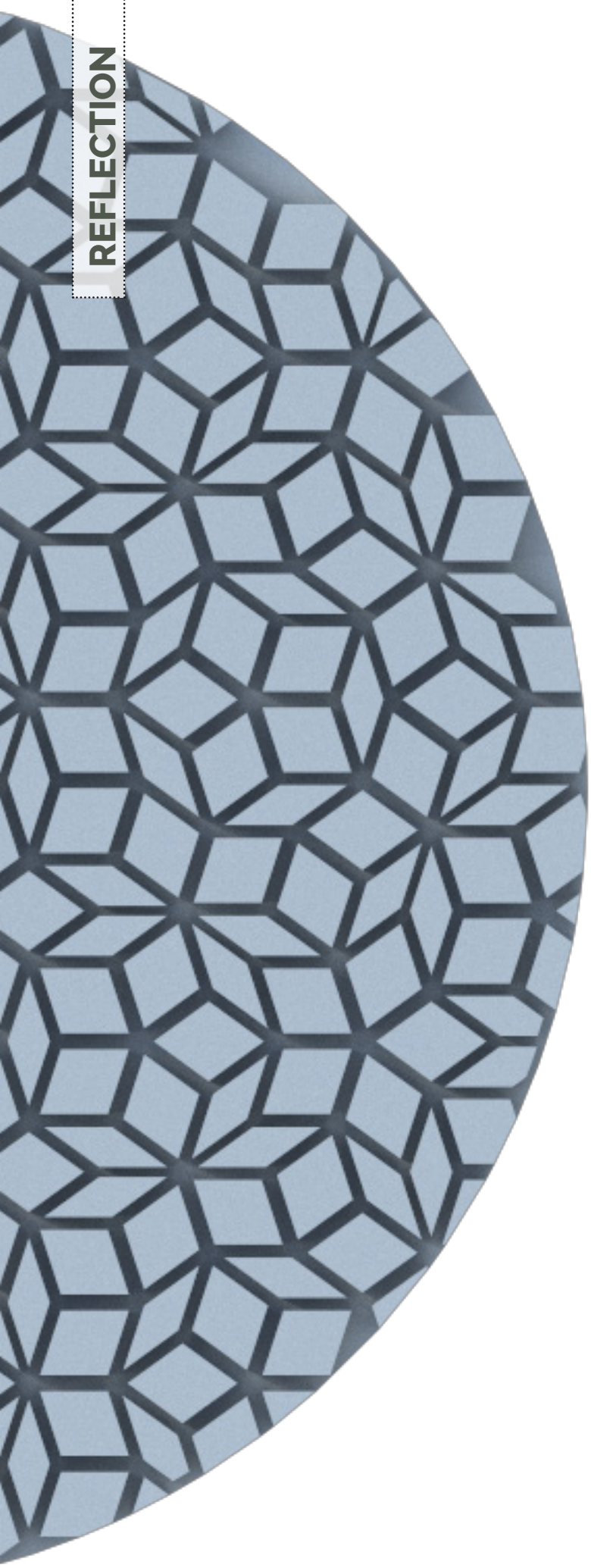

The current research is part of the Sustainable Design Graduation studio within the master track of Building Technology. The link between the focus of the graduation lab, the master track and the problematic introduced by this project is the improvement of indoor environmental quality with respect to a sustainable assembly and disassembly system, while targeting the specific needs of a preschool population. Next to that the research had to fit within two disciplines, which in this case were Climate that formed the base of the literature review and Computational design that provided the mean to produce and evaluate different design alternatives.

Considering the inherent complexity of the chosen topic the approach followed by this research tried to handle the different scales that affected the perceived sound moving from macro-geometry to micro-geometry. After formulating the working hypothesis based on previously conducted research, the initial idea was to evaluate different surface patterns and conclude upon which frequency ranges needed to be diffused, rather than absorbed aiming for improved speech intelligibility and speech privacy. However, various questions arose in the process that raised the level of complexity. To what extend should some frequencies be absorbed or diffused? What properties of the spatial geometries influence the acoustic measures? What design properties concerning preschool environment could inform the acoustic research? Can a simple surface pattern raise a similar acoustic performance to a complex one? Can the design rules of a mass-produced finite set of tiles covering a surface with reduced manufacturing cost have a comparable performance to a customized expensive solution? Can the relevant depth for scattering be minimized if certain geometrical rules are applied, accounting for reduced material resources? These are only a few of the questions that triggered this research. Considering that every design proposal aims to improve the environmental quality of its users and since the target users of a preschool population are sensitive to various parameters, a holistically approach was favoured. As far as the evaluation procedure of different surface samples is concerned, the methodology had to be revised given the available resources. Since acoustic scattering on the contrary to absorption is a topic that is under investigation only for the past decade, software for estimating such coefficients being currently under development, are computational intensive and pose limitations. Though the tools used are highly experimental, they do provide results that are thought to be trustworthy for comparison purposes.

The societal matters that influence the current project vary. Modern architecture was once based on efficient, rational, fast industrial production to provide affordable designs for the public. The target however nowadays has been shifted from the user to the investor, in that buildings are now speculative tools for users that are unknown. To that end, evaluating results of previously conducted research that are based on the analysis of users' needs and quality standards is thought to be of great importance. Moreover, the complexity of the form is occasionally increased in order to achieve higher profit. The current project tries to avoid complex digital forms and seeks for simplicity and architectural smartness, preserving the economy of means for the end users. Though it investigates both customized and mass-produced options, it argues that the same goals can be met also with low-cost alternatives, if certain geometrical rules are applied.

The current research-based practice is part of a recent discussion involving interdisciplinary experts ranging from acoustics, audiology, psychology to neuroscience that aim to analyse the effects of the acoustic environment on early childhood. Recent results stress out the vulnerability of young listeners and require a transition from measures of acoustics and noise coming from the adult world. A series of questions arise: how can brain research reveal facts on early auditory learning? and how do children perceive noise levels at preschools? In that discussion designers should undertake

a leading role by informing their design decisions to meet acoustic standards. Understanding how a 1-5-year-old child perceives the sound environment is crucial for evaluating the design choices.

The proposed materials are carefully chosen depending on their sustainability properties while considering their effect on the indoor air-quality. To minimize environmental impact, acoustic treatments need to account for recycled materials or resources that are natural or plentiful. Final products must be recyclable, reusable and/or biodegradable. Materials need to be sourced locally and waste recycling to be included during the manufacturing process. The product's packaging and the environmental impact of transportation need to be assessed. Nowadays, sustainable and smart building design apply leading-edge technologies in order to optimize space and design of lightweight structures by exploiting less resources while improving the performance of the acoustic solutions (Jiménez et al., 2017). In this context sustainability and indoor environmental quality need to be integral in the design process. Discussions about sustainability mainly focus on sustainable materials but rarely consider the entire lifespan of building components. If the design is unable to adapt to new circumstances and developments a series of problems arise. The solution to every problem begins with the acknowledgement that there is a problem. Since usually design interventions have a long-term relationship with their environment and their inhabitants' various questions arise. Could they be used for different purposes in the distant future? How might new technologies influence the user's demands? How will research results reform the preschool environment? Every environment should adapt to changing circumstances coming from the users' preferences or technological developments. With the demolition and construction sectors being major contributors of CO_2 emissions, principles of reuse and upcycling are becoming increasingly important. Each design system could allow to readjust its interface and in case of decay replacement of its components should be an option. The possible deconstruction of the building product could also be designed before its construction and should be guided by an ecologically sustainable process. To sum up, the future legacy of the design product is thought to be a central asset of the initial design.

Design can create a positive impact on people's lives and need to move beyond good intentions. Though the project aims at a design product rather than a building the previous mentioned principles are considered. Considering the health implications of a noisy preschool environment, where children are exposed to high levels of intermittent and often high frequency sound, acoustics are often overlooked during design proposals. However, more and more studies indicate that children of that age that spend most of their day in preschools are strongly affected by noise. In order to cope with it they develop strategies such as raising their voices, losing concentration or withdrawing. Recent studies show that preschool children need greater freedom to manipulate the spatial and temporal settings achieving both time with the collective as well as time alone (Lisa, 2017). In that respect the building environment needs to adjust in order to meet new standards for design and acoustic comfort. Sustainability should be therefore considered in terms of the assembly and disassembly system. This is considered crucial for a preschool environment, since it should be transformable due to the nature of its users. It should be adaptable to change rather that comply with a preconceived norm. To that end, the confluence of design and research is thought to be crucial.

Last but not least, the scientific relevance of this work argues upon the need for a workflow that allows the confluence of an interdisciplinary collaboration towards creative ways of improving the indoor environmental quality.

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