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INFORMATION, COMMUNICATION & COMPUTING

Fields of Expertise TU Graz

Source: Lunghammer – TU Graz

Kay Uwe Römer,

Information, Communication & Computing

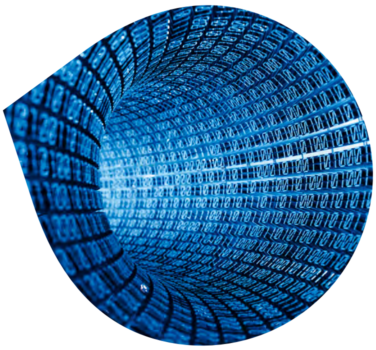
After a successful first round in 2020, this year the FoE ICC again had a tenure-track professorship to fill with a broad scope covering all areas of Information, Communication & Computing.

We received a staggering 179 applications from all over the world, including also many applications from former and current TU Graz members. The selection committee, composed of the deans, FoE leaders, and representatives of non-tenured staff of all three participating faculties as well as student representatives, had the challenging task of screening these applications and selecting the best 25 to be forwarded to three expert reviewers for a detailed assessment. Based on the reviews, the selection board invited nine candidates for interviews in early July. As part of the interviews, numerous meetings were arranged among the applicants and the institutes that would potentially host them. Impressed by the outstanding quality of these interviews, the selection board composed a short list of seven candidates, all of whom would have deserved to be offered a position. Unfortunately we had only one position to fill and were lucky enough that the top-ranking applicant accepted our offer of the tenure-track professorship. We will hear more from the winner of this competition as soon as he starts his work at TU Graz. With the application deadline set for the beginning of May and the shortlist being approved by the Rector in mid-July, the whole selection process was completed in a record time of just two and a half months. I am grateful to the selection board who were faced not just with a huge amount of work due to the large number of applicants, but also with the difficult task of comparing applicants from very different backgrounds – from mathematics and computer science to electrical engineering. A special thank you goes to Stephanie Mühlbacher from F&T House, who was instrumental in the organization of the whole process, paperwork, and communication.

In this edition of TU Graz research Christian Adams, professor at the Institute of Fundamentals and Theory in Electrical Engineering, gives us some insights into his research. Enjoy reading!

Christian Adams

Acoustics and Environmental Noise

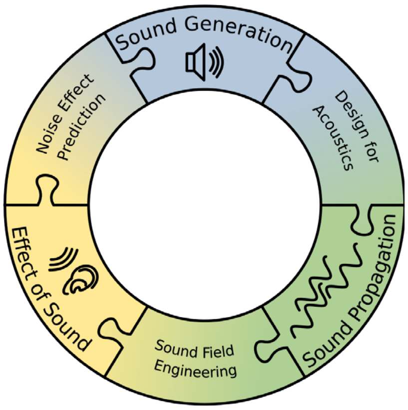


BMK endowed professorship on noise impact research:
Competence Center for Traffic Noise and Health

Noise is a sound that an individual perceives as disturbing. In 2019, a third of Austrians stated that they were disturbed by noise at home and 48.5% said traffic was a significant source of noise. Across Europe, around 140 million people are exposed to harmful noise, with road (113 million), rail (22 million), and air traffic (4 million) being the primary sources of noise. Around one million people are affected by industrial noise. In addition, high noise pollution also threatens wildlife.

The Professorship for Acoustics and Environmental Noise is an endowed professorship and receives five years of funding from the Austrian Research Promotion Agency (Österreichische Forschungsförderungsgesellschaft mbH) and industry partners. Together with ÖBB-Infrastruktur AG, Linz AG Linien, Wiener Linien GmbH & Co KG, AVL List GmbH, ASFINAG, KTM F&E GmbH, and The Austrian Airports Association, we focus on transportation noise and its effects on humans. In the long term, we are opening up the application field of urban noise, and in particular noise in residential areas, with the goal of achieving a quiet city.

Figure 1: The Noise Effect Cycle – a holistic concept for noise impact research.
Source: Author's own illustration



THE NOISE EFFECT CYCLE

We aim to control noise as close to the source as possible. Ideally, unwanted noise should not be generated at all. We achieve this through Design for Acoustics of sound sources. Then, we need to understand how sound propagates into the environment to develop efficient noise protection measures through Sound Field Engineering. Finally, we want to understand better how noise affects people, including the health consequences of noise exposure. This knowledge will be fed back into the design of noise sources through Noise Effect Prediction. The result is a positive cycle that reduces the noise at the source, controls propagation and minimises harmful effects on humans – the noise effect cycle (Figure 1).

DESIGN FOR ACOUSTICS

Sound-absorbing materials can reduce noise from sound sources, but must be designed correctly during product development to be effective. These materials can be tested in an impedance tube. Figure 2 shows the setup and the absorption coefficient of acoustic foams, which is the ratio between the absorbed sound power and sound power at normal incidence. The red solid line (μ) and the black dashed line ($\mu \pm \sigma$) represent the mean and one standard deviation from mean, respectively, while the grey lines illustrate the data set consisting of 980 individual measurements. Some data variation is intended and can be controlled through material type, density, or thickness. But a significant amount of variation is caused by the measurement procedure itself, such as the cutting technology and cutting precision of the specimens. We developed a machine learning framework that can distinguish between these variations and explain which frequencies have been decisive. Such knowledge is essential to selecting appropriate acoustic materials during product development so that our investigation can help to design acoustically optimised products more efficiently. >

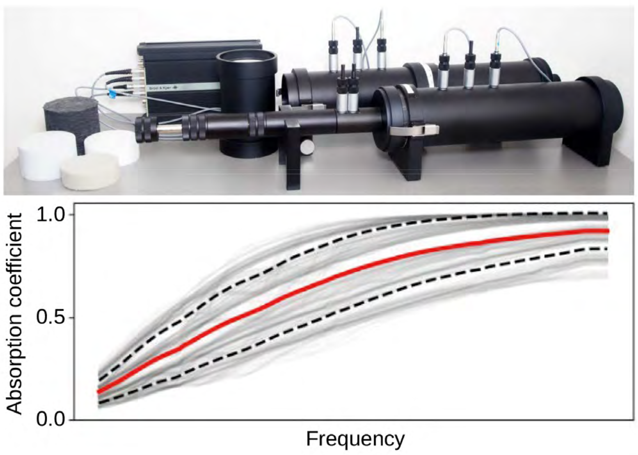


Figure 2: Impedance tube for sound absorption measurements (top).
Source: Gerald Maurer
Absorption coefficients versus frequency with several parameter variations (bottom).
Source: Alfonso Caiazzo

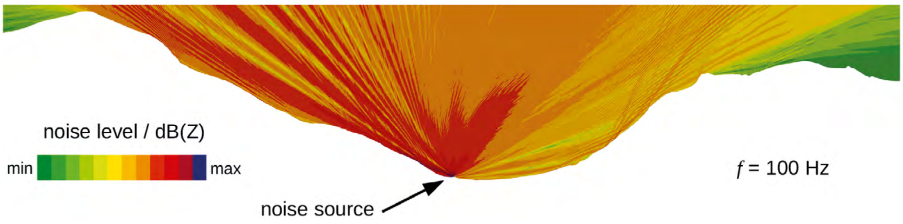


Figure 3: Sound level distribution at a frequency of 100 Hz in a valley near Wald am Schoberpass.

Source: Florian Kraxberger

SOUND FIELD ENGINEERING

Sound propagation into the environment must consider all physical effects to correctly predict noise, particularly at low frequencies (approximately 20 Hz–200 Hz). We research discontinuous Galerkin methods to efficiently and accurately predict noise immissions in large domains such as the environment. Our goal is to understand better how sound waves propagate into the environment and to predict the effects of noise reduction measures such as noise barriers or walls more accurately. Figure 3 is a cross-section through a valley near Wald am Schoberpass in Austria, where roads and rails cause traffic noise. It illustrates how noise levels are distributed at a frequency of 100 Hz if a noise barrier is set on the right-hand side of the sound sources. Noise is shielded in the right part of the valley, which highlights the effect of the noise barrier on noise immission even at 100 Hz, where noise barriers are usually less effective.

Christian Adams

is Professor of Acoustics and Environmental Noise at the Faculty of ETIT at TU Graz. He holds a newly established endowed professorship, which will be funded by the BMK and companies for the first five years. He is researching physical noise mechanisms at the source, simulation of the noise propagation into the environment and new approaches to noise impact and protection.

Source: Lunghammer – TU Graz

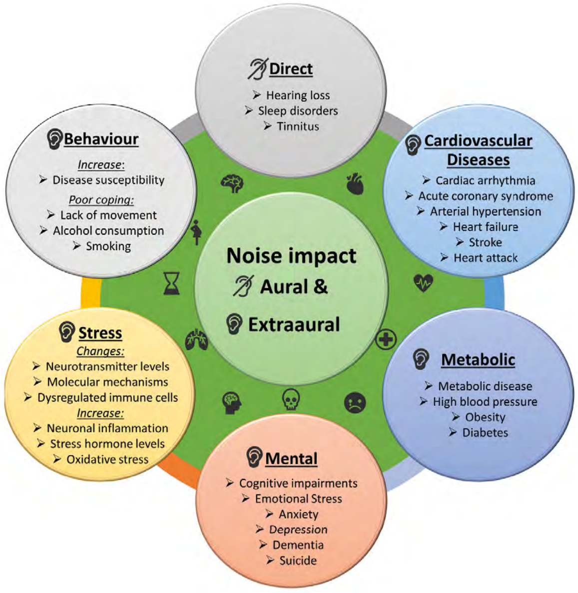


Figure 4: Summary of noise impacts on humans.

Source: Julia Donnerer

NOISE EFFECT PREDICTION

Noise protection measures are based on dose-effect relationships. They refer to the sound exposure and measure the effect on annoyance and health of those affected. Today, design and effects of noise sources are not connected. Knowledge about noise impacts is rather empirical, as the summary in Figure 4 illustrates. This is the starting point for our future noise impact research. We aim to connect the noise effects with the technical aspects of noise sources. Psychoacoustics provides us with the tools to translate empirical knowledge about noise effects for technical acoustics to improve noise source design.