PhD scholarship offer (4 years) - ETS (Montreal, Canada) - Design of realistic artificial heads adapted for testing hearing protectors against stationary and impulsive noises

A PhD funding opportunity of 48 months (30,000 CAD/year) is offered.

Location : The PhD will be conducted at the École de Technologie Supérieure (ETS) in Montreal within a dynamic, multidisciplinary research team recognized internationally in the field of hearing protection. Located in the heart of Montreal, ETS is easily accessible by bike or public transport. Often described as an appealing blend of North American and European culture, Montreal has consistently ranked as the best student city in North America according to Quacquarelli Symonds since 2016.

Research team : The student will have access to the ICAR laboratory (http://gram.etsmtl.ca/equipment/), equipped with cutting-edge technology, where experimental infrastructure, offices, meeting rooms, and relaxation spaces are grouped together to foster collaborative work. The thesis will be co-supervised by Dr. F. Sgard from IRSST and adjoint professor at ETS, and Professor O. Doutres from ETS.

Context : The selection of a hearing protector, the last line of defense against noise exposure, primarily relies on the acoustic attenuation it can provide. To measure this attenuation, Acoustic Test Fixtures (ATFs), which are artificial heads equipped with ear simulators, can be used. To date, no ATF, by its design, allows for estimating the effects of intra- and inter-individual variability of subjects (e.g., the effect of sex) on the attenuation of hearing protectors for both stationary and impulsive noises, nor can it reproduce bone conduction through a human head. The effects of the protective mechanisms of the middle ear on attenuation remain unknown and are consequently not considered in existing ATFs.

PhD project topic : The proposed research project aims to overcome these limitations. It seeks to design a prototype of an artificial head representative of a sample of subjects, adapted for testing hearing protectors against impulsive and stationary noises. The first step will involve developing a geometric model of the head representative of the subject group based on individual anthropometric data and previous work done by the team on artificial heads. In the second step, a measurement campaign will be conducted on the subject group to evaluate the effects of non-linear protective mechanisms of the ear (stapedius reflex and contraction of the annular ligament of the stapes) on noise levels in the auditory canal in both open and protected ears. In the third step, a probabilistic numerical model of the complete head, with and without hearing protectors, will be developed to predict their attenuation for impulsive and continuous noises based on the team's previous work, and then calibrated/validated within a Bayesian framework. Once validated, a set of parameters for designing the artificial head representative of this subject group will be proposed. In the fourth step, this head will be manufactured. Finally, the artificial head will be evaluated through statistical comparisons of objective attenuation measurements of various protectors on this head and those obtained from the subject group. The inter-individual variability associated with the morphology of the auditory canals and anatomical differences will be estimated using the probabilistic models that served to design the artificial head.

Main tasks : In addition to carrying out the PhD project in compliance with research ethics, the student will contribute to the writing of deliverables (e.g., articles, presentations, reports) and will be encouraged to present their work at international scientific conferences.

Profile : This project involves both modeling and experimental aspects. The student should hold an equivalent of a master's degree in engineering or physics. A background in acoustics, finite element modeling, mathematics (probability, statistics), design, measurement, and Matlab programming is recommended. Skills in image analysis and processing, as well as knowledge of human anatomy and audiology, would be a plus. The candidate must (i) be able to communicate in French and/or English, both orally and in writing, (ii) enjoy working in a team, and (iii) be able to meet deadlines.

Starting date : To be determined (Estimated Date: January 2025).

Status in Canada : Must be a Canadian citizen, permanent resident, or have a valid Immigration, Refugees and Citizenship Canada (IRCC) permit to study in Quebec.

Contact : Send CV + motivation letter to Franck Sgard (Franck.Sgard@irsst.qc.ca) **before October 31st 2024**