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On the use of linear aero-acoustic models

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The classical theory of aero-acoustics is based on Lighthills acoustic analogy which essentially leads to a wave equation with a source term defined by the flow field. This source term is assumed unaffected by the acoustic field and the resulting model can be seen as a linear model which, e.g., for duct acoustic problems can be formulated as an acoustic multi-port. Such linear aero-acoustic models can be applied to most aero-acoustic problems occurring in engineering practice with the exception of whistling, i.e., situations where the source term is affected by the acoustic field. At KTH this methodology has been applied to a number of applications over the years ranging from cooling and ventilation fans to flow generated noise from ducted orifices (valves) and air terminal devices. In this paper the experience from these works is summarized and the experimental techniques developed at KTH to characterize linear aero-acoustic sources are described. Recent efforts to extract linear aero-acoustic models from numerical calculations are also addressed.