Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Mean Flow Perturbation Analysis of an Underexpanded Jet SWAGATA BHAUMIK, DATTA GAITONDE, Ohio State Univ - Columbus, HAO SHEN, Acoustics Technology, Boeing Research & Technology, The Boeing Company, ACOUSTICS TECHNOLOGY, BOEING RESEARCH & TECHNOLOGY, THE BOEING COMPANY COLLABORATION — Here, we illustrate a novel method to predict sound generated by imperfectly expanded jets where the resulting shock-cells can yield significant broadband noise in the far-field. We describe continued development of mean flow perturbation method to analyze the response of an under-expanded jet to small perturbations. This method originates from the work of Touber & Sandham (Theor. Comput. Fluid. Dyn., 2009) for nominally 2D shock-wave turbulent-boundary layer interactions. This method is an initial boundary value problem and is equally applicable to flows with sharp gradients. It degenerates into the LST, global and PSE analysis under suitable conditions. We use this method to study finer details of the noise generation mechanisms of an under-expanded round jet at $M = 1.0$. Preliminary results on time-averaged mean turbulent flow-field perturbed by an annular multi-periodic excitation close to the nozzle-exit plane show interaction of downstream propagating disturbances with the feet of the shock-cells. This causes significant amplification of disturbances resulting in the formation of toroidal vortical structures. This further destabilize the shock-cells, finally resulting in acoustic wave propagation in two distinct downstream and upstream directions.

Swagata Bhaumik
Ohio State Univ - Columbus

Date submitted: 01 Aug 2015 Electronic form version 1.4