Title: Recent progress in simulation and modeling of gas-particle flows

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A quantitative understanding of heat, mass, and momentum transfer in gas-particle flows is critical for improving system design at the industrial scale. Strong coupling between particles and turbulence gives rise to a range of complicated flow behaviors, from dense clusters to particle-free voids. The nonlinear and multiscale nature of such flows often precludes a direct analytic or numerical solution, and instead one must turn to simulations that rely on subgrid-scale models. In this talk I will make the case that a "perfect model" should correctly capture one-point statistics of each phase (e.g., turbulent kinetic energy and granular temperature) and two-point spatial statistics such as clustering. Yet to date, no such model exists. I will first present recent developments in CFD-DEM that enable high-resolution simulations of turbulent particle-laden flows. The remainder of the talk will explore coarse graining approaches to achieve quantitative predictions at industrial scales.