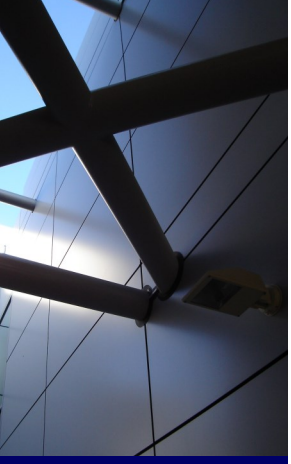

MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Nico Schulte

Friday, December 4th, 2015, 2PM
in Bourns Hall A265

The Impact of Roadside Barriers and Buildings on Near Road Concentrations of Vehicle Emissions

Doctor of Philosophy, Graduate Program in Mechanical Engineering
University of California, Riverside, December 2015
Dr. Akula Venkatram Chairperson

Exposure to elevated concentrations of vehicle emitted pollutants is associated with negative health effects. Elevated concentrations are typically found within several hundred meters of high traffic roads, where atmospheric dispersion has not sufficiently diluted pollutants.

Tall buildings next to roads reduce dispersion, thereby creating pollutant hot spots and increasing exposure to vehicle emissions for city residents. Roadside barriers enhance dispersion of roadway emissions and thus can be used to mitigate elevated concentrations next to large roads. The work in this thesis develops semi-empirical dispersion models that are useful for estimating near road concentrations of vehicle emissions when there are buildings or barriers next to the road.

Dispersion models that account for the effect of near road barriers on concentrations are developed and evaluated with data from a wind tunnel and a field tracer study. The model evaluation shows that the primary effect of roadside barriers is enhancement of the vertical mixing by an amount proportional to the barrier height. Additionally, turbulence is enhanced in the barrier's wake, resulting in more rapid growth of the pollutant plume. The models perform well during neutral and stable atmospheric conditions. During unstable conditions the models overestimate concentrations. A model that accounts for reduction of the mean wind speed in the barrier wake is unbiased for all stabilities.

Models of the impact of tall buildings next to the road on near road concentrations of vehicle emissions are developed. The models are evaluated with data from field measurements conducted in Los Angeles and Riverside counties, CA, and with data from an urban area in Hannover, Germany. The study specifically investigates dispersion in cities with significant building height variability. Model evaluation shows that vertical turbulent transport dominates dispersion in cities. The primary variables governing near road concentrations of vehicle emissions in cities are the ratio of area weighted building height to street width and the vertical averaged standard deviation of vertical velocity fluctuations. The model informs design of transit oriented developments, dense residential areas located in close proximity to transportation infrastructure, which are used to reduce pollution and greenhouse gas emissions due to transportation.