Psycho-physical car-following models are widely used as an accepted method in practice for simulating car-following. However, current simulation models may not fully capture car-following driver behavior specific to freeway work zones. This dissertation presents a new multidimensional psycho-physical framework for modeling car-following based on statistical evaluation of work zone and non-work zone driver behavior. This dissertation used two methodologies for collecting data: (1) a questionnaire to collect demographics and work zone behavior data, and (2) a real-time vehicle data from a field experiment involving human participants. It is hypothesized that the parameters needed to calibrate the multidimensional framework for work zone driver behavior can be derived statistically by using an Instrumented Research Vehicle (IRV) in a Living Laboratory (LL) along a roadway. A real life experiment was developed in this dissertation where 64 participants drove the IRV through an LL set up along a work zone on I-95 near Washington D.C. in order to validate this hypothesis. The new framework was applied and it demonstrated that there are four different categories of car-following behavior models each with different parameter distributions. The four categories are divided by traffic condition (congested vs. uncongested) and by roadway condition (work zone vs. non-work zone). The calibrated threshold values are presented for each of these four categories. By applying this new multidimensional framework, modeling of car-following behavior can enhance vehicle behavior in microsimulation modeling. Driver behavior was also explored through combining vehicle data and survey techniques to augment the model calibrations to improve the understanding of car-following behavior in freeway work zones. The results identify a set of survey questions that can potentially guide the selection of parameters for car-following models. The findings presented in this dissertation can be used to improve the performance of driver behavior models specific to work zones. This in return will more acutely forecast the impact a work zone design has on capacity during congestion.