Grant Deliverables and Reporting Requirements for UTC Grants

UTC Project Information	
Project Title	Active Transportation and Community Health Impacts of Automated Vehicle Scenarios: An Integration of the San Francisco Bay Area Activity Based Travel Demand Model and the Integrated Transport and Health Impacts Model (ITHIM)
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Funding Source(s) and Amounts Provided (by each agency or organization)	USDOT: $ 160,130 UCD $116,272
Total Project Cost	$ 276,402
Agency ID or Contract Number	Sponsor Source: Federal Government CFDA #: 20.701 Agreement ID: 69A3551747119
Start and End Dates	• Start date: 10/1/2018 • End date: 3/31/2020
Brief Description of Research Project	This project evaluated the potential human health impacts from connected and autonomous vehicles (CAVs) scenarios in the San Francisco Bay Area. The study concentrates on impacts derived from AVs' effects on travel demand, safety, and environmental emissions. The study combined an extensive literature review about the extent of such effects, expert judgement, and results from activity-based travel modeling, to quantify the human health impacts of CAVs using the Integrated Transport and Health Impacts Model (ITHIM). Specifically, ITHIM estimates the impacts considering changes in travel demand (e.g., vehicle miles traveled) and levels of physical activity. The results show significant opportunities for road traffic injury reductions, as well as mitigation of environmental emissions. However, reduced physical activity from the mode shift to passenger vehicles (from active travel) could increase the cases of human health issues (e.g. diabetes and lung cancer). Moreover, the authors explored a set of scenarios that could mitigate some of the health-related disbenefits from CAVs.

Describe Implementation of Research Outcomes (or why not implemented)

Place Any Photos Here

CAVs can alter travel demand in many ways, which affect transportation emissions, safety, and human health activity. Overall, different studies evaluate changes in travel demand by increasing roadway capacity due to shorter headways and smaller vehicles; reduced in-vehicle VOT due to the eliminated driving burden; lower operation cost (due to reduced insurance and fuel costs as well as avoided labor costs in taxis); induced demand (new user groups who were not traveling before because of age (too young or old), disability or lower income); and the impacts of automated shared mobility services and parking patterns. Additionally, Figure 1 shows the various assumptions (lower and upper bound) about the impacts from safety and travel emission resulting from CAVs operations.

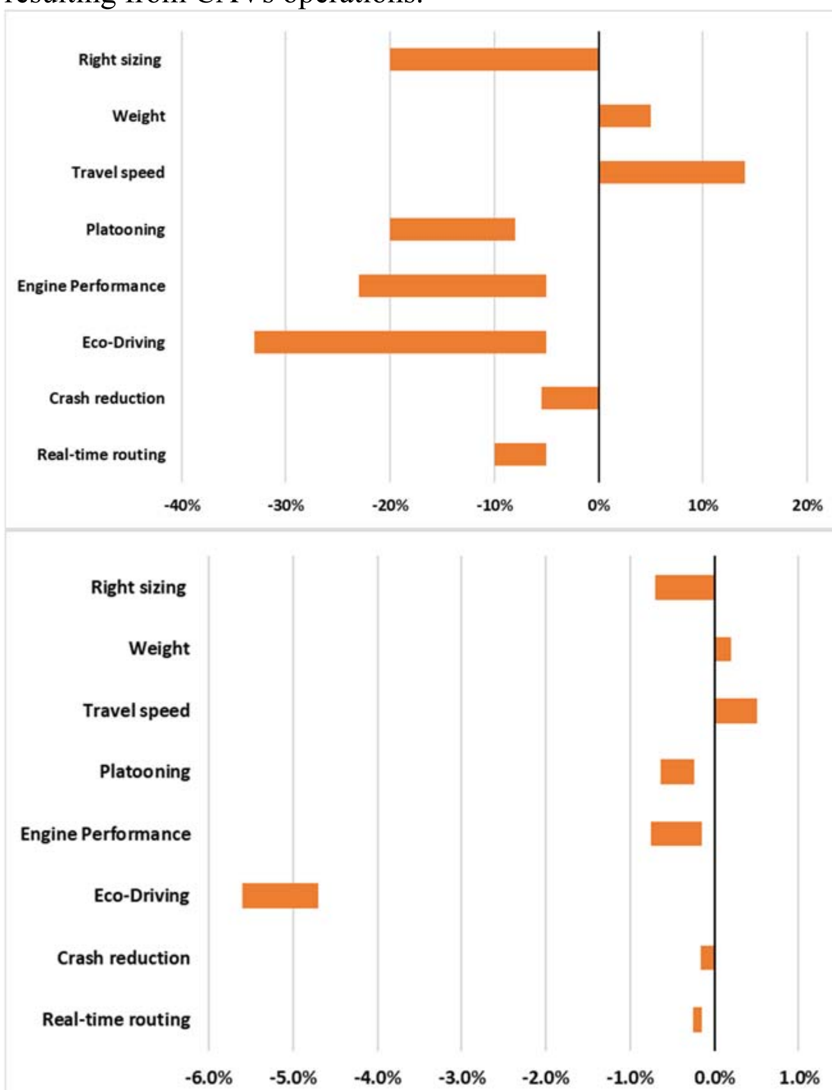


FIGURE 1 Summary of estimated ranges of operational emission impacts of vehicle automation through different mechanisms in San Francisco, Bay Area, (top) CO_2; (bottom) $PM_{2.5}$

The team estimated various CAVs scenarios considering doubled roadway capacity; 25% reduction of in-vehicle value of time; 20% reduction in vehicle operating cost per mile; induced demand from people that could not drive before because of age restrictions or vehicle accessibility. Table 1 shows the results of the combined scenario.

TABLE 1 CAV Combined Scenario Results

Measure	**Value**	**Base Case**	**CAV**
VMT (vehicle-mile)	Total Daily	186,680,784	204,827,275
	Change (%)	-----	10%
VHT (vehicle-hour)	Total Daily	5,141,012	4,914,833
	Change (%)	-----	-4%
Delay (vehicle-hour)	Total Daily	862,505	300,990
	Change (%)	-----	-65%
Mode share	SOV	11,616,115 (48%)	12,607,211 (52%)
	Change (%)	-----	9%
	Shared Ride	8,789,456 (36%)	8,550,862 (35%)
	Change (%)	-----	-3%
	Transit	1,176,641 (5%)	944,931 (4%)
	Change (%)	-----	-20%
	Walk\Bike	2,624,613 (11%)	2,324,475 (9%)
	Change (%)	-----	-11%
	Total Trips	24,206,825	24,427,479
	Change (%)	-----	1%

The team used the CAV scenario to estimate the impacts, and assumed some additional scenarios considering an increase in the active travel trips of 10% and 50%. The following figures show the results.

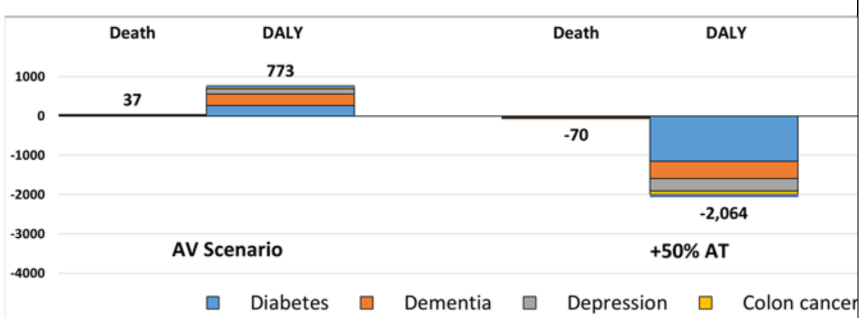
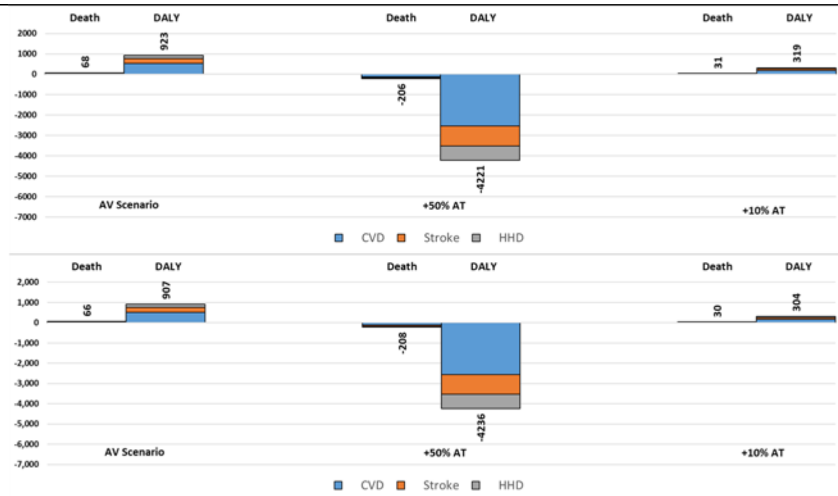
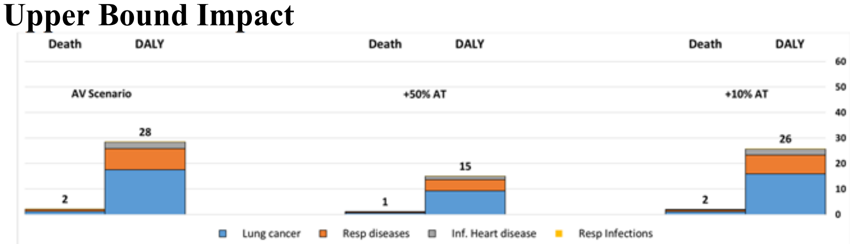
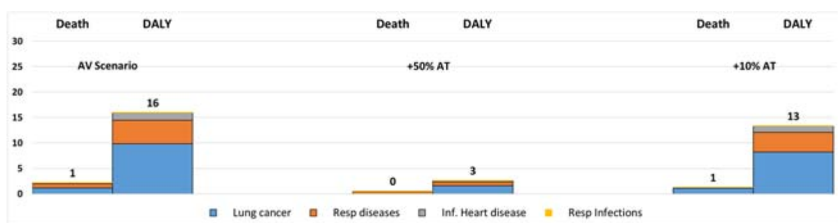
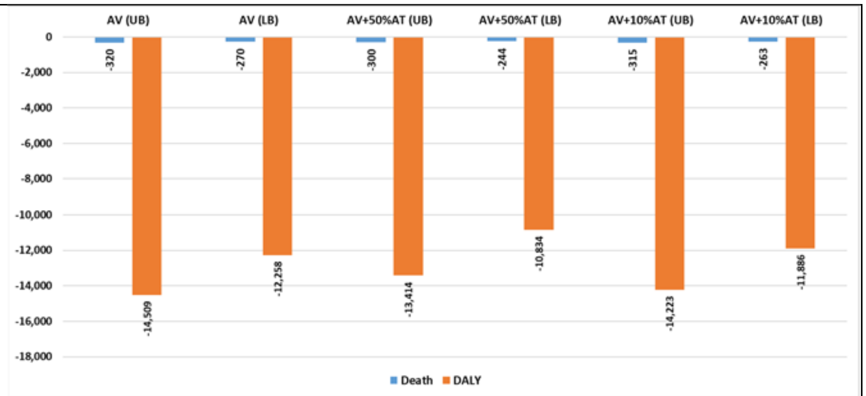


FIGURE 2 Predicted Annual Change in Burden of Disease from Physical Activity Compared with Baseline by Scenario and by Cause of Death and Disability: San Francisco Bay Area, CA

	 **FIGURE 3 Predicted Annual Change in Disease Burden from Physical Activity and PM2.5 by Scenario and Cause of Death and Disability: (top) Lower Bound Impact; (bottom) Upper Bound Impact**  (a)  (b) **FIGURE 4 Predicted Annual Change in Burden of Disease from PM2.5 Compared with Baseline by Scenario and by Cause of Death and Disability: San Francisco Bay Area, CA, (top) Lower Bound Impact; (bottom) Upper Bound Impact**

	 **FIGURE 5 Predicted Annual Change in Disease Burden from Road Traffic Injuries by Scenario** The results show a potential for CAVs to benefit human health by avoiding premature deaths as well as DALYs, through road traffic injury reduction. Efficient and environmentally friendlier CAVs could reduce emissions, particularly CO_2, by 76% per year. However, appealing travel experiences with CAVs could potentially shift away current active travel to these vehicles. The results found a shift of about 11% walk/bike trips to cars, which generated an additional 773 DALYs per year for physical activity related diseases (more importantly for diabetes, dementia and depression) and averaged 915 DALYs per year in combination with $PM_{2.5}$ effects (mostly for CVD). The potential reduction in physical activity from active travel because of mode shifts would are the main reason for human health disbenefits. Results showed that at least 20% increase in active modes (shifted from car trips) could offset the negative impacts from CAVs. There is much uncertainty about the impacts of CAVs, and while there are limitations in the study, it can provide light into the human health impacts, under various assumptions. The work shows how planners could enhance their travel demand modeling capabilities to conduct health assessment impacts with a tool such as ITHIM.
Impacts/Benefits of Implementation (actual, not anticipated)	The team presented the results at the Transportation Research Board Meeting, and will be publishing a journal article. The team has conducted outreached activities with different OEMs through the UCD Institute of Transportation Studies' Sustainable Transportation Energy Pathways Program, for which the OEMs are sponsors of different projects. The team has also communicated the results to various regulatory and planning agencies. The team expects to expand this study in future work to: (1) measure safety impacts from CAVs using microsimulation and incorporating available crash data for the case study; (2) estimate

	emission impacts following macro-simulation approaches for the case study; (3) incorporate additional health measures such as noise reduction and accessibility improvements from CAVs; and, (4) model CAVs' operations in the context of new mobility services (e.g., TNC), as well as parking patterns and behaviors.
Web Links • Reports • Project website	http://ctech.cee.cornell.edu/final-project-reports/