WORK ASSIGNMENT 4-16 UNDER
PRIME CONTRACT 68HE0C18C0001

EXTERNAL PEER REVIEW OF MOVES3.R1 REPORTS:

UPDATES TO THE MODELING OF ELECTRIC VEHICLES AND UPDATES TO REFUELING AND NH_3 CRITERIA EMISSIONS

FINAL PEER REVIEW REPORT
February 15, 2023

Submitted to:
U.S. Environmental Protection Agency
Office of Transportation and Air Quality (OTAQ)
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1.0 INTRODUCTION

Eastern Research Group, Inc. (ERG), a contractor to the U.S. Environmental Protection Agency (EPA), organized an independent external peer review of seven draft technical reports for updates to EPA's *MOtor Vehicle Emissions Simulator* (Version: MOVES3.R1), developed by EPA's Office of Transportation & Air Quality (OTAQ). This document briefly describes ERG's peer review process (Section 2.0). Appendix A provides the technical charge to reviewers; Appendix B provides the individual peer reviewer written comments; Appendix C provides peer reviewer resumes; and Appendix D provides signed peer reviewer conflict of interest (COI) statements.

2.0 PEER REVIEW PROCESS

2.1 Reviewer Search and Selection

For this review, ERG identified, screened, and selected two groups of reviewers who had no conflict of interest in performing the review and who collectively met the following technical selection criteria provided by EPA:

- **Modeling of Electric Vehicles within MOVES**
    - Light Duty and Heavy Duty EV energy usage
    - EV charging and battery deterioration
    - EV temperature effect
    - EV population penetration

- **Updates to refueling and ammonia (NH_3) criteria emissions**
    - Light Duty and Heavy Duty NH_3 emissions
    - Vehicle evaporative emissions

ERG screened the pool of interested and available candidates against these selection criteria. From the set of candidates who met those criteria, ERG proposed four candidates to EPA on October 17, 2022. Upon EPA confirmation that the proposed candidates met the selection criteria, ERG confirmed the services of the four final reviewers. ERG contracted with and committed the following four experts to perform the review (see Appendix C for resumes):

- **Modeling of Electric Vehicles within MOVES**
    - Shawn W. Midlam-Mohler, Ph.D.; Professor, Ohio State University
    - Guoyuan Wu, Ph.D.; Adjunct Professor, CE-CERT, University of California Riverside
- **Updates to refueling and ammonia (NH_3) criteria emissions**
    - Thomas D. Durbin, Ph.D.; Research Engineer, CE-CERT, University of California, Riverside
    - Keshav S. Varde, Ph.D.; Professor (Emeritus), University of Michigan

2.2 Conducting the Review

ERG provided reviewers with instructions for conducting the review; the assigned review technical report, including a list of the sections in each report that were the focus of this review; and the technical charge to reviewers prepared by EPA (see Appendix A). ERG instructed reviewers that they should maintain the confidentiality of the review documents and not share the review materials or consult with anyone during the review process. ERG scheduled and facilitated a briefing teleconference with reviewers and EPA on November 16, 2022, to provide reviewers with a background on the materials under review and to answer any questions of clarification on the technical charge, materials, or peer review process. After the briefing teleconference reviewers worked individually (i.e., without contact with other reviewers, colleagues, or EPA) to prepare written comments in response to the charge questions over a four-week period following the briefing teleconference (from November 3 to December 2, 2022).

ERG monitored the review and responded to one additional technical question from a reviewer. Upon receipt of the written comments from reviewers, ERG confirmed that all reviewers had responded clearly to all charge questions. One reviewer provided annotations to the reports they reviewed. ERG then sent the individual comments to EPA to review for any needed clarifications and compiled this report. EPA requested clarifications from three reviewers. Two reviewers provided revised comments for the report in question and the original comments were replaced in this report with the revised versions. One reviewer provided clarifications via email and those clarifications have been footnoted in this report. Comments are presented exactly as submitted, without editing or correction of typographical errors (if any).

APPENDIX A

TECHNICAL CHARGE TO REVIEWERS

Technical Charge to External Peer Reviewers

Contract No. 68HE0C18C0001
Work Assignment 4-16
November 2022

External Peer Review of MOVES3.R1 Reports:

Updates to the Modeling of Electric Vehicles within MOVES and Updates to Refueling and NH_3 Criteria Emissions

BACKGROUND

The Motor Vehicle Emissions Simulator (MOVES) is a vehicle emission model developed by the Office of Transportation and Air Quality (OTAQ) in the US Environmental Protection Agency (EPA). MOVES estimates emissions from onroad vehicles and nonroad engines, and uses emissions, activity and vehicle population data to estimate emissions for a broad range of pollutants. The data and algorithms used in MOVES are documented in technical reports. When EPA makes significant updates to the data and/or algorithms in MOVES these are documented in draft reports and the externally peer-reviewed.

The latest public release of MOVES, MOVES3, included significant updates to the nonroad equipment and nonroad emissions. Peer-reviews of the changes to the onroad emission rates and fuel supply defaults were conducted prior to the release of MOVES3. Since the last peer-review, EPA has made significant updates to the development version of MOVES, referred to as 'MOVES3.R1'.

REVIEW MATERIALS

Please focus your review on the updated sections only of the reports listed below:

Updates to Refueling and NH_3 Criteria Emissions

Report #1: Exhaust Emission rates for Light-Duty
- Section 6
- Section 8

Report #2: Exhaust Emission rates for Heavy-Duty
- Section 5
- Section 7

Report #3: GHG & Energy Consumption Rates
- Section 3.b

Report #4: Evaporative Emissions from Onroad Vehicles
- Section 3.6

Updates to the Modeling of Electric Vehicles within MOVES

Report #1: Emission Adjustments
- Section 2.7
- Section 6
- Section 7

- Appendix D

Report #2: Exhaust Emission rates for Heavy-Duty
- Section 2.3
- Section 4
- Section 6.3

Report #3: GHG & Energy Consumption Rates
- Section 2.a.iii
- Section 2.b.i
- Section 2.b.ii
- Appendix C
- Appendix D

Report#4: Population and Activity of Onroad Vehicles
- Section 5.2

CHARGE QUESTIONS

Please respond to each charge question for each report.

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?
   Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?
2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?
   Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?
3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?
   Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

   In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.
4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?
   If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.
5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?
   Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

APPENDIX B

INDIVIDUAL REVIEWER COMMENTS

COMMENTS RECEIVED FROM

Shawn W. Midlam-Mohler, Ph.D.

Professor, Department of Mechanical and Aerospace Engineering
Ohio State University
Columbus, Ohio

Updates to the Modeling of Electric Vehicles within MOVES

Updates to the Modeling of Electric Vehicles within MOVES

Report #1: Emission Adjustments

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

Section 2.7: Yes, the information provided gives an adequate view of the analysis.

Section 6: Yes, the sources were described clearly.[1]

Section 7: Yes.

Appendix D: Yes.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

Section 2.7: There is likely more data out there, but the data selected is adequate. This is an area that will likely improve as OEMs develop better approaches for thermal management.

Section 6: I am concerned that charging information for busses seems to be used for all electric vehicles. There were many data sources referenced, some of which seemed to refer to light-duty vehicles. [2]

Section 7: No.

Appendix D: Same comments as Section 2.7.

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

Section 2.7: Yes.

Section 6: It is not clear how the base bus data is adequately justified for use on other classes of vehicles. The approach of adjusting by age seems correct, however, it does not seem well supported by data.

Section 7: Yes.

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1 My main concern here is that the primary data used for battery efficiency deterioration is from a single reference [55] that is based on a model. The model is validated based on the following reference [https://survey.pluginamerica.org/leaf/Leaf-Battery-Survey.pdf] which is not peer-reviewed or even a formal publication. That reference also only deals with overall capacity rather than internal resistance – to the validation of the model is really mainly around capacity rather than efficiency.

I did a quick review and did not find any particularly exhaustive reviews of this topic unfortunately. I feel that to best support this there needs to be a small literature review included in the section with a few references of the best peer-reviewed papers that can be located.

2 Same as footnote #1 above.

Appendix D: Yes.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Section 2.7: This could really benefit from showing the data and fits for the temperature correction as well as metrics of fit quality.

Section 6: See previous comments. Some additional figures supporting the method would be valuable.

Section 7: Some additional figures/tables would be helpful to describe the method. For instance, elaboration of Eq. 7-2 with some standard assumptions and across the model years in Table 7-1 would be helpful.

Appendix D: This does mitigate some concerns I had with Section 2.7, however, it does seem that more rigor could be applied here.

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

Section 2.7: Perhaps. Without a figure showing the fit quality of Eq 2-17 and error metrics it is not possible to say.

Section 6: The method of having an age-based adjustment is valid. See above caveats on the source data.

Section 7: Yes.

Appendix D: Yes, but with caveats noted for Section 2.7.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Section 2.7: No. The method should be appropriate with the caveats listed above.

Section 6: See above.

Section 7: ~~Yes~~.[3]

Appendix D: No. The method should be appropriate with the caveats listed above.

3 This was an error on my part – I did not intend a "yes" response to this. Sorry for the confusion.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

Section 2.7: Perhaps. As noted above, I feel that there is more that should be done to ensure the best approach is being used here.

Section 6: Concerns noted above.

Section 7: Yes.

Appendix D: Same comment as Section 2.7.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

N/A

5. **Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?**

Section 2.7: Yes.

Section 6: Concerns noted above.

Section 7: Yes.

Appendix D: Yes.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Section 2.7: Yes.

Section 6: Concerns noted above.

Section 7: Yes.

Appendix D: Yes.

Updates to the Modeling of Electric Vehicles within MOVES

Report #2: Exhaust Emission rates for Heavy-Duty

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

Sections 2.3 and 4 are very well documented and clear. Section 6.3 is much sparser and based on some assumptions that are not clearly stated.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

The reviewer is not aware of any better data sources.

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

The methods are described well enough to be clear. As noted above, the approach in 6.3 is not well documented.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Yes.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

With the exception to 6.3, the methods used seem appropriate and reasonable.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

N/A

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

Section 6.3 seemed to be lacking rigor. I am not aware of any sources that can provide context to the assumptions made regarding heavy-duty CNG and gasoline engine crankcase emissions, however, I could not conduct a literature review with the scope of this review. I feel that there is some peer-reviewed literature out there that could support this.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

N/A

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

Yes.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes.

Updates to the Modeling of Electric Vehicles within MOVES

Report #3: GHG & Energy Consumption Rates

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

Yes with caveats here and below.

Section 2.b.1: It is not clear to me which of the references cited are the source for the EER.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

Section 2.a.iii: It is not clear why ALPHA models were used to simulate vehicles with known economy information. Using the model output rather than the known experimental values includes unnecessary errors. This is particularly true for the light-duty vehicles in which there is a wide range of vehicle data publicly available.

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

Generally, yes. Some concerns were noted above. Additionally, the hoteling in 2.b.ii is lacking robust data as noted in the report. It seems that the best approach possible was applied given the sparsity.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Yes.

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

Yes.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Nothing not already noted above.

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

Yes.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

N/A

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

Yes. As noted above, it is not clear why the experimental values widely available for light-duty vehicles are not adopted directly rather than using ALPHA models of the same vehicles.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes.

Updates to the Modeling of Electric Vehicles within MOVES

Report #4: Population and Activity of Onroad Vehicles

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

Yes. The formatting of the references could be improved to a more formal structure. For instance, the data is referenced as "2020 IHS data" without a formal reference. Other data is properly cited but it should be consistently cited.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

There are no public data sources that I am aware of that are better than those used.

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

Yes. The method is fairly straightforward despite the mathematical expression describing it being somewhat cumbersome (but necessary.)

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Yes.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

This is a straightforward application of statistics and seems to be reasonable and appropriate.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

N/A

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

Motorcycles were not considered due to sparsity of data and the sparsity of alternative fueled motorcycles. It is likely negligible; however, this should be cited with some sources. The remaining assumptions seems appropriate and reasonable and were backed up by citations.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

N/A

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

Yes, within the scope permitted by the review the inputs were appropriate.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes, within the scope permitted by the review the inputs seemed consistent.

COMMENTS RECEIVED FROM

Guoyuan Wu, Ph.D.

Adjunct Professor, Electrical and Computer Engineering Department and
Researcher, College of Engineering – Center for Environmental Research and Technology (CE-CERT)
University of California at Riverside
Riverside, California

Updates to the Modeling of Electric Vehicles within MOVES

Updates to the Modeling of Electric Vehicles within MOVES

Report #1: Emission Adjustments

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

Section 2.7: Yes.

Section 6: Yes.

Section 7: Yes.

Appendix D: Mostly.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

[no comments]

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

Section 2.7: Mostly.

Section 6: Mostly.

Section 7: Yes.

Appendix D: Mostly.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Section 2.7: a) on Page 43, it is said "Relative to room temperature, the AAA found a 39% reduction in miles per gallon equivalent (MPGe) at 20 F and a 17% reduction in MPGe at 95°F, corresponding to a 64% and 20% increase in energy consumption, respectively.", but it is not very straightforward to relate these figures; b) it is not clear to me why 67°F is calculated as the minimum heat index.

Section 6: a) It is not clear why modeling of emissions from power plant and associated air quality changes needs to be considered for BEVs? By contrast, does it mean that the fuel production, evaporation or other loss during transportation need to be considered also for ICEVs? b) Will Table 6-1 be applied to FCEVs, too?

Appendix D: on Page 86, in Figure D-1, it is not clear how the curve was fitted, e.g., least square?

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

Section 2.7: Yes.

Section 6: Mostly.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Section 6: on Page 69, it is said "Individual counties will, of course, have different electric vehicle sales fractions, but emission compliance is determined at the national level, thus we use MOVES national default values in these calculations even when MOVES is run at county or project scale". However, this may vary quite significantly, e.g., California vs. Iowa.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

Section 7: One Page 77, the sampleVehiclePopulation should be varied with state or event county. The number between two states could be very large.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

[no comment]

5. **Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?**

Section 2.7: Yes.

Section 6: Yes.

Section 7: Yes.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Section 2.7: Yes.

Section 6: Yes.

Section 7: Yes.

Updates to the Modeling of Electric Vehicles within MOVES

Report #2: Exhaust Emission rates for Heavy-Duty

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

Section 2.3: Mostly.

Section 4: Mostly.

Section 6.3: Yes.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

Section 2.3: 1) on Page 115, "Testing was conducted on 12 heavy-duty diesel trucks and 12 transit buses in Colorado by McCormick et al. Ten of the trucks were Class 8 heavy-duty semi-tractors, one was a Class 7 truck, and one of the vehicles was a school bus." Does it mean a school bus was counted as HD diesel truck? 2) on Page 117, "Emissions data from the references in the data sources section (2.3.1.1) was classified into one of three idle conditions. The first condition, which has a low engine speed (<1,000 rpm) and no air conditioning is representative of curb idle. The second condition is representative of extended idle with higher engine speed (>1,000 rpm) and no air conditioning. The third represents an extended idle condition with higher engine speed (>1,000 rpm) and air conditioning", then what about the four condition which has a low engine speed but with air conditioning; 3) on Page 117, "For both the MY 1960-1990 and 1991-2006 vehicles, using the data summarized in Appendix E, adjusted emission rates were calculated for each pollutant by weighting the overall "high speed idle, A/C on" results by 0.33 and the "low speed idle, A/C off" (i.e., curb idle) results by 0.67 to account for the fraction of idling at high and low engine speeds", where do those two numbers, 0.33 and 0.67, come from? 4) on Page 120, Table 2-47, are those two temperatures representative enough and consistent to be applied across different sourceTypes.

Section 4: on Page 189, it is said "The methane fraction from CNG vehicles is 89% and 96% for model year groups 1960-2004 and 2002-2060 respectively, as documented in the Speciation report", so how to handle the overlapped years, i.e., 2002 – 2004?

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

Section 2.3: Not completely.

Section 4: Mostly.

Section 6.3: Yes.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Section 2.3: on Page 123, it is said that "We initially expected the data to show a decrease in the extended idle emission rates beginning in MY 2008 to account for the California Clean Idle Certification (all MY 2008 and later trucks were clean-idle certified). However, no reduction was observed. We also expected to observe a decrease in 2012, with the full implementation of SCR, but this was also not the case.", so are there any hypotheses to explain these observations?

Section 4: on Page 200, it is said that "for $PM_{2.5}$, in MOVES3, ages 0-3 and 4-5 have no deterioration and the MOVES2014 light-duty $PM_{2.5}$ deterioration factor for age 6-7 is applied to all CNG $PM_{2.5}$ emission rates for ages 6+, thus making the $PM_{2.5}$ and gaseous pollutant methods more (but not fully) aligned. Note that, unlike gaseous pollutants, the $PM_{2.5}$ deterioration factor does not vary between operating modes for a given age group. See Section 3.1.2.1.3 for more details and Table 4-4 for a comparison between MOVES3 and MOVES2014". It is not clear to me if this statement is an assumption or an observation.

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

Section 2.3: Mostly.

Section 4: Not completely.

Section 6.3: Yes.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Section 2.3: a) Usually the technology market (e.g., SCR) penetration rate has strong correlation with the MY. This needs to be paid attention; b) on Page 127, it is said "First, MHD trucks are estimated to account for only 5 percent of long-haul combination trucks in the US and therefore, they are a minor contributor to the emissions from extended idling trucks", but I don't think this is an appropriate rationale to support the statement "The extended idle emission rates for MHD are assumed to be the same as HHD for the following two reasons".

Section 4: a) The CBD drive cycle (in Figure 4-2) might be too artificial; b) on Page 195, I would suggest to use "Simulating Cycle Average Emission Factor" rather than "Simulating Cycle Average Emission Rates". It would be better to use "factor" than "rate", as the latter usually refers to something over time, not over distance; c) It is assumed that "the deterioration factor (per operating mode) is same across age groups for ages 6+ but varies between operating modes within an age group". This seems to be a strong assumption and does not make too much sense; d) The "dips" in Figure 4-6 and Figure 4-7 do not make engineering sense. It is suggested to smoothed them out with more robust data before and after the dips.

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

Section 2.3: Mostly.

Section 4: Yes.

Section 6.3: Yes.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

Section 2.3: a) The earliest dataset seems to be Year 1984, so why MY range starts from Year 1960? b) why the emissions rates for different pollutants, e.g., from Figure 2-65 to Figure 2-69, were grouped by year differently?

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

Section 2.3: Yes.

Section 4: Yes.

Section 6.3: Yes.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Section 2.3: Yes.

Section 4: Yes.

Section 6.3: Yes.

Updates to the Modeling of Electric Vehicles within MOVES

Report #3: GHG & Energy Consumption Rates

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

Section 2.a.iii: Yes.

Section 2.b.i: Yes.

Section 2.b.ii: Yes.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

Section 2.a.iii, it would be better to add data from third-party certification.

Section 2.b.i: Currently, MOVES focuses on 1-D speed trajectories (drive cycle), but the lateral movement may have impacts on energy consumption. There should be some additional data to address this issue. This suggestion applies to other sections and reports, too.

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

Section 2.a.iii: Not completely.

Section 2.b.i: Yes.

Section 2.b.ii: Yes.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Section 2.a.iii: on Page 15, it is not clear why some parameters are chosen for the custom-built cycle, e.g., why "50 hard accelerations", why "from 0 to about 75 – 80 mph", why "data during deceleration back to 0 mph was ignore".

Appendix D: on Page 49, I don't know how the number "1.61" was calculated. If averaging the last column, the value should be 1.68. If taking the median of the last column, the value should be 1.60.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

Section 2.a.iii: Mostly.

Section 2.b.i: Mostly.

Section 2.b.ii: Mostly.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Section 2.a.iii: we may consider to add estimation error bars in addition to estimation itself to partially address the uncertainties in the data. This suggestion may apply to most of the sections that were reviewed in this task.

Section 2.b.i: 1) it would be better to differentiate in-vehicle technologies used between BEVs and diesel vehicles; 2) EER should be function of other parameters than "speed" only, such as opMode, acceleration, model year. 3) it would be better to have the regulatory class or source type is defined to match with the vehicle classification defined by FHWA. This would provide a consistent foundation for analysis, modeling and simulation of traffic-related emissions or energy consumption.

Section 2.b.ii: on Page 23, "we assume that the energy consumption for all fuel types using shore power is the same." This seems to be a strong assumption as different technologies (available for different fuel type) in different MY may have different energy consumption.

Appendix D; on Page 48, it is said that "Table D-4 shows EERs averaged for each available source type with equal weighting given to each reference", but I would recommend to use median rather than average for the representative EER number. This may be a more robust way considering the large variations in data and potential outliers. This suggestion may apply to other sections or other reports in this review task.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

Section 2.a.iii: Agree.

Section 2.b.i: not completely.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

Section 2.b.i: the assumption "Due to a lack of available data, we define EER only by source type and apply the same ratio for all heavy-duty regulatory classes and model years." seems to be too strong.

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

Section 2.a.iii: yes.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Section 2.a.iii: on Page 16, it is not clear why in opMode Bin 16, the energy rate of EV is higher than ICEV. The trend is not

Appendix C: in Table C-2, it seems that the overall range is underestimated; UDDS drive cycle (City) is overestimated, but results of HWY drive cycle are underestimated. More explanation is needed. Is it because overestimate regenerative braking effect and overestimate energy consumption for high-speed scenarios? Or drive cycles of EVs are different from drive cycles of conventional vehicle as pointed out by some research.

Updates to the Modeling of Electric Vehicles within MOVES

Report #4: Population and Activity of Onroad Vehicles

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

Yes.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

[no comment]

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

Yes.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Yes.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

Mostly.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

On Page 40, it is said that "However, electric refuse truck distributions for model years 2019 and earlier were calculated using 2019 Annual Production Volume Reports into Engine and Vehicle Compliance Information System reported to EPA, and motor homes used the 2014 IHS data for all model years 2013 and earlier." We should use projection to get 2020 results for consistency on electric refuse truck distributions.

On Page 44, it is not clear where "1500 vehicle sale" comes from. Also, for Equation 5-3, I would suggest to differentiate FT and ET (if applicable). It does not make too much sense to only look into MY. Also, the sum of Eq. 5 -3 I does not equal to 1?

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

Mostly.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

It is noted that “As the 2020 IHS data does not contain complete information on model year 2020 and later vehicles, we held regulatory class distributions for these vehicles constant at the model year 2019 values”. There could be a better way (e.g., regression) to project the RC distributions for future years (after 2020) by examining these distributions from 2014 and 2020 HIS data. The “constant” assumption, though simple, may result in a significant bias. Another example, in Section 5.2.2, it is said that “The market shares for other fuel types were proportionally reduced so that the total market share for all fuel types sums to 100%.” This might not be a reasonable assumption. Due to the nationwide policy for sustainable transportation, the market shared for clean energy powered passenger cars (besides electric cars) should be increased, which may be justified by other sources (e.g., registration database from DMV).

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

Yes.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes.

COMMENTS RECEIVED FROM

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Updates to Refueling and NH_3 Criteria Emissions

Updates to Refueling and NH_3 Criteria Emissions

Report #1: Exhaust Emission rates for Light-Duty

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

Section 6.1.1 – it looks like the Sierra report used data from the Harvey reference 94 for the 1975-1980 vehicles, so that reference could be used for the 3rd sentence in the section. The other main study used by Sierra work for NH3 (Durbin et al., 2002), did not have any pre-1981 vehicles.

For table 6-2, it lists the different RSD testing campaigns. Are there any references that describe these testing efforts? Its realized that the data comes from the website, but its probably not realistic that most readers would be able to access and look at these data in too much detail. It would be useful to have some additional background on the different testing campaigns that might be available through literature references (even if these articles may not include NH3 emissions).

Section 6.1.2.4. 2nd paragraph. It talks about the results of the MOVES2010 correlation on NH3 with power based on CE-CERT studies. The final sentence talks about this being reported in other studies, but these are actually just the CE-CERT studies, so they are not really “other” studies.

For the NO, NO2, HONO ratios in section 8, for the light-duty diesel vehicles, these assumptions are discussed in the corresponding report #2 on heavy-duty diesel vehicles, and comments related to this can be found in the report #2 charge questions. It should be noted that the second to last reference should be 105 instead of 111, as 111 references the older 2020 report on this topic.

For the NO, NO2, HONO ratios in section 8, for the light-duty gasoline vehicles and motorcycles, it appears that the data trace back to the Sierra Research data analysis and use in 2012, which in turn is based on an earlier CE-CERT (with 2001 and older vehicles).

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

CARB/UCR has recently conducted a study of the impacts of E15 on modern vehicles that included NH3 emissions. In general, the emission rates are below 10 mg/mi, which could be used to check against some of the later 2020 and 2021 RSD studies when they get incorporated into the model.

https://ww2.arb.ca.gov/resources/documents/comparison-exhaust-emissions-between-e10-carfg-and-splash-blended-e15

Another recent study is the following: Abualqumboz, Motasem S., Randal S. Martin, and Joe Thomas. "On-road tailpipe characterization of exhaust ammonia emissions from in-use light-duty gasoline motor vehicles." *Atmospheric Pollution Research* 13, no. 6 (2022): 101449.

UCR/CE-CERT has characterized NH3 emissions from light-duty diesel vehicles in the CRC AVFL-17b study.

https://crcao.org/wp-content/uploads/2019/05/CRC-Final-Report_AVFL-17b.pdf

I don’t know of other key sources of NO/NO2 data for light-duty gasoline vehicles, but perhaps some data might be available to EPA through either the EPACT or internal EPA studies.

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

Table 6-1. The emission rates are given in g/hour. It would at least be useful to provide some information related to how many miles are covered in the hour, or what other assumptions are made for this estimate.

Section 6.1.2.3 – 4th paragraph. It talks about the MOVES2010 using scaling factors for the 1981-1996 model year group, but its not clear how these were applied. Were the scaling factors to make the emission rates younger than 10 years old smaller.

Section 6.1.2.3 – 4th paragraph. The discussion on the age-related scaling factors is not totally clear to me. There is one set of factors that scale up from the 0-3 age group, and then there is a second that scales down from the 15-19 year age group. I guess the first question for me is what is the average age of the fleet in these different age groups, since presumably you are taking the average emission factor and adjusting it up or down for older/newer vehicles, respectively. The remaining sections talk in greater detail about the specifics of how this method is applied for different model year groups, but its still hard to follow since the idea is probably not as clear as it could be from the start.

In looking at Figure 6-2, 6-4, and 6-5 compared to figure 6-6 I am wondering if there is a better way of typing things together. I think it would be useful to understand where the speed acceleration profiles from the RSD data fall relative to the bins in Figure 6-6. Are the RSD data more for low/medium or high power events?

Figure 6-7 is useful, showing how the emission rates vary over time (i.e., calendar years). It is a bit interesting to see how there are little bumps in the distributions that must be a product of the assumptions/data limitations. The other thing is that looking at the 2004-2010 data, the emission rates are actually lower for the 2024 vs. 2017 calendar year, which is a little confusing, since the corresponding paragraph talks about the aging impact being seen. Is there some off-setting factor that the older vehicles are driving less aggressively that could contribute to that trend.

For section 8, perhaps for the light-duty gasoline vehicles, that a reference could be added to the CE-CERT study that was actually used to develop the NO/NO2 ratios. This would allow the reader some direct information on what data was primarily used for the estimates, as opposed to going back to the 2012 report, which in turn uses the older CE-CERT study.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Figure 6-1 to 6-7 are useful. Table 6-4 and associated other tables would probably be more useful if the underlying discussion was clearer.

The tables in section 8 seem suitable to present the NOx composition data.

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

Overall, I think the methods are reasonable, although some could be clarified further to make the report easier to understand. It would be useful to understand how the RSD data compares in terms of what ages and what operating modes represent the typical averages in Figure 6-2.

For section 8 on NOx composition, the methods seem appropriate, with the main limitation being with the input data, although this is less of a limitation for the heavy-duty data which would make a more significant contribution for NOx.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Again, the main suggestion is just to clarify the discussion related to how the methods are applied in section 6.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

Section 6.1. It talks about NH3 emissions during cold start, and that elevated NH3 emissions can occur there. This should be clarified that this is after catalyst light-off, so its not really during the true cold start. So, its probably pretty reasonable to not focus too much on cold starts. Perhaps some comparison between bag 1 and bag 3 emissions for studies with FTP emissions so see how strong an effect this is.

For the 1980 and older vehicle, EPA used a simple average of 1960-1974 and 1975-1980 vehicles. EPA notes, and as expected, the contribution of these vehicles is small. Can this be quantified. For example, is the contribution less than 1% or 0.5%? It would also be interesting to at least know if the population is skewed to one of the other model group, in which case perhaps the emission rate could be population weighted. Or perhaps a discussion of what calendars EPA expects might be. For example, in Figure 6-7 pre-1980 vehicles are not even included in the oldest calendar year presented (2010), and pre-1987 vehicles are not included in the 2017 calendar year.

Section 6.1.2.2 – The EPA assumes 1981-1988 vehicles to have the same emission rates as the other pre-1996 vehicles. Its probably reasonable to make this simplification, as the inventory impact should be small. Again, it would be useful to get a context as to have small this contribution would be, say less than 0.5%, or whatever. And or that the calendar years to be modeled will likely exclude these vehicles going into the future.

The assumption that the E85 vehicles can be made equal to the light-duty gasoline vehicles appears reasonable. More information related to this can be found in the recent CARB E10-E15 referenced above. The CARB study showed some vehicles with differences between E10 and E15, but not consistent trends, and in some cases with larger experimental variability.

NH3 data for light-duty diesel vehicles is pretty limited. Suarez-Bertoa et al. (references 90 and 91) show emission rates below 10 mg/mi, consistent with the use of a low fuel –based emission factor of 0.18 g/kg-fuel for diesel. UCR/CE-CERT also found emissions rates below 10 mg/mi in the CRC AVLF-17b study, provided above. I would at least include a sentence with these references in them just to have more complete coverage.

For section 8 on NOx composition for the light-duty gasoline vehicles, although data is limited, it is unlikely that NO2 ratios would be significantly higher than 16%, so the assumption from the older studies is probably reasonable.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

I think the suggestions are generally OK, with some possible clarification, as discussed above.

5. **Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?**

Looking at Figure 6-3, while it does show that aging effects do seem to something that is found at many of the different sites, one other thing that it seems to show is that there are marked differences in the emission rates for different sites (sometimes more than double, especially given the log scale). The emission rates for IL_CHIC and CA_LA in particular seem to be much higher than those for the other sites. In looking at the sites themselves, does anything stand out in the locations that might be creating a bias?

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Figure 6-2 is central to the inputs into the model, so its worthwhile looking at this one a bit deeper. As a guidepost, I used 7.87 liters/100 km (see ref 87) to allow comparisons with studies reporting in units of mg/mi. Based on this, we get roughly the following for the 2004-2013 model years.

=(0.5 g/kg *(0.74 kg/L)* (7.87 liters/100 km)*(1 km/0.62 miles) = 47 mg/mi

Higher emission rates have been seen for 1990s vintage vehicles, as shown in an older Durbin et al. (2002) study, that was used extensively in the Sierra report on emission rate developments. **Durbin, T. D.**, R. D Wilson, J. M. Norbeck, J. W. Miller, T. Huai, S. Rhee. 2002. Estimates of the Emission Rates of Ammonia from Light-Duty Vehicles using Standard Chassis Dynamometer Test Cycles. *Atmospheric Environment*, vol. 36, 1475-1482.

Reference 87 shows many emissions rates in a similar ballpark that seem to be in a very similar range. I have not done the unit conversion, but I am guessing that this is in the range of the values for the 2004-2013 vehicles. I think it would be worthwhile adding one sentence to the end of section 6.1.2.1 talking about the emission rates from reference 87, just to show how they compare to the emission rates shown in figure 6-2.

Overall, the estimates for the NO/NO2 ratio seem reasonable within the limitations of the available data. A more extensive discussion on the diesel NO/NO2 ratio is given in the discussion on report #2.

Updates to Refueling and NH_3 Criteria Emissions

Report #2: Exhaust Emission rates for Heavy-Duty

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

For the NH3 section, the report does provide a reasonable description of the data sources, which provides important details but is relatively succinct. I suggestions for additional NH3 data sets, as discussed below.

For the NO2 & HONO/NOx ratio, we see many of the same studies and descriptions. Again, I have suggestions for additional data sets, as discussed below. I did not see a description of the Kurtenbach et al. (2001) study that was used for the previous MOVES model, that are largely unchanged with the newest model. Since this study is central to the factor used in the model, I believe some further description of the study is needed. I doesn't nee to be too extensive, but there should be a sentence or two.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

Several other studies being/have been conducted in California can provided some additional data in terms of heavy-duty vehicle NH3 emission rates, including the nearly completed 200 vehicle study, as well as a precursor to this study. These studies involved both UCR and WVU. While the final report for the second study is in its final stages, the other reports have been completed, and are available, and could be added to the table. From these data, it does appear that NH3 emissions for HD diesel vehicles are pretty vehicle specific, with some vehicle types showing measurable NH3 emissions, while a larger fraction of vehicles do not. These studies also provide information on both cold start and hot start emissions.

Carder, D., Gautam, M., Thiruvengadam, A., Besch, M., 2014. In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines. Final Report by West Virginia University for the South Coast Air Quality Management District.

Miller, J. W., Johnson, C. K., Durbin, T., Dixit, P., 2013. In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines. Final Report by the University of California at Riverside to the South Coast Air Quality Management District under Contract No. 11612.

For NH3 from CNG vehicles, the following studies can be used as data sources, which show higher NH3 emissions levels. Also, the current 200 vehicle study results that will be coming out shortly show much higher emission levels.

Karavalakis, G., Jiang, Y., Yang, J., Hajbabaei, M., Johnson, K., Durbin, T., 2016, Gaseous and Particulate Emissions from a Waste Hauler Equipped with a Stoichiometric Natural Gas Engine on Different Fuel Compositions, SAE Technical Paper No. 2016-01-0799, Society of Automotive Engineers, World Congress 2016.

Karavalakis, G., Hajbabaei, M., Jiang, Y., Yang, J., Johnson, K.C., Cocker, D.R.; Durbin, T.D., 2016, Regulated, Greenhouse Gas, and Particulate Emissions from Lean-Burn and Stoichiometric Natural Gas Heavy-Duty Vehicles on Different Fuel Compositions, Fuel, 175, 146-156.

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

Overall, the description seems to be OK, within the context of the other comments provided.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Tables 5-1, 5-2, and figure 5-1 are useful illustrations. Section 5-4 is a summary section, but it only includes a figure of gasoline heavy-duty vehicles, which seems odd, and figure 5-4 only shows gasoline heavy-duty vehicles.

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

While data from tunnel studies can be important, in some cases, the NH3 emissions could be at very low levels, so they might be difficult to estimate.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

Depending on the impact of CNG heavy-duty vehicles, it is suggested that information from some of the studies above would provide a better estimate than simply setting the values equal to the heavy-duty gasoline vehicles. Also, the rates as a function of model year would not be appropriate for CNG heavy-duty vehicles, as these vehicles were not equipped with stoichiometric engines until approximate 2007. Before that, the engines were lean burn, which would probably be closer to diesel vehicles.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

The assumption that the NH3 emission rates for heavy-duty CNG vehicles can be set equal to the heavy-duty gasoline vehicles is not one that I feel is supported by the data. In particular, CNG heavy-duty vehicles tend to operate slight richly of stoichiometric operating conditions, to achieve lower NOx emissions, as opposed to gasoline vehicles. So, the CNG vehicles generally have much higher NH3 emission rates than those shown in table Figure 5-3, including several other CE-CERT studies that are not referenced, but are listed above, and results from our upcoming 200 vehicle study.

The assumption of relatively minor idle and cold start emissions for the heavy-duty diesel that can be zeroed out for the model is probably a reasonable one, given the expected small overall impact on the inventory.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

For NH3 for heavy-duty CNG, it appears that there sufficient data available in the literature that could provide for direct estimates, as opposed to using heavy-duty gasoline vehicles.

5. **Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?**

As discussed above, I believe the assumptions related to heavy-duty CNG being close to heavy-duty gasoline vehicles should be evaluated further.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

NH3 emissions from some of the UCR studies discussed above are on the order of 1.5 g/mi, so higher than the estimated used in EMFAC.

The estimates for the NO2/NOx ratios from Carder et al. are on the order of 0.18 for the SCR-equipped diesel vehicles, while those from Miller et al. (2013) are somewhat higher, at around 0.45. Carder et al. (2013) showed very low NO2/NOx ratios for CNG vehicles.

Updates to Refueling and NH_3 Criteria Emissions

Report #3: GHG & Energy Consumption Rates

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

Section 1.1.2 – I like the description of the data sources given, with just a few sentences on each, which is sufficient to give the reader a feel for the data, but not being overwhelming.

Section b 1. Light-duty diesel – Its hard to tell how much data is incorporated into the 1990-2006 GHG report. Graham et al. listed later has some more recent data that is a bit newer.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

Several other studies being/have been conducted in California can provided some additional data in terms of heavy-duty vehicle N2O emission rates, including the nearly completed 200 vehicle study. Overall, the emission rates from the UCR data appear to be on the higher side of the g/kg estimates presented in Table 3.4, but these data also provide a good profile of how N2O emissions can vary as a function of driving condition. On a g/hour basis, our data is in the range of 2.5 to 5 g/hour for SCR vehicles, which seems to be more in the range of the lower load bins in Figure 3.4. Our estimates, in general, appear to be on the higher end of the data ~0.3 to 0.5 g/mi for SCR vehicles. These studies also provide differences between cold start and hot start emissions.

Light-duty diesel vehicle data is more scarce, but Graham et al. (2009) reported median emissions from diesel LDVs meeting the increasingly stringent T2.B10, EURO3, and EURO4 standards of 2, 4, and 5.5 mg N2O/km, respectively. So, they are a bit higher than what is being used in MOVES. Although this study is older, they also give a good review of prior studies, including some comparisons with the GHG reports. Graham, L.A., Belisle, S.L., Rieger, P., 2009. Nitrous oxide emissions from light duty vehicles. Atmos. Environ. 43, 2031-2044.

Another recent review is the following - Hoekman, S. Kent. "Review of Nitrous Oxide (N 2 O) Emissions from Motor Vehicles." *SAE International Journal of Fuels and Lubricants* 13, no. 1 (2020): 79-98.

There are also a few European studies

Suarez-Bertoa, Ricardo, Pablo Mendoza-Villafuerte, Pierre Bonnel, Velizara Lilova, Leslie Hill, Adolfo Perujo, and Covadonga Astorga. "On-road measurement of NH3 and N2O emissions from a Euro V heavy-duty vehicle." *Atmospheric Environment* 139 (2016): 167-175.

Lambert, Christine, Douglas Dobson, Christine Gierczak, Gang Guo, Justin Ura, and James Warner. "Nitrous oxide emissions from a medium-duty diesel truck exhaust system." *International Journal of Powertrains* 3, no. 1 (2014): 4-25.

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

Things are reasonably clear with some exceptions. The paragraph below table 3.4 references a 2016 Preble study, which should be 2019.

One thing that is worth discussing is in going from the LDV section, where emissions are given in g/mi to the heavy-duty section where there are fuel-based emission factors and bins. Some additional information should be provided to better differentiate between the methods.

Our recent data does suggest higher cold start N2O emissions for heavy-duty vehicles. Its probably a pretty small contribution in the broader scheme, as suggested in the section, so its probably not worth making updates at this point, but these data should be considered for the next version of the model.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Table 3-4 and Figure 3-4 are both useful in describing the methodology.

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

The methods appear to be pretty straightforward overall, as data for N2O data is a bit more limited.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

The approach taken appears to be reasonable. Overall, some of the suggestions provided above about differences between light-duty g/mi vs. heavy-duty fuel-based emission factors, and cold starts for heavy-duty vehicles should also apply here.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

More information on cold start heavy-duty N2O emissions should be available shortly, and should be added to the next version of the model. As the overall cold start contribution is probably small for heavy-duty vehicles, this is probably adequate for the time being.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

Most of the suggestions are related to clarity of the presentation and to additional sources of data. The assumptions based on the data sets being used appear to be reasonable.

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

As discussed above, the data inputs for the light-duty vehicles could be improved based on an additional evaluation of the literature. For heavy-duty vehicles, there is data that is nearly published that can be used to update the N2O emissions rates for running emissions and cold starts.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

See previous discussions in terms of the limitations of the model inputs being used.

Updates to Refueling and NH_3 Criteria Emissions

Report #4: Evaporative Emissions from Onroad Vehicles

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

It appears that there are some solid recent data for this portion of the modeling, with the studies for references 42, 43, and 44 all being 2021 or newer. While some of the other studies are older, a number deal with foundational items that should not change dramatically with age, such as temperatures between tank and dispensed fuel (41), vapor vs. RVP (39), and temperature of dispensed fuel (40). It is also good that there is now a value for ORVR vehicles of 0.0361 g/gal, based on IUVP data.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

The data sources for this part of the model appear to be good.

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

There are some parts of the discussion that could be improved.

a. 2nd paragraph – It talks about MOVES not accounting for any interaction between ORVR and dispensing stations. Its just unclear what this means. And the next sentence about the technology adjustment being the same for all locations. Perhaps these could both be included later where they are discussed specifically.

b. Section 3.6.1 equation 13. DT is defined as temperature difference between tank and dispensed … Presumably this is dispensed gasoline temperature.

c. Section 3.6.2 – It is not really clear why spillage is a big function of Stage II and ORVR. Presumably this is the droplets that are dropped when the nozzle goes between the pump and the gas fill location on the car. It seems like this could be defined just to make it clearer.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

I like table 26, which shows the phase in of ORVR.

Where possible, it seems like it would be useful to include descriptive information about how widely the parameters vary. For example, the ambient temperatures being between 45 and 90F. The -0.68%/year, and the 0.0361 g/gal. With that context, it seems like it would be useful for the reader to get an idea for how wide a range there is for "E" in equation 13 (displaced vapor) and the refueling displacement vapor loss in equation 14.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

Overall, the principles used appear to be sound, as refueling losses are going to be function of things like temperature and RVP, with technology adjustments for ORVR and Stage II, that appear to be adequately considered.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

The approach taken appears to be reasonable.

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

It looks like EPA has done a good job in expanding the data used in this section, with data from IUVP testing and a recent high evaporative emission field study, as well as estimates of new estimates for ORVR systems.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

The data sources and associated assumptions appear to be reasonable.

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

The inputs, based on temperature and RVP, with technology adjustments for ORVR and Stage II, that appear to be appropriate.

One item that might be worth considering is that some areas where pollution can be pretty high may have temperature greater than 90F, and that the vapors under those conditions might have a greater impact on high pollution events.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes. The model inputs appear to be consistent with the literature. With EPA having some great sources of data in the IUVP data that would not otherwise be obtained through more traditional studies.

COMMENTS RECEIVED FROM

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Updates to Refueling and NH_3 Criteria Emissions

Updates to Refueling and NH_3 Criteria Emissions

Report #1: Exhaust Emission rates for Light-Duty

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

Yes. The report has clearly identified data sources used to model NH3 emissions from light-duty vehicle (LDV) and trucks (LDT). Selected data sources are described in sufficient details for the reader to make judgement on its quality and extensiveness. Any assumptions made in the process are also identified.

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

No. The data is quite extensive and of good quality. The University of Denver (U of D) data has been cited in several publications.

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

The procedure and methodology used to update NH3 emissions from LDV and LDT in the latest version of the model are described adequately in the report. The averaging process for earlier model year vehicles (1960-1980) is well justified while the remote sensing data used for later model years is described in details. The report provide steps taken, and in some cases description of the steps taken, for developing model inputs.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

The tables and figures represented in the report support the assumptions made in developing the inputs.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

Rigorous methods and procedures are used to validate the U of D data for LDV and LDT> modification of the data for unit consistency is also used in the updated model. The graphical presentation of NH3 emissions for the 1981-2018 vehicle groups and the subsequent equations used to determine FER demonstrate an approach that is rooted in math/statistics and physics.

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

In general, the approaches used are good. The concern is in distinguishing the fuel use in the vehicles in the U of D remote sensing data. The data does not seem to discriminate NH3 emissions between E0, E10 and E85 fueled vehicles. The impact of this on emissions would depend on the number of vehicles with higher oxygenated fuel.

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

Most of the assumptions made to form the approaches are appropriate. The averaging of emissions for earlier model year vehicles is a reasonable assumption and won't introduce much error since the population of these vehicles is bound to be lower compared to recent model year vehicles,

There is very little published data on nitrous acid (HONO) from diesel powered vehicles. The ratio of HONO/NOx ~ 0.8% is reasonable and has been mentioned in the literature.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

It is unclear if all vehicles in the U of D data are assumed to use conventional gasoline (E10 or E0). Recent study (Suarez-Bertoa, 2015) suggests NH3 emissions for the E85 fuel may be slightly higher than the corresponding value for the E10. In addition, there is no accounting if any of the vehicles in the data sets were powered by natural gas which may emit higher levels of NH3 depending on the control system (Farren, et al, 2020). If the data couldn't discriminate between the fuels used, if any, then the report should state so or indicate the assumption made on the fuel usage.

Likewise, it appears that Table 8-3 assumes the fuel in light-diesel powered vehicles is diesel (regular or ULSD). But, some later model diesel vehicles use biodiesel blends, which tend to produce slightly higher NOx than that is produced by 100% diesel. The report may like to mention the type of fuel used in Table 8-3.

5. **Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?**

In general, most of the model inputs are appropriate including those for LDV powered by diesel fuel. The updated report does recognize the limitations of using data from a single location, as was done using the U of D data.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes, based on assumptions made.

Updates to Refueling and NH_3 Criteria Emissions

Report #2: Exhaust Emission rates for Heavy-Duty

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

Yes. The report lists several data sources for the NH3 emissions from heavy-duty (HD) diesel vehicles. It details the year and the location where the data was collected, the number of vehicles involved and the vehicles' after-treatment technologies, etc., to give the reader a general view of the quality, quantity and representativeness of the data

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

The data is very comprehensive

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

The procedure and analytical methods described in the report provide adequate information to the reader to understand the steps taken during the process to develop the model inputs. Most of the assumptions made during the process are implied in the procedure

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

The tables have detailed information on the vehicles and show statistical spread in the values of NH3 emissions rate by exhaust after-treatment technology. The graphical presentation is certainly helpful

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

In general, the methods and procedures used in the computation are technically sound and conform to the physics and engineering disciplines

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

The data used in developing NH3 emissions rate (Preble, et al, 2019) involves snapshot of exhaust analysis including NH3. It is converted to emissions rate through the use of fuel consumption rate described in the earlier part of the report. It would be helpful if the fuel consumption rate is referenced here.

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

The assumptions made by EPA in cases where the data is scant are quite valid

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

The model inputs, derived from the actual measurements or assumed based on the vehicles operating conditions, model year and the after-treatment technology are appropriate and consistent with the chemical and physical processes involved in the on-road vehicles

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes, they are consistent

Updates to Refueling and NH_3 Criteria Emissions

Report #3: GHG & Energy Consumption Rates

1. **Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?**

The report cites data sources to allow the reader to form a comprehensive view of the quality, quantity and representativeness od the data. The data is based on a large inventory of information, collected over a period of several years, for light and heavy-duty diesel powered vehicles

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

The data used in the report is quite good

2. **Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?**

The procedure and analytic methods described in the report are clear in understanding of the steps taken and contains adequate information. It also distinguishes vehicles by model year and exhaust system after-treatment technology.

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

Yes, they are. While there are some differences in the N2O emission rates, these differences are not unusual and come about due to operating conditions as well as the state of the exhaust after-treatment system and its control

3. **Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?**

The procedure employed to arrive at the N2O emission rates is quite valid and uses recent data. Equation 3-1 takes into account physical and mathematical relationships, including variability in N2O levels reported in the data

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

[no comment]

4. Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?

The assumptions made in the report are very reasonable. There is hardly any reliable published data on N2O emissions from diesel or compressed natural gas (CNG) powered vehicles at idle.

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

It would be desirable to include emission rate at idle if and when the data becomes available; its contribution may alter the greenhouse gas (GHG) emission, given the fact that heavy-duty diesel powered vehicle tend to idle for extended periods

5. Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?

The model inputs are appropriate given the information currently available. The relationships used in the model are consistent with physical and mathematical considerations.

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes, they appear to be consistent

Updates to Refueling and NH_3 Criteria Emissions

Report #4: Evaporative Emissions from Onroad Vehicles

1. Does the report describe the selected data sources sufficiently to allow the reader to form a general view of the quantity, quality and representativeness of data used in the analysis?

The report describes data sources that are used to develop evaporative emissions from on-road vehicles. It includes vapor recapturing program at the pump (referred to as Stage II vapor control). The report does identify several sources (data and/or tables) that are used to estimate displaced vapor. While the report relies on data from the state and local authority, it is aware some of the state or local database may not be up to date due to changes and/or termination of some Stage II programs. The data used for the onboard refueling vapor recovery program (ORVR) does account for the phase-in by model year and the type of the vehicle

Can you recommend alternate data sources that might better allow the model to estimate national or regional default values?

The data sources used in the program capture available information quite adequately

2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made by EPA while developing the model inputs?

In general, the methods and procedures provide adequate information to the reader on the steps taken while developing the model inputs. The accounting for spillage for Stage II and ORVR type controls is described clearly enough for readers to understand (those who are familiar with evaporative losses)

Are examples selected for tables and figures well-chosen and effective in improving the reader's understanding of approaches and methods?

The tables are clearly listed (and included) in the report so the reader can comprehend the approaches used in the process.

3. Are the methods and procedures employed technically appropriate and reasonable, with respect to the relevant disciplines, including physics, chemistry, engineering, mathematics, and statistics?

The equation (equation 13) used to estimate displaced vapor has appropriate parameters such as Reid vapor pressure (RVP), temperature of the dispensed gasoline, etc. A study by Wade-Reddy (SAE Trans, 1986) using detailed chemical kinetics showed the tank vapor formation has very similar parameters as those used in equation (13). It is consistent with chemical, engineering and mathematical aspects of the process. The procedure is clear and states specific equations used to arrive at the variables

In making recommendations, please distinguish between instances involving reasonable disagreement in adoption of methods as opposed to instances where you conclude that current methods involve specific technical errors.

Can you suggest or recommend alternate approaches that might better achieve the goal of developing accurate and representative model inputs?

While the methods and approaches are appropriate, it might be helpful to the reader if the report addressed the following:

(a) Does the estimated vapor loss account for the elevation?

(b) Is it assumed that the vapor storage system is unsaturated?

(c) Is there an assumption that there is no difference in fuel temperature between a closed and open fuel injection system?

4. **Where EPA has concluded that applicable data is meager or unavailable, and consequently has made assumptions to frame approaches and arrive at solutions, do you agree that the assumptions are appropriate and reasonable?**

Yes, the assumptions made are appropriate based on when the data was obtained

If not, and you are able to do so, please suggest alternative assumptions that might lead to more reasonable or accurate model inputs.

It may be necessary to visit the diurnal temperatures used in the study

5. **Are the resulting model inputs appropriate and, to the best of your knowledge and experience, reasonably consistent with physical and chemical processes involved in mobile source emissions, formation, and control?**

The inputs to the model seem very reasonable given the complexity of thermochemical reactions that occur in the fuel tank. Most of the model inputs have been derived from physical and/or chemical phenomena

Are the resulting model inputs empirically consistent with the body of data and literature with which you are familiar?

Yes, they are

APPENDIX C

PEER REVIEWER RESUMES

CURRICULUM VITAE

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Work

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Education

University of California, Riverside (9/88 to 1/94)

Ph.D. in Physics awarded January 1994

M.S. in Physics awarded December 1989

University of California, Riverside (9/84 to 6/88)

B.S. in Physics awarded June 1988 (with High Honors)

Professional Experience

Present as of July 2021 Research Engineer, V, Center for Environmental Research and

Technology, University of California, Riverside

Principal investigator for a variety of mobile source related programs with annual budgets of approximately >$1,000,000. Responsibilities include research and program development and management, proposals, project budgeting, the establishment and execution of project plans and schedules, daily oversight of project testing, the analysis and interpretation of test results, and the preparation of project reports and scientific articles.

Previous Experience

2018 – 2021 Research Engineer, VI, Center for Environmental Research and Technology, University of California, Riverside

2015 – 2018 Research Engineer, III, Center for Environmental Research and Technology, University of California, Riverside

2012 – 2015 Research Engineer, II, Center for Environmental Research and Technology, University of California, Riverside

2009 – 2012 Research Engineer, I, Center for Environmental Research and Technology, University of California, Riverside

2007 – 2009 Associate Research Engineer, III, Center for Environmental Research and Technology, University of California, Riverside

2005 – 2007 Associate Research Engineer, II, Center for Environmental Research and Technology, University of California, Riverside

2003 – 2005 Associate Research Engineer, I, Center for Environmental Research and Technology, University of California, Riverside

1996 – 2003 Assistant Research Engineer, Levels II-IV, Center for Environmental Research and Technology, University of California, Riverside

1994 – 1996 Post Doctoral Researcher, Center for Environmental Research and Technology, University of California, Riverside

1994 Lecturer, Physics Department, University of California, Riverside

1992 – 1993 Research Assistant, Center for Environmental Research and Technology, University of California, Riverside

1992 – 1993 Astronomy Instructor, Natural and Agricultural Sciences, Riverside Community College, Riverside, CA

1990 – 1994 Graduate Student Researcher, Physics Department, University of California, Riverside

1990 Assistant Technical Staff Member, The Aerospace Corp., El Segundo, CA

1988 – 1994 Teaching Assistant, Physics Department, University of California, Riverside

1985 and 1988 Technical Summer, Rockwell International, Lakewood and El Segundo, CA

Grants

- CARB, Low NOx monitoring, $500,000.
- CARB, Sensor demonstration, $750,000.
- CALSTART, Hyster top handler, $21,898.
- Attorney General – VW, xxxx, $2,000,000.
- US EPA/ERG, NOx Sensor Evaluation & Support: Sensor Performance & Aging Behavior in Real World, 87549, 7/01/2020 - 6/30/2021, $50,000.
- Tetra Tech, Inc. (Port of Los Angeles), Pasha Green Omni Terminal Project Performance Testing, 3/15/2021 - 11/30/2021, $77,215, PI.
- Eastern Research Group (ERG), Developing a Database for Marine Emissions, 7/1/2020 - 6/30/2021, $55,497, PI.
- Tetra Tech, Inc. (LA County Dept of Public Works), Devil's Gate Emissions Monitoring and Verification, 7/20/2020 - 12/31/2021, $57,130, PI.
- ERG/EPA, “Heavy Duty Vehicle Testing and Data Analysis”, 7/01/20 - 6/30/21, $22,928. PI
- CALSTART/DOE, Medium and Heavy-Duty EV Deployment - Data Collection, 5/01/2020 - 12/31/2022, $435,665, Co-PI.
- CARB, Renewable Diesel Agricultural Engine Testing, 7/01/2021 - 9/30/2022, $150,000, PI.
- CARB, Durability & Performance of Zero-Emission and Near-Zero-Emission Off-Road Equipment, 5/01/2021 - 5/31/2023, $552,000, Co-PI.
- Bureau of Automotive Repair (CA Dept. of Consumer Affairs), Smog Check Performance Report, 4/01/2021 - 3/31/2022, $54,794, PI.

- SCAQMD, Onboard Sensing, Analysis, and Reporting (OSAR): Phase 1 Sensor Evaluation on Heavy Duty Trucks, 5/19/2020 - 5/18/2022, $201,088, co-PI.
- CARB, Collection & Analysis of Agricultural Equipment Activity Data, 6/1/2020 - 5/31/2023, $400,000, PI.
- U.S. Department of Transportation Maritime Administration, Measurement of Criteria Emissions from the MARAD RRF Vessel Cape Henry, 3/04/2020 - 1/31/2021, $138,428, co-PI.
- CARB, Comparison of Exhaust Emissions between E10 CaRFG and Splash Blend E15, 1/01/2020 - 6/30/2021, $500,000, co-PI.
- Volvo Truck Corporation (ARB), Volvo Low Impact Green Heavy Transport Solutions (LIGHTS), 10/18/2019 - 3/31/2022, $172,069.
- Tetra Tech, Inc., “Data Collection & Analysis under the CA Air Resource Board (CARB) Zero-and-Near-Zero Emissions Freight Facility Grant”, 1/01/2019 - 12/31/202 9/01/2019 - 4/01/2021, $200,000. PI.
- Eastern Research Group (ERG), Developing a Database for Marine Emissions, 7/12/2019 - 6/30/2020, $122,996, PI.
- Eastern Research Group (ERG), Developing New and Improving Existing Mobile Source Emission Inventories, 7/09/2019 - 6/30/2020, $42,124, PI.
- SCAQMD, Renewable Diesel for Off-Road Diesel Engines, 6/21/2019 - 10/30/2020, $261,000, co-PI.
- ERG/EPA, “Heavy Duty Vehicle Testing and Data Analysis”, 3/01/19 - 2/29/20, $21,640. PI
- CARB, “Confirmatory and Efficacy Testing of Additive-Based Alternative Diesel Fuel Formulations”, 2/26/2019 - 4/15/2021, $500,000. PI.
- Tetra Tech, Inc., “POLB LCTF + AQIP Off-road Equipment Data Monitoring”, 1/01/2019 - 12/31/2020, $200,000. PI.
- MBTech North America, LLC, “Light Duty PEMS Validation/Chassis Dyno Study”, 10/16/2017 - 10/15/2018, $215,000. Co-PI.
- Cummins Westport Inc., “Ultra Low NOX NG HDT Evaluation”, 8/01/2018 - 3/31/2019, $117,451. Co-PI.
- Eastern Research Group (ERG), Developing New and Improving Existing Mobile Source Emission Inventories, 8/22/2018 - 6/30/2019, $14,537, PI.
- Eastern Research Group (ERG) (Prime sponsor is CARB), “Updates to Heavy-Duty Emission Deterioration in EMFAC”, 6/01/2018 - 5/31/2020, $28,667. PI.
- Gas Technology Inst (GTI - prime sponsor: CEC), “Optimized Hybrid Ultra-Low NOx Class 8 Heavy Duty Natural Gas Truck”, 5/07/2018 - 9/15/2022, $292,274. Co-PI.
- ERG/EPA, “Heavy Duty Vehicle Testing and Data Analysis”, 3/01/2018 - 2/28/2019, $20,317. PI
- CARB, “Low Emission Diesel (LED) Study”, 6/1/2018 - 4/30/2020, $932,499. PI.
- CARB, “Activity Data of Off-Road Engines in Construction”, 2/01/2018 - 1/31/2020, $200,000. PI.
- Volkwagen, “Volkswagen Group In-Use Testing Services and Reporting”, 8/17 – 9/19, $978,825, co-PI.
- SCAQMD, “GDI PEMS - Real World Evaluation of PM and PN emissions from Light-Duty GDI Vehicles using PEMS”, 7/17 – 7/18, $222,000, co-PI.

- SCAQMD, CEC, CARB, and SoCalGas, “In-Use Emissions Testing and Fuel Usage Profile of On-Road Heavy-Duty Vehicles”, 6/17 – 2/20, $1,625,000, PI.
- Ramboll, “On-Road Cycle-Based Light-Duty Vehicle Emissions Testing”, 4/17 – 10/18, $255,523, PI.
- CRC, “Combustion & Emissions Characteristics of a Medium Duty Vehicle Operating on a Hydrogenated Vegetable Oil Renewable Diesel”, 2/17 – 3/18, $180,768, co-PI.
- Growth Energy, “Influence of Ethanol & Aromatics Contents on Gaseous & Particulate Emissions from Current Technology GDI Vehicles”, 8/16 - 7/17, $560,547, co-PI.
- IMC Inc., “Secondary Organic Aerosol (SOA) Forming Potential from Flexible Fuel Vehicles with Direct Injection Fueling on E10, E10 with high aromatics content”, 6/16 - 2/17, $126,000, co-PI.
- ERG-EPA, “PEMS - National Deployment of Portable Emissions & Activity Measurement Systems in Support of the Development & Improvement of Mobile Source Emission Factors”, 5/16 - 1/17, $106,582, PI.
- California Air Resources Board (CARB) “Heavy-Duty on Road Vehicle Inspection and Maintenance Program”, 5/16 – 4/18, $500,000, PI.
- Manufacturers of Emissions Controls Association (MECA), “Secondary Organic Aerosol (SOA) Forming Potential from Light-Duty Gasoline Direct Injection Vehicles Fitted with Gasoline Particle Filters (GPFs)”, 1/16 - 12/17, $64,998, co-PI.
- Electrical Power Research Institute (EPRI), “Relationship between SO3 and H2SO4 in Power Plant Flue Gas”, 1/16 – 10/16, $26,678, Co-PI.
- American Petroleum Institute (API), “Fuel Effects on PM Emissions from Different Vehicle/Engine Configurations: A Literature Review”, 1/16 – 10/16, $53,738, Co-PI.
- AGRON Bioenergy, Biodiesel Testing, 8/15 – 3/16, $94,362, PI.
- CARB “Certification and In-Use Compliance Testing for Heavy-Duty Diesel Engines to Understand High In-Use NOx Emissions engine v chassis”, 9/15 – 8/17, $500,000, PI.
- ERG-EPA, “PEMS - National Deployment of Portable Emissions & Activity Measurement Systems in Support of the Development & Improvement of Mobile Source Emission Factors”, 10/1/2015 - 1/31/2016, $64,590.
- Coordinating Research Council (CRC), “Very Low PM Mass Measurement Phase 2: Evaluation of Partial Flow Dilution, E-99-2”,7/15 – 12/16, $522,078, Co-PI.
- National Center for Sustainable Transportation, “Evaluation of DMC”, 9/30/2015 - 9/30/2018, $38,224, PI.
- CARB “Aerodynamic GHG Emissions Reduction Assessment of Non 53-foot Trailers Pulled by Heavy-Duty Tractors”, 6/15 – 6/17, $500,000, Co-PI.
- NGK Spark Plug, “Evaluate the NTKs Emissions Measurement System”,5/15 – 4/16, $29,329, Co-PI.
- EPRI, “NO Quantum Tunable Diode Laser Evaluation (NO Measurement Investigation)”,5/15 – 12/15, $31,510, Co-PI.
- Tetra Tech, Inc., “Zero/Near Zero Emissions Drayage Truck Testing & Demonstration Guideline Plan”,5/15 – 9/15, $25,000, Co-PI.
- Neste Oil Company, “Fuel Economy Testing for Two HD Vehicles Operated with Alternative Diesel Formulations”, 3/15 – 2/16, $87,685, Co-PI.

- Engine Manufacturers Association (EMA), "Heavy-Duty Chassis Dynamometer Testing," 10/14-6/15, $220,000 PI.
- California Air Resources Board (CARB), "NCST NG Infrastructure Study," 10/14-4/16, $62,500 PI.
- California Air Resources Board (CARB), "Evaluation of Impacts of Emissions Averaging & Flexibility Programs for all Tier 4 Final Off-road Diesel Engines," 8/14-2/17, $300,000 Co-PI.
- CARB, "Evaluation of feasibility, cost-effectiveness, & necessity of Equipping Small Off-road Diesel Engines with Advanced PM and/or NOx aftertreatment," 8/14-8/16, $800,000 PI.
- California Energy Commission (CEC), "CARB LNG Test - Evaluation of Performance & Air Pollutant Emissions of Vehicles Operating on Various Natural Gas Blends - Phase 2," 8/13-3/15, $400,000 PI.
- CARB, "CARB LNG Test - Evaluation of Performance & Air Pollutant Emissions of Vehicles Operating on Various Natural Gas Blends - Phase 2," 6/13-3/15, $120,000 PI.
- Coordinating Research Council (CRC), "Very Low PM Measurements for Light-Duty Vehicles (E-99)," 10/12-12/14, $434,600 Co-PI.
- CARB, "Very Low PM Measurements for Light-Duty Vehicles (E-99)," 2/13-7/15, $100,000 Co-PI.
- California Air Resources Board (CARB), "Evaluation of Fuel Additives as Certified Biodiesel B20 NOx Mitigation Strategies," 6/12-6/14, $300,000 PI.
- CARB, "Biodiesel Emissions Characterization Study of Engines Fueled with B5 Biodiesel Blends," 6/12-6/14, $480,000 Co-PI.
- CEC, "RNG and Fungible Fuels Infrastructure Compatibility Study." 6/12-6/14, $1,200,000, Co-PI.
- CRC, "Biodiesel and Renewable Diesel Characterization & Testing in Modern LD Diesel Passenger Cars & Trucks," 5/12-7/13, $264,704, Co-PI.
- Electric Power Research Institute (EPRI), "UCR Lab TDL Test Cell Modifications for Investigation of Moisture Interference,"5/12-4/13, $50,211, PI.
- Caltrans, "Developing a Model to Quantify Emissions from HD Construction Equipment as Related to Job Site Activity," 4/12-4/14, $200,000 Co-PI.
- American Petroleum Institute, "Impacts of Aromatics in Late Model Vehicles,"2/12-2/13, $265,000 PI.
- South Coast Air Quality Management District (SCAQMD), "Determining the Physical & Chemical Composition & Associated Health Effects of Tailpipe PM Emissions,"1/12-7/13, $175,000 PI.
- SCAQMD, "Health Effects of PM Particles Emitted from Heavy-Duty Vehicles – A Comparison Between Different Biodiesel Fuels,"1/12-1/13, $207,000 Co-PI.
- SCAQMD, "Characterization of the Physical, Chemical, & Biological Properties of PM Emissions, VOCs, & Carbonyl Groups from Commercial Cooking,"1/12-4/13, $150,000 Co-PI.
- SCAQMD, "In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines,"8/11-12/13, $689,000 Co-PI.
- CARB, "Air Quality Improvement Program (AQIP): Hybrid Deployment and Testing Evaluation,"6/11-6/13, $2,000,000 Co-PI.
- EPRI, "Laboratory Testing of HCL and HF TDL instrumentation,"4/11-12/12, $104,797 PI.

- CARB, “Development of a Portable In-Use Reference PM Measurement System,”4/11-9/13, $300,000 Co-PI.
- CARB, “Construction of a Low-Level SO2 DOAS for Installation at a CARB Emissions Test Facility,”4/11-9/13, $90,000 PI.
- CARB, “Biodiesel Certification Testing,” 3/11-6/13, $300,000 PI.
- International Sustainable Systems Research Center, “Evaluation of Air Pollutant Emissions and Fuel Economy of Liquified Petroleum Gas (LPG) Powered Buses/Trucks, 3/11-9/11, $102,458, Co-PI.
- Calumet, “Evaluation of Regulated and Toxic Emissions from 2-Stroke Utility Engines.” 11/10-6/11, $48,071, Co-PI.
- BP Global Fuels Technology, Inc. “Emissions Testing Program.” 11/10-6/11, $250,295, Co-PI.
- CEC “Alternative Fuels/Mixed Alcohols Testing Program.” 7/10-1/14, $1,200,000, PI.
- CARB, “Evaluation of the Performance and Air Pollutant Emissions of Vehicles Operating on Various Natural Gas Blends.,”7/10-8/13, $280,000 Co-PI.
- Sensors, Inc. “Supplemental Testing of PPMD to Resolve Issues with PPMD Observed During the HDIUT PM MA Program,” 7/10-2/11, $67,338, Co-PI.
- Coordinating Research Council (CRC), “Effects of Olefins Content on Exhaust Emissions – Project E-83,” 12/09-12/10, $210,757, PI.
- CARB, “Study of In-Use Engine Deterioration in Diesel Off-Road Equipment,”11/09-5/13, $300,000 PI.
- CEC “PIER Transportation Research Area Alternative Fuel Research Roadmap and Gaps Assessment.” 9/09-10/10, $307,182, PI.
- CARB, “Measurement of Diesel Solid Nanoparticle Emissions using a Catalytic Stripper for Comparison with Europe’s PMP Protocol,”7/09-12/11, $170,000 co-PI.
- CARB, “PM PEMS Validation Testing with a 1065 Compliant PM Laboratory for the PM-PEMS Measurement Allowance Determination for the HDIUT Program,”5/09-12/10, $573,113 PI.
- CARB (from National Biodiesel Board), “Assessment of Emissions from Use of Biodiesel as a Motor Vehicle Fuel in California: Biodiesel Characterization and NOx Formation and Mitigation Study,” 3/09-6/11, $50,000, PI.
- Neste Oil Corporation, “Assessment of Emissions from Use of California Air Resources Board Qualified Diesel in Comparison with Federal Diesel,” 2/08-6/10, $50,000, PI.
- SCAQMD, “Evaluation of the Performance and Air Pollutant Emissions of Vehicles Operating on Various Natural Gas Blends,” 1/09-8/11, $50,000, PI.
- SCAQMD, “Control Device Verification Testing for Stationary Diesel Engines,” 12/08-6/09, $25,000, PI.
- SCAQMD, “Evaluation of Emission Benefits/Debits of Gasoline Fuels in the South Coast Air Basin,” 10/08-9/10, $250,000, PI.
- CARB, “Comparison of PM PEMS for the HDIUT Program with a 1065 Compliant PM Mobile Laboratory,”12/07-6/09, $284,667 PI.

- SCAQMD, “Assessment of Emissions from Use of Biodiesel as a Motor Vehicle Fuel in California: Biodiesel Characterization and NOx Formation and Mitigation Study,” 8/08-6/11, $150,000, PI.
- Caltrans, “Measuring and Modeling PM Emissions from Heavy-Duty Construction Equipment.” 7/08-6/11, $150,000, PI.
- Caltrans, “Evaluation of In-Field Emissions Impacts of Biodiesel Fuels.” 7/08-12/09, $100,000, PI.
- CARB, “Assessment of Emissions from Use of California Air Resources Board Qualified Diesel in Comparison with Federal Diesel,” 6/08-5/10, $1,000,000, PI.
- CEC “Evaluation of the Performance and Air Pollutant Emissions of Vehicles Operating on Various Natural Gas Blends.” 12/07-3/13, $400,000, PI.
- Engine Manufacturers Association “PM Measurement Allowance Phase 1: On-Road Testing Using the CE-CERT Mobile Emissions Laboratory.” 11/07-6/09, $192,770, PI.
- CARB, “Assessment of Emissions from Use of Biodiesel as a Motor Vehicle Fuel in California: Biodiesel Characterization and NOx Formation and Mitigation Study,” 6/07-6/09, $1,360,000, PI.
- CARB, “Assessment of the Emissions from the Use of Biodiesel as a Fuel in California,” 6/06-5/08, $100,000, PI.
- US Environmental Protection Agency (US EPA), “Air Quality and Emissions Measurement at the University of California, Riverside,” 8/06-9/07, $107,200, Co-PI.
- CARB, “Evaluation of the Proposed New European Methodology for Determination of Particle Number Emissions and its Potential in California for In-use Screening”, 6/06-9/07, $250,000, PI.
- CARB, “Measurement Allowance Project,” 7/04-1/08, $500,000, Co-PI.
- CARB, “Evaluate High PM Emitters on Highway,” $249,826, PI.
- O2 Diesel, “Emissions Testing Related to the 02DieselTM Demonstration Program at the Nellis Air Force Base,” 11/05-12/06, $400,000, Co-PI.
- Caltrans, “Evaluating the Emissions from Heavy-Duty Construction Equipment”, 4/05-6/08, $299,641, Co-PI
- UC Berkeley, “Feasibility Study for Biodiesel in the Caltrans Fleet,” 9/05-6/07, $102,307, Co-PI.
- City of Los Angeles, “Implementation Strategies and Training for Alternative Fuel Vehicles,” 4/05-1/07, $90,300, Co-PI.
- US Department of Navy, “Demonstration Plan for Effect for Biodiesel on Diesel Engine Nitrogen Oxide and Other Regulated Emissions,” 8/03-6/06, ~$200,000, Co-PI.
- US Environmental Protection Agency (US EPA), “Air Quality and Emissions Measurement at the University of California, Riverside,” 1/05-9/06, $127,100, Co-PI.
- CARB, “Evaluation of On-Board Diagnostic II (OBD-II) and Tailpipe Test for Use in Smog Check,” 6/03-6/05, $325,666, Co-PI.
- CARB, “Literature Searches for Internal Combustion Engine Air Toxic Emissions and Particulate Matter Mass Measurement and Physical Characterization,” 3/03-6/04, $64,519, Co-PI.
- CRC, “Effects of Ethanol and Volatile Parameters on Exhaust and Evaporative Emissions,” 4/03-3/04, $807,979, Co-PI

- Cal EPA Integrated Waste Management Board, "Yosemite Closing the Loop," 12/02-5/03, $27,500, PI
- CRC, "Ammonia Emissions from Late Model Vehicles – Project E-60," 2/01-12/02, $758,833, Co-PI
- CRC, "Engine Oil Contributions to Emissions – Project E-61," 2/01-12/02, $222,178, Co-PI
- U.S. EPA, "Evaluation of Emissions from Off-Road, 8/01-3/03, $247,799, PI
- NREL & Ford Motor Company, "Emissions Testing of Light Trucks Equipped with Catalyst Particle filters," 3/01-3/02, $117,397, PI
- U.S.EPA, "Investigation of Emission Rates of Ammonia and Other Toxic and Low-Level Compounds as a Function of Gasoline Sulfur Content," 9/00-8/01, $160,500, PI.
- SCAQMD, "Evaluation of the Emissions Impact of Additives, Lubricants, and Engine Flushing Systems," 7/00-7/04, $100,000
- CARB, "Determination of Non-Registration Rates for On-Road Vehicles in California," 4/00-11/01, $210,000, PI
- U.S. EPA, "Evaluation of the Effectiveness of On-Board Diagnostics II (OBD II) in Controlling Emissions," 7/99-3/01, $185,103, PI
- U.S. EPA, "Investigation of Emission Rates of Toxic and Other Low-Level Compounds Using FTIR," 7/99-9/00 $38,070 PI
- CARB, "Off-Highway Motorcycle/All Terrain Vehicle Activity-Data Collection; Personal Watercraft Activity-Data Collection; and Test Cycle Development," 6/99-12/00, $220,000, PI
- SCAQMD, "Evaluation of the Effects of Biodiesel Fuel on Emissions from heavy-duty Non-Road Vehicles: Pilot Study," 6/99-2/00, $25,037, PI
- SCAQMD, "Investigation of Emission Rates of Ammonia and Other Toxic and Low-Level Compounds Using FTIR," 6/99-2/01, $100,000, PI
- SCAQMD, "Evaluation of the Effects of Biodiesel and Biodiesel Blends on Exhaust Emission Rates and Reactivity-Phase 2," 5/99-4/01, $300,000 + gift $25,000, PI
- U.S. EPA, "Investigation of Exhaust Emissions from Light-Duty Vehicles as a Function of Payload," 4/99-3/00, $146,931, PI
- SCAQMD, "Evaluate Effects of Alternative Diesel Fuel Formulation on Exhaust Emission Rates," 6/98-1/99, $258,700, PI
- CARB, "Emissions Testing of Low-Emitting Utility Engines," 3/98-3/99, $49,994, PI
- National Renewable Energy Lab., "Particulate Measurement and Emissions Characterization of Alternative Fuel Vehicle Exhaust," 2/97-10/98, $162,403, pi
- U.S. EPA/Desert Research Institute, "Simple Particulate Emission Measuring System," $36,983, PI
- Magnum Environmental Technologies, Inc., additive testing, 5/00-10/00, $241,636, PI.

Honors and Activities

- Contributing Author IPCC 2006 Inventory for Greenhouse Gases
- Third Alternate Member of the EPA's Federal Advisory Committee Act
- Mobile Source Technical Review Subcommittee [MSTRC] (1999-2003)

- Member of the EPA's OBDII policy workgroup [under the MSTRC] (1999-2003)
- Member Society of Automotive Engineering
- Event Captain 2002 Future Truck Competition
- American Physical Society Student Travel Award (1993)
- Early Dean's Graduate Fellowship at UC Riverside (1988-89)
- Habitat for Humanity (1997/1998)
- Mexico home building volunteer (2007)
- Eagle Scout
- Fraternity Man of the Year (1989)

Journal Articles (Refereed)

1. Kado, N. Y.; Liu, X.; Na, K.; Kobayashi, R.; Durbin, T. D.; Robertson, W.; Austin, J.; Flower, T.; and Okamoto, R. A., 2016, Soy, Animal Biodiesel, and Renewable Diesel: Analyses of Blends with Diesel Fuel and Mutagenic Emissions of the Particle and the Vapor Phases from a Heavy-Duty Vehicle Tested on a Chassis Dynamometer, in preparation xxxx.
2. Tanfeng Cao, Kent C. Johnson, Robert L. Russell, Thomas D. Durbin, David R. Cocker III, Andrew Burnette, Joseph Calavita, and Hector Maldonado, 2017, A Generalized Approach for Characterizing Emissions Benefits of Hybrid Off-Road Equipment via Physical Activity and Engine Work: A Case Study for Bulldozers, in preparation xxxx.
3. S Sato, YJ Jiang, RL Russell, JW Miller, G Karavalakis, TD Durbin, 2022, Experimental driving performance evaluation of battery-powered medium and heavy duty all-electric vehicles, International Journal of Electrical Power & Energy Systems 141, 108100.
4. C McCaffery, H Zhu, CMS Ahmed, A Canchola, JY Chen, C Li, 2022, Effects of hydrogenated vegetable oil (HVO) and HVO/biodiesel blends on the physicochemical and toxicological properties of emissions from an off-road heavy-duty diesel engine, Fuel 323, 124283.
5. C McCaffery, J Yang, G Karavalakis, S Yoon, KC Johnson, JW Miller, 2022, Evaluation of small off-road diesel engine emissions and aftertreatment systems, Energy 251, 123903.
6. S Ghadimi, H Zhu, TD Durbin, DR Cocker, G Karavalakis, 2022, The impact of hydrogenated vegetable oil (HVO) on the formation of secondary organic aerosol (SOA) from in-use heavy-duty diesel vehicles, Science of The Total Environment 822, 153583
7. H Zhu, G Scora, G Karavalakis, K Johnson, R Russell, T Durbin, 2022, Real-world Emissions from 10 Tier 4F Off-road Construction Equipment,
8. C Frederickson, T Durbin, C Li, T Ma, G Scora, H Jung, K Johnson, 2022, Performance and activity Characteristics of Zero Emission Battery-Electric Cargo Handling Equipment at a Port Terminal.
9. Yu Jiang, Yi Tan, Jiacheng Yang, Georgios Karavalakis, Kent C. Johnson, Seungju Yoon, Jorn Herner, Thomas D. Durbin, 2022, Understanding elevated real-world NOx emissions: “Heavy-duty diesel” engine certification testing versus in-use vehicle testing, Fuel 307, 121771.
10. Jiacheng Yang, Tianbo Tang, Yu Jiang, Georgios Karavalakis, Thomas D. Durbin, J. Wayne Miller, David R. Cocker III, Kent C. Johnson, 2021, Controlling emissions from an ocean-going container vessel with a wet scrubber system, Fuel 304, 121323.
11. Chengguo Li, Poornima Dixit, Bill Welch, Abhilash Nigam, Bonnie Soriano, John Lee, Robert L. Russell, Yu Jiang, Hanwei Zhu, Georgios Karavalakis, Kent C. Johnson, David R. Cocker III, Thomas D. Durbin, J.

Wayne Miller, 2021, Yard tractors: Their path to zero emissions, Transportation Research Part D 98, 102972.

12. Cavan McCaffery, Hanwei Zhu, Tianbo Tang, Chengguo Li, Georgios Karavalakis, Sam Cao, Adewale Oshinuga, Andrew Burnette, Kent C. Johnson, Thomas D. Durbin, 2021, Real-world NOx emissions from heavy-duty diesel, natural gas, and diesel hybrid electric vehicles of different vocations on California roadways, Science of the Total Environment, 784, 147224.
13. Niina Kuittinen, Cavan McCaffery, Weihan Peng, Stephen Zimmerman, Patrick Roth, Pauli Simonen, Panu Karjalainen, Jorma Keskinen, David R. Cocker, Thomas D. Durbin, Topi Ronkko, Roya Bahreini, Georgios Karavalakis, 2021, Effects of driving conditions on secondary aerosol formation from a GDI vehicle using an oxidation flow reactor, Environmental Pollution, 282, 117069.
14. Luciana M.B. Ventura, Yu (Jade) Jiang, Kanok Boriboonsomsin, George Scora, Kent Johnson, Sonya Collier, Seungju Yoon, Thomas D. Durbin, 2021, Characterizing non-box trailer activity and aerodynamic devices for greenhouse gas emissions reductions, Transportation Research Part D, 93, 102763.
15. Yu Jiang, Jiacheng Yang, Yi Tan, Seungju Yoon, Hung-Li Chang, John Collins, Hector Maldonado, Mark Carlock, Nigel Clark, David McKain, David Cocker III, Georgios Karavalakis, Kent C. Johnson, Thomas D. Durbin, 2021, Evaluation of emissions benefits of OBD-based repairs for potential application in a heavy-duty vehicle Inspection and Maintenance program, Atmospheric Environment, 247, 118186.
16. C McCaffery, TD Durbin, KC Johnson, G Karavalakis, 2020, The effect of ethanol and iso-butanol blends on polycyclic aromatic hydrocarbon (PAH) emissions from PFI and GDI vehicles Atmospheric Pollution Research, 11, 2056-2067.
17. C McCaffery, H Zhu, G Karavalakis, TD Durbin, JW Miller, KC Johnson, 2020, Sources of air pollutants from a Tier 2 ocean-going container vessel: Main engine, auxiliary engine, and auxiliary boiler Atmospheric Environment, 245, 118023.
18. Hanwei Zhu, Cavan McCaffery, Jiacheng Yang, Chengguo Li, Georgios Karavalakis, Kent C. Johnson, Thomas D. Durbin, 2020, Characterizing emission rates of regulated and unregulated pollutants from two ultra-low NOx CNG heavy-duty vehicles, Fuel, 277, 118192.
19. Patrick Roth, Jiacheng Yang, Christos Stamatis, Kelley C. Barsanti, David R.Cocker III, , Thomas D. Durbin, Akua Asa-Awuku, Georgios Karavalakis, 2020, Evaluating the relationships between aromatic and ethanol levels in gasoline on secondary aerosol formation from a gasoline direct injection vehicle, Science of The Total Environment, 737, 140333.
20. McCaffery, C., Karavalakis, G., Durbin, T., Jung, H., Johnson, K., 2020, Engine-Out Emissions Characteristics of a Light Duty Vehicle Operating on a Hydrogenated Vegetable Oil Renewable Diesel, SAE Technical Paper 2020-01-0337, https://doi.org/10.4271/2020-01-0337.
21. Cavan McCaffery, Hanwei Zhu, Chengguo Li, Thomas D. Durbin, Kent C. Johnson, Heejung Jung, Rasto Brezny, Michael Geller, and Georgios Karavalakis, 2020, On-road gaseous and particulate emissions from GDI vehicles with and without gasoline particulate filters (GPFs) using portable emissions measurement systems (PEMS), Science of The Total Environment, 710, 136366.
22. Jiacheng Yang, Liem Pham, Kent C. Johnson, Thomas D. Durbin, Georgios Karavalakis, David Kittelson, Heejung Jung, 2020, Impacts of Exhaust Transfer System Contamination on Particulate Matter Measurements, Emission Control Science and Technology, 6, 163–177.

23. Patrick Roth, Jiacheng Yang, Weihan Peng, David R. Cocker III, Thomas D. Durbin, Akua Asa-Awuku, and Georgios Karavalakis, 2020, Intermediate and high ethanol blends reduce secondary organic aerosol formation from gasoline direct injection vehicles, Atmospheric Environment, 220, 117064.

24. Jiacheng Yang, Patrick Roth, Thomas D Durbin, Martin M Shafer, Jocelyn Hemming, Dagmara S Antkiewicz, Akua Asa-Awuku, Georgios Karavalakis, 2019, Emissions from a flex fuel GDI vehicle operating on ethanol fuels show marked contrasts in chemical, physical and toxicological characteristics as a function of ethanol content, Science of The Total Environment, 683, 749-761.

25. Jiacheng Yang, Patrick Roth, Hanwei Zhu, Thomas Durbin, and Georgios Karavalakis, 2019, Impacts of Gasoline Aromatic and Ethanol Levels on the Emissions from GDI Vehicles: Part 2. Influence on Particulate Matter, Black Carbon, and Nanoparticle Emissions, Fuel, 252, 812-820.

26. Jiacheng Yang, Patrick Roth, Thomas Durbin, and Georgios Karavalakis, 2019, Impacts of Gasoline Aromatic and Ethanol Levels on the Emissions from GDI Vehicles: Part 1. Influence on Regulated and Gaseous Toxic Pollutants, Fuel, 252, 799-811.

27. Scora, G., Boriboonsomsin, K., Durbin, T.D., Johnson, K., Yoon, S., Collins, J., Dai, Z., 2019, Variability in Real-world Activity Patterns of Heavy-duty Vehicles by Vocation, Transportation Research Board Record, 2673, 51-61.

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31. Vogel, C.F.A., S.Y. Kado, R. Kobayashi, X. Liu, P. Wong, K. Na, T. Durbin, R. A. Okamoto, and N.Y. Kado, 2019, Inflammatory Marker and Ah Receptor Responses in Human Macrophage Cells Exposed to Soy and Animal Biodiesel and Renewable Diesel Emissions Blended with California Diesel Fuel, Chemosphere, 53, 3037-3047, DOI: 10.1021/acs.est.8b06418.

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33. Patrick Roth, Jiacheng Yang, Emmanuel Fofie, David R. Cocker, III, Thomas D. Durbin, Rasto Brezny, Michael Geller, Akua Asa-Awuku, and Georgios Karavalakis 2019, Environ. Sci. Technol., 53, 3037–3047, DOI: 10.1021/acs.est.8b06418.

34. Jiacheng Yang, Patrick Roth, Christopher R. Ruehl, Martin M. Shafer, Dagmara S. Antkiewicz, Thomas D. Durbin, David Cocker, Akua Asa-Awuku, Georgios Karavalakis, 2019, Physical, Chemical, and Toxicological Characteristics of Particulate Emissions from Current Technology Gasoline Direct Injection Vehicles, Science of the Total Environment, 650, 1182-1194, doi: 10.1016/j.scitotenv.2018.09.110.

35. Yang, J., Roth, P., Durbin, T., Johnson, K., Asa-Awuku, A., Cocker, D., Karavalakis, G., 2019, Investigation of the effect of mid- and high-level ethanol blends on the particulate and the mobile source air toxic

emissions from a Gasoline Direct Injection flex fuel vehicle, Energy & Fuels, 33, 429–440, DOI: 10.1021/acs.energyfuels.8b02206.

36. Pham, L., Yang, J., Johnson, K., Durbin, T., Karavalakis, G., Miller, W., Kittelson, D., Jung, H.S., 2018, Evaluation of Partial Flow Dilution Systems for Very Low PM Mass Measurements, Emission Control Science and Technology, 4, 247-259, doi: 10.1007/s40825-018-0099-1.
37. Thomas Durbin, Kent Johnson, J. Wayne Miller, 2018, Editorial, Science of the Total Environment, 642, 1439–1440.
38. Jiacheng Yang, Thomas D. Durbin, Yu Jiang, Takeshi Tange, David R. Cocker III, Kent C. Johnson, 2018, A Comparison of a mini-PEMS and a Fully 1065-Compliant PEMS for On-Road Gaseous and Particulate Emissions from a Light Duty Diesel Truck, Science of the Total Environment, 640-641, 364-376.
39. Tanfeng Cao, Kent C. Johnson, Robert L. Russell, Thomas D. Durbin, David R. Cocker III, Andrew Burnette, Joseph Calavita, and Hector Maldonado, 2018, A Generalized Approach for Characterizing Emissions Benefits of Hybrid Off-Road Equipment via Physical Activity and Engine Work: A Case Study for Excavators, Science of the Total Environment, 635, 112-119.
40. Kanok Boriboonsomsin, Tom Durbin, George Scora, Kent Johnson, Daniel Sandez, Alexander Vu, Yu Jiang, Andrew Burnette, Seungju Yoon, John Collins, Zhen Dai, Carl Fulper, Sandeep Kishan, Michael Sabisch, and Doug Jackson, 2018, Real-World Exhaust Temperature Profiles of On-Road Heavy-Duty Diesel Vehicles Equipped with Selective Catalytic Reduction, Science of the Total Environment, 634, 909-921.
41. Kanok Boriboonsomsin, Thomas Durbin, George Scora, Kent Johnson, Daniel Sandez, Alexander Vu, Yu Jiang, Andrew Burnette, Seungju Yoon, John Collins, Zhen Dai, Carl Fulper, Sandeep Kishan, Michael Sabisch, Doug Jackson, 2018, Real-world exhaust temperature and engine load distributions of on-road heavy-duty diesel vehicles in various vocations, Data in Brief, 18, 1520-1543.
42. Yu Jiang, Jiacheng Yang, Stéphanie Gagné, Tak W. Chan, Kevin Thomson, Emmanuel Fofie, Robert A Cary, Dan Rutherford, Bryan Comer, Jacob Swanson, Yue Lin, Paul Van Rooy, Akua Asa-Awuku, Heejung Jung, Kelley Barsanti, Georgios Karavalakis, David Cocker, Thomas D. Durbin, Wayne Miller, Kent C. Johnson, 2018, Sources of variance in BC mass measurements from a small marine engine: Influence of the instruments, fuels and loads, Atmospheric Environment, 182, 128-137.
43. Georgios Karavalakis, Thomas D. Durbin, Jiacheng (Joey) Yang, Luciana Ventura, and Karen Huaying Xu 2018, Fuel Effects on PM Emissions from Different Vehicle/Engine Configurations: A Literature Review and Statistical Analysis, SAE Technical Paper No. 2018-01-0349, Society of Automotive Engineers, World Congress 2018.
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47. Jacob Swanson, Liem Pham, Jian Xue, Tom Durbin, Robert Russell, and Wayne Miller, David Kittelson, Heejung Jung and Kent Johnson, Uncertainty in Gravimetric Analysis Required for LEV III Light-Duty Vehicle PM Emission Measurements, 2018, SAE Int. J. Engines, 11(3):2018, doi:10.4271/03-11-03-0024.

48. Poornima Dixit, J. Wayne Miller, David R. Cocker III, Adewale Oshinuga, Yu Jiang, Thomas D. Durbin, and Kent C. Johnson, 2017, Differences between Emissions Measured in Urban Driving and Certification Testing of Heavy-duty Diesel Engines, Atmospheric Environment, 166, 275-285.

49. Georgios Karavalakis, Nicholas Gysel, Debra A. Schmitz, Arthur K. Cho, Constantinos Sioutas, James J. Schauer, David R. Cocker, Thomas D. Durbin, 2017, Impact of biodiesel on regulated and unregulated emissions, and redox and proinflammatory properties of PM emitted from heavy-duty vehicles, Science of The Total Environment, 584-585, 1230-1238.

50. Daniel Short, Diep Vu, Vincent Chen, Carlos Espinosa, Tyler Berte, Georgios Karavalakis, Thomas D. Durbin, and Akua Asa-Awuku, 2016. Select Particle Compositions from Spray and Wall-Guided GDI and Flex Fuel Vehicles Operating on Various Ethanol and Iso-butanol Gasoline Blends, Aerosol Sci. & Technol., 51, 330-341.

51. Diep Vu, Daniel Short, Georgios Karavalakis, Thomas Durbin, and Akua Asa-Awuku, 2016. Will Aerosol Hygroscopicity Change with Biodiesel and Renewable Diesel Fuels and Emission Control Technologies?, Environ. Sci. Technol., 51, 1580-1586.

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55. Jian Xue, Ph.D; Yang Li; David Quiros; Xiaoliang Wang; Thomas D Durbin; Kent C Johnson; Georgios Karavalakis; Shaohua Hu; Tao Huai; Alberto Ayala, 2016, Using a new inversion matrix for a fast-sizing spectrometer and a photo-acoustic instrument to determine suspended particulate mass over a transient cycle for light-duty vehicles, Aerosol Science and Technology, 50, 1227-1238.

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62. Thomas D. Durbin, Georgios Karavalakis, Joseph M. Norbeck, Chan Sueng Park, Junior Castillo, Youngwoo Rheem, Kurt Bumiller, Jiacheng Yang, Vincent Van, and Kyle Hunter, 2016, Material Compatibility Evaluation for Elastomers, Plastics, and Metals Exposed to Ethanol and Butanol Blends, Fuel, 163, 248-259.

63. Keith L. Mackay, Alak Chanda, Gervase Mackay, John T. Pisano and Thomas D. Durbin, Keith Crabbe, 2016, Measurement of Hydrogen Chloride in Coal Fired Power Plant Emissions Using Tunable Diode Laser Spectrometry. Journal of Applied Spectroscopy, 83, 627-633.

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Magazine

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CURRICULUM VITAE

Shawn W. Midlam-Mohler

Current Appointments:

Professor of Practice – Primary Appointment 8/2019 to present
Ohio State University Department of Mechanical and Aerospace Engineering, Columbus, OH

Director 7/2017 to present
Ohio State University Simulation Innovation and Modeling Center, Columbus, OH

Fellow 8/2012 to present
Ohio State University Center for Automotive Research, Columbus, OH

Education:

Ph.D. Mechanical Engineering 6/2005
The Ohio State University Columbus, OH
Dissertation Title: "Modeling, Control, and Diagnosis of a Diesel Lean NOx Trap Catalyst"

M.S. Mechanical Engineering 3/2001
The Ohio State University Columbus, OH
Thesis Title: "A Novel Fuel-Operated Heater for Automotive Thermal Management"

B.S. Mechanical Engineering Summa cum Laude, 4.0 GPA 6/1999
Wright State University Dayton, OH

Academic Experience:

Associate Professor of Practice 9/2015 - 8/2019
Ohio State University Department of Mechanical and Aerospace Engineering, Columbus, OH

Associate Director 1/2014 - 6/2017
Ohio State University Simulation Innovation and Modeling Center, Columbus, OH

Assistant Professor of Practice 8/2012 - 8/2015
Ohio State University Department of Mechanical and Aerospace Engineering, Columbus, OH

Research Scientist 10/2008 - 7/2012
Ohio State University Center for Automotive Research, Columbus, OH

Senior Research Associate 11/2005 - 9/2008
Ohio State University Center for Automotive Research, Columbus, OH

Research Associate II 2/2004 - 10/2005
Ohio State University Center for Automotive Research, Columbus, OH

Professional Licenses:

Professional Engineer License 75703
State of Ohio Inactive

Project Management Professional License 1622962
Project Management Institute Inactive

Awards:

National Science Foundation Outstanding Faculty Advisor Award 5/2018

1. Presented to the EcoCAR faculty advisor who best promotes the goals, objectives, and activities related to the EcoCAR student design competition

Honda-OSU Partnership Award 5/2016

2. Presented to an individual who has made significant contributions towards promoting and strengthening the Honda-OSU Partnership

Outstanding Faculty Advisor – Ohio State University College of Engineering 2/2015

3. Presented to most impactful faculty advisor of student engineering teams in the College

Applied Automotive Engineering Fellow - Department of Energy 6/2015

4. Presented to acknowledge significant contributions to applied automotive engineering research and education

Outstanding Technology Team – TechColumbus 2/2012

5. Presented to a team of OSU-CAR faculty and research staff because of their extensive partnerships driving technology forward in Ohio

National Science Foundation Outstanding Incoming Faculty Advisor Award 7/2011

6. Presented to the junior EcoCAR faculty advisor who best promotes the goals, objectives, and activities related to the EcoCAR student design competition

TEACHING AND MENTORING

Doctoral Student Advised:

1. 2015 – 2019 Vivek Bithar. The Ohio State University. Robust MPC-Based Motion Planning and Control of Autonomous Ground Vehicles. 2019.
2. 2014 – 2020 Greg Jankord. The Ohio State University. Control of Criteria Emissions and Energy Management in Hybrid Electric Vehicles with Consideration of Three-Way Catalyst Dynamics. 2020.
3. 2017 – 2020 Phillip Aquino. The Ohio State University.
4. 2014 - 2021 David Hillstrom. The Ohio State University.
5. 2016 – 2021 Wilson Perez. The Ohio State University.
6. 2015 – Present Aditya Karamanchi. The Ohio State University.
7. 2021 – Present Eric Belknap. The Ohio State University
8. 2021 – Present Mayur Patil. The Ohio State University

Doctoral Students Mentored & Funded[1]

1. 2010-2012 Qiuming Gong. The Ohio State University.
2. 2009-2011 Jason Meyer. The Ohio State University.
3. 2007-2010 Kenny Follen. The Ohio State University.

[1]Prior to becoming a Professor of Practice, Dr. Midlam-Mohler was not permitted co-advisor status of PhD students

Masters Student (Advisor / Lead Co-Advisor)

1. M. Fang, Analysis of Variability and Injection Optimization of a Compression Ignition Engine, 2009.
2. R. S. Maringanti, Inverse-Distsance Interpolation Based Setpoint Generation Methods for Closed-Loop Combstion Control of a CIDI Engine, 2009.
3. C. M. Hoops, Uncertainty Analysis for Control Inputs of Diesel Engines, 2010.
4. R. B. Cooley, Engine Selection, Modeling, and Control Development for an Extended Range Electric Vehicle, 2010.
5. B. Bezaire, Modeling and Control of an Electrically-Heated Catalyst, 2011.
6. R. V. Everett, An Improved Model-Based Methodology for Calibration of an Alternative Fueled Engine, 2011.
7. J. M. Davis, Diesel Engine Experimental Design and Advanced Analysis Techniques, 2011.
8. Gupta, Characterization of Engine and Transmission Lubricants for Electric, Hybrid, and Plug-in Hybrid Vehicles, 2012.
9. M. Garcia, Feed-Forward Air-Fuel Ratio Control during Transient Operation of an Alternative Fueled Engine, 2013.
10. N. Hyde, Development of a Traction Control System for a Parallel-Series PHEV, 2014.
11. S. Gurusubramanian, A comprehensive process for Automotive Model-Based Control, 2013.
12. T. Ma, Model-Based Control Design and Experimental Validation of an Automated Manual Transmission, 2013.
13. N. V. Baradwaj, Uncertainty Analysis of Resistive Soot Sensors for On-Board Diagnostics of Automotive Particulate Filters, 2013.
14. S. A. Ramirez, Supervisory Control Validation of a Fuel Cell Hybrid Bus Using Software-in-the-Loop and Hardware-in-the-Loop Techniques, 2013.
15. M. J. Organiscak, Model Based Suspension Calibration for Hybrid Vehicle Ride and Handling Recovery, 2014.
16. D. R. Hillstrom, Light Duty Natural Gas Engine Characterization, 2014.
17. T. Mukherjee, One Dimensional Air System Modeling of Advanced Technology Compressed Natural Gas Engines, 2014.
18. S. Shivaprasad, Model Based Investigation of Lean Gasoline PM and NOx Control, 2014.
19. E. M. Gallo, Development of Series Mode Control of a Parallel-Series Plug-In Hybrid Electric Vehicle, 2014.
20. W. Spiegel, A Soft ECU Approach to Develop a Powertrain Control Strategy, 2015.
21. B. Hegde, Look-Ahead Energy Management Strategies for Hybrid Vehicles., 2018.
22. J. Ward, Modeling and Simulating a Performance Hybrid Electric Vehicle, 2015.
23. S. Yacinthe, System Safety Development of a Performance PHEV Through a Model-Based Systems Engineering Approach, 2016.
24. Khanna, Full-Vehicle Model Development of a Hybrid Electric Vehicle And Development of a Controls Testing Framework, 2016.
25. L. A. Cardinale, Automating the Subjective Analysis of Knock during Hot Engine Starts, 2016.
26. J. Mack, Calibration of Automotive Aftertreatment Models through Co-Simulation with MATLAB Optimization Routines, 2016.
27. M. J. Yatsko, Development of a Hybrid Vehicle Control System, 2016.
28. C. Huester, Design and Validation of an Active Stereo Vision System for the OSU EcoCAR 3, 2017.
29. Modak, Modeling and Control of an Automated Manual Transmission for EcoCAR 3 Vehicle, 2017.
30. D. S. Kibalama, Design and Implementation of a Belted Alternator Starter System for the OSU EcoCAR 3 Vehicle, 2017.
31. B. Bishop, Model-Based Suspension Optimization of the Ohio State EcoCAR 3 Vehicle, 2018.
32. S. J. Trask, Systems and Safety Engineering in Hybrid-Electric and Semi-Autonomous Vehicles, 2019.

33. M. A. Mandokhot, Development of Predictive Gasoline Direct Fuel Injector Model for Improved In-cylinder Combustion Characterization, 2018.
34. E. G. Clepper, Agile Project Management/Systems Engineering of an AV Interior Prototype, 2018.
    A. Thomas, Modeling and Performance Analysis of a 10-Speed Automatic Transmission for X-in-the-Loop Simulation, 2018.
35. J. Hurd, Design of Reconfigurable Interior for Autonomous Vehicle Prototype, 2018.
36. K. B. Kavathia, Uncertainty Analysis of an Engine Test Cell, 2018.
37. S. K. Sahu, Model-Supported Heat- Flux Sensor Development, 2018.
38. U. R. Gambhira, Powertrain Optimization of an Autonomous Electric Vehicle, 2018.
39. E. Stoddart, Computer Vision Techniques for Automotive Perception Systems, 2019.
40. 2018 – 2020 P. Dalke. The Ohio State University.
41. 2018 – 2020 M. Patil. The Ohio State University.
42. 2018 – 2020 K. Kuwabara. The Ohio State University.
43. 2018 – 2020 L. Longmire. The Ohio State University.
44. 2018 – 2020 M. Satra. The Ohio State University.
45. 2019 – 2020 J. Karl-DeFrain. The Ohio State University.
46. 2019 – 2020 S. Goel. The Ohio State University.
47. 2019 – 2020 A. Narasimhan. The Ohio State University.
48. 2019 – 2020 K. Gena. The Ohio State University
49. 2019 – 2021 H. Rangarajan. The Ohio State University.
50. 2018 – 2021 Y. Jin. The Ohio State University.
51. 2019 – 2021 TJ Kirby. The Ohio State University.
52. 2020 – 2021 Vikhyat Kalra. The Ohio State University.
53. 2020 – 2021 Kanna Sundararaman Venkateshwara. The Ohio State University.
54. 2020 – 2021 Iric Bernal. The Ohio State University.
55. 2020 – present Mia Bridgman. The Ohio State University.
56. 2020 – present Vincente Capito-Ruiz
57. 2020 – present Gage Sovey. The Ohio State University.
58. 2020 – present Colin Knight. The Ohio State University.
59. 2021 – present Ron Smith. The Ohio State University.
60. 2021 – present Shaumya Jha. The Ohio State University.
61. 2022 – present Abhijeet Killol. The Ohio State University.
62. 2022 – present Kami Russell. The Ohio State University.
63. 2022 – present Karun Singh. The Ohio State University.

MS Students Mentored and Funded:[2]

1. Eric Snyder, 2005. The Ohio State University.
2. Adam Vosz, 2006. The Ohio State University.
3. Courtney Coburn, 2006. The Ohio State University.
4. Kenny Follen, 2007. The Ohio State University.
5. Josh Cowgill, 2007. The Ohio State University.

[2]These students were mentored by Dr. Midlam-Mohler as a staff member prior to having advising status

Visiting Scholars Supervised:

The following individuals conducted research at Ohio State for periods of 3 – 12 while completing MS/PhD programs at other institutions.

1. Simone Bernasconi, 2007, The Ohio State University.

2. Patrick Rebechi, 2008, The Ohio State University.
3. Andrea Pezzini, 2008, The Ohio State University.
4. Adalbert Wolany, 2009, The Ohio State University.
5. Bernhard Grimm, 2010, The Ohio State University.
6. Asier Martinez, 2011, The Ohio State University.
7. Dennis Kibilama, 2014, The Ohio State University.
8. Africa Junior, 2014, The Ohio State University.
9. Tom Kigezi, 2014, The Ohio State University.
10. Guido Guercioni, 2016, The Ohio State University.
11. Vincente Capito, 2019, The Ohio State University.

Undergraduate Research (Advisor/Supervisor)

1. 2006 – 2007 Rhisee Bhatt. The Ohio State University.
2. 2007 Joshua Supplee. The Ohio State University.
3. 2008 John Lutz. The Ohio State University.
4. 2008 Konrad Svzed. The Ohio State University.
5. 2008 – 2009 Chris Hoops. The Ohio State University.
6. 2008 – 2009 Al Godfrey. The Ohio State University.
7. 2009 Ross Want. The Ohio State University.
8. 2009 Sean Ewing. The Ohio State University.
9. 2009 David Griffin. The Ohio State University.
10. 2009 – 2010 Jennifer Loy. The Ohio State University.
11. 2009 – 2010 John Macauley. The Ohio State University.
12. 2009 – 2010 Alixandra Keil. The Ohio State University.
13. 2009 – 2010 Andrew Arnold. The Ohio State University.
14. 2009 – 2010 Ryan Everett. The Ohio State University.
15. 2009 – 2010 John Davis. The Ohio State University.
16. 2009 – 2010 Katherine Bovee. The Ohio State University.
17. 2010 – 2013 Sarah Jadwin. The Ohio State University.
18. 2010 – 2011 Abbey Underwood. The Ohio State University.
19. 2011 Jerrin Lutcsh. The Ohio State University.
20. 2012 – 2013 Tom Brown. The Ohio State University.
21. 2012 – 2013 Jason Ward. The Ohio State University.
22. 2012 – 2013 Tyler Joswick. The Ohio State University.
23. 2012 – 2013 Sarah Vasey. The Ohio State University.
24. 2012 – 2013 Andrew Speigel. The Ohio State University.
25. 2013 – 2014 Bryan Silverman. The Ohio State University.
26. 2013 – 2014 MJ Yatsko. The Ohio State University.
27. 2013 – 2014 Gaurav Krishnaraj. The Ohio State University.
28. 2012 – 2014 Arjun Khanna. The Ohio State University.
29. 2016 – 2017 Shuhan Yang. The Ohio State University.
30. 2017 – 2018 Briana Antorino. The Ohio State University.
31. 2018 – 2019 Jacqueline Karl-DeFrain. The Ohio State University.
32. 2018 – 2019 Alisson Mellor. The Ohio State University.
33. 2018 – 2019 Kristina Kuwabara. The Ohio State University.
34. 2018 – 2019 Phillip Dalke. The Ohio State University.
35. 2019 – 2020 Iric Bernal. The Ohio State University.
36. 2020 – 2020 Ron Smith. The Ohio State University.

37. 2021 – 2021 Kami Russell. The Ohio State University.
38. 2021 – 2022 James Enders. The Ohio State University

Research Staff Supervision:

Dr. Midlam-Mohler has supervised the following technical staff. Only their current/terminal position is listed.

1. 2014 - 2019 Punit Tulpule. Research Scientist. The Ohio State University.
2. 2015 – 2017 Ayyoub Rezaeian. Post-Doctoral Researcher. The Ohio State University.
3. 2015 – 2021 Emily Nutwell, Research Specialist. The Ohio State University.
4. 2015 – 2019 Sheng Dong, Research Scientist. The Ohio State University.
5. 2015 – 2019 Zhenyu Wang, Research Scientist. The Ohio State University.
6. 2015 – 2021 Raju Dantuluri. Senior Research Associate - Engineer. The Ohio State University.
7. 2017 – Present Satchit Ramnath, Research Associate 2 - Engineer. The Ohio State University.
8. 2017 – Present Peiyu Yang, Research Associate 2 - Engineer. The Ohio State University.
9. 2017 – 2019 Ali Nassiri, Research Scientist. The Ohio State University.
10. 2018 – 2020 Luke Fredette, Post-Doctoral Researcher. The Ohio State University.
11. 2019 – 2021 Rodrigo Auza Gutierrrez, Research Associate 2 – Engineer. The Ohio State University.
12. 2019 – 2020 Rasoul Esmaeilpour, Post-Doctoral Researcher. The Ohio State University.
13. 2021 – Present David Hillstrom, Research Specialist. The Ohio State University.
14. 2021 – Present Dennis Kibalama, Research Specialist. The Ohio State University.

Undergraduate and Graduate Courses:

Dr. Midlam-Mohler’s teaching focuses on automotive technical electives and capstone senior design. His cumulative mean electronic student evaluation score for “Overall Rating” is 4.7 out of a 5-point scale.

Period Offered	**Course Number and Title**
Spring 2007	ME 730 Internal Combustion Engine Modeling
Winter 2009	ME 631 Automotive Powertrain Laboratory
Spring 2009	ME 730 Internal Combustion Engine Modeling
Winter 2010	ME 631 Automotive Powertrain Laboratory
Winter 2011	ENGR 659.01 Multidisciplinary Capstone 1
Winter 2011	ME 565.02 Mechanical Engineering Design 1
Winter 2011	ME 631 Automotive Powertrain Laboratory
Spring 2011	ENGR 659.02 Multidisciplinary Capstone 2
Spring 2011	ME 565.03 Mechanical Engineering Design 2
Winter 2012	ENGR 659.01 Multidisciplinary Capstone 1
Winter 2012	ME 565.02 Mechanical Engineering Design 1
Winter 2012	ME 631 Automotive Powertrain Laboratory
Spring 2012	ENGR 659.02 Multidisciplinary Capstone 2
Spring 2012	ME 565.03 Mechanical Engineering Design 2
Fall 2012	ME 4902.01 Mechanical Engineering Capstone 1

Spring 2013	ME 4902.02 Mechanical Engineering Capstone 2
Spring 2013	ME 5531 Automotive Powertrain Laboratory
Fall 2013	ME 4902.01 Mechanical Engineering Capstone 1
Fall 2013	ME 4194 Applied Project Management and System Engineering 1 (Pilot)
Spring 2014	ME 4902.02 Mechanical Engineering Capstone 2
Spring 2014	ME 5531 Automotive Powertrain Laboratory
Spring 2014	ME 4194 Applied Project Management and System Engineering 2 (Pilot)
Fall 2014	ME 4902.02 Engineering Capstone
Fall 2014	ME 5194 Applied Project Management and System Engineering 1
Spring 2015	ME 5531 Automotive Powertrain Laboratory
Spring 2015	ME 5194 Hardware-in-the-Loop for Control System Development (Pilot)
Spring 2015	ME 4902.02 Mechanical Engineering Capstone 2
Fall 2016	ME 5600 Applied Project Management and System Engineering
Fall 2016	ME 4902.02 Mechanical Engineering Capstone 1
Spring 2017	ME 4902.02 Mechanical Engineering Capstone 2
Fall 2017	ME 4902.02 Mechanical Engineering Capstone 1
Spring 2017	ME 5531 Automotive Powertrain Laboratory
Spring 2017	ME 4902.02 Mechanical Engineering Capstone 2
Autumn 2017	MECHENG 4902.01 ME Capstone Design II: Student Design Competitions
Spring 2018	MECHENG 5531 Automotive Powertrain Laboratory
Spring 2018	MECHENG 4902.02 ME Capstone Design III: Student Design Competitions
Spring 2018	ME 5531 Automotive Powertrain Laboratory
Autumn 2018	ME 4900 ME Capstone Design I
Autumn 2018	ME 4902.01 ME Capstone Design II: Student Design Competitions
Spring 2019	ME 4902.02 ME Capstone Design III: Student Design Competitions
Autumn 2019	ME 4900 ME Capstone Design I
Autumn 2019	ME 4902.01 ME Capstone Design II: Student Design Competitions
Spring 2020	MECHENG 4902.02 ME Capstone Design III: Student Design Competitions
Spring 2020	ME 5531 Automotive Powertrain Laboratory
Autumn 2020	ME 4900 ME Capstone Design I
Autumn 2020	ME 4902.01 ME Capstone Design II: Student Design Competitions
Spring 2021	MECHENG 4902.02 ME Capstone Design III: Student Design Competitions
Spring 2021	ME 5531 Automotive Powertrain Laboratory

Autumn 2021 ME 4900 ME Capstone Design I

Autumn 2021 ME 4902.01 ME Capstone Design II: Student Design Competitions

Curriculum Development – Internal:

ME 5531 Advanced Automotive Systems Analysis 2019, Ohio State University, Columbus, OH

7. Redeveloped previous 5531 course to include autonomous vehicle sensing and electrified powertrains
8. Reused < 50% of previous material
9. Secured donations of equipment for the lab from Fiat Chrysler and Honda

ME 4900 ME Capstone Design I 2018, Ohio State University, Columbus, OH

- Developed a dedicated 4900 course for students engaged in the Student Design Competition Capstone
- Used < 5% of colleague's 4900 course material

ME 5600 Applied Project Management and System Engineering 2016, Ohio State University, Columbus, OH

- Developed new course based on MAE EAB feedback on value of course for our undergraduates
- Course immerses students in a system engineering and project management role-playing scenario

ME 5194 Hardware-in-the-Loop for Control System Development (Pilot) 2015, Ohio State University, Columbus, OH

- Developed new course on HIL to complement existing controls / system modeling courses
- Effort was funded via a competitive grant from The Mathworks

ME 565.02/.02 Mechanical Engineering Design 1 & 2 2011, Ohio State University, Columbus, OH

- Adapted existing MAE and ENGR to work with student design competition teams
- Developed sponsors to fund the activity fully and have never used department funds

ME 631 Internal Combustion Engine Modeling 2009, Ohio State University, Columbus, OH

- Redeveloped course with <25% reuse of previous lecture material and total redevelopment of assignments
- Developed content that walked students through building an entire engine model in stages, developed project that used industry-standard simulation package

ME 730 Internal Combustion Engine Modeling 2007, Ohio State University, Columbus, OH

- Redeveloped course with <10% reuse of previous material/labs
- Developed adaptable labs/content that utilized latest research engines/vehicles at CAR to provide industry-relevant experience for students

Curriculum Development – External:

Dr. Midlam-Mohler is an active participant in the industry-focused distance education program through the Center for Automotive Research. He has also developed a number of courses in his area of expertise for the Department of Energy sponsored advanced technology vehicle competition program.

Internal Combustion Engine Control 2015, Ohio State University, Columbus, OH

- Developed a 6-hour seminar from on IC engine control
- Supported by the Department of Energy

<u>Internal Combustion Engines from a System Perspective 2014, Ohio State University, Columbus, OH</u>

- Developed a 6-hour seminar from on IC engines from a systems perspective
- Supported by the Department of Energy

<u>IC Engine Modeling 2014, Ohio State University, Columbus, OH</u>

- Developed a 6-hour seminar from on modeling of internal combustion engines
- Supported by the Department of Energy

<u>Matlab for Data Analysis and Calibration Seminar 2013, Ohio State University, Columbus, OH</u>

- Developed a 10-hour seminar on the use of Matlab for data analysis and calibration
- Developed for the CAR Distance Education program

<u>SIL/HIL Techniques for Automotive Control Development 2013, Ohio State University, Columbus, OH</u>

- Developed a 10-hour seminar on the use of software-in-the-loop and hardware-in-the-loop techniques for control code validation and verification
- Developed for the CAR Distance Education program

<u>Alternative Fuels Seminar 2013, Ohio State University, Columbus, OH</u>

- Developed a 10-hour seminar on automotive alternative fuels
- Developed for the CAR Distance Education program

<u>Model-Based Control of Hybrid Electric Vehicles 2012, Ohio State University, Columbus, OH</u>

- Developed a 6-hour seminar from on model-based control of hybrid vehicles
- Supported by the Department of Energy

INTERNAL SERVICE

Simulation Innovation and Modeling Center, Director 2017 to present, Ohio State University, Columbus, OH

- Responsible for all Center leadership activities
- Supervise 3 business and 12 technical staff
- Grew center to $6.5M in research annual expenditures
- Supports research of more than 70 faculty, 30 graduate students, and 60 undergraduates

Simulation Innovation and Modeling Center, Associate Director 2014 to 2017, Ohio State University, Columbus, OH

- Responsible for day-to-day operation of the center
- Co-responsible for strategic leadership of the center
- Responsible for all hiring and staff performance
- Responsible for status reports to College and Honda

Business Staff Supervision:

1. 2015 – 2017 Alexis Duffy, Program Manager, The Ohio State University.
2. 2016 – Present Layla Mohamad-Ali, HR/Fiscal Generalist, The Ohio State University.
3. 2017 – Present Heather Sever, Associate Director, The Ohio State University.
4. 2017 – Present Amber Pasternak, Program Manager, The Ohio State University.
5. 2019 – Present Camille Weiker-Isaman, Program Assistant, The Ohio State University.

Internal Board/Committee Involvement:

Simulation Innovation and Modeling Center Steering Board 2014 to present, Ohio State University, Columbus, OH

- Work with other faculty to advance the mission of the SIMCenter

Center for Automotive Research Faculty Advisory Board 2014 to present, Ohio State University, Columbus, OH

- Work with other faculty to advance the mission of the Center for Automotive Research

MAE Graduate Admissions Committee 2012 to 2019, Ohio State University, Columbus, OH

- Reviews graduate student applications and recommends acceptance to the Department and consideration for Department and University fellowships

Student Organization Advising:

EcoCAR Mobility Challenge Hybrid / Autonomous Vehicle Team 8/2018 – present, Ohio State University, Columbus, OH

- Serve as lead co-adviser of a 40 member (~80% undergraduate) student design project team competing in U.S. Department of Energy sponsored vehicle competition
- The team won the competition in the first year along with multiple honors amongst the various award categories

EcoCAR 3 Hybrid Electric Vehicle Team 8/2014 – 5/2018, Ohio State University, Columbus, OH

- Serve as lead co-adviser of a 40 member (~80% undergraduate) student design project team competing in U.S. Department of Energy sponsored vehicle competition
- The team has won the competition in each of the four competition years along with multiple honors amongst the various award categories

EcoCAR 2 Hybrid Electric Vehicle Team 7/2011 – 6/2014, Ohio State University, Columbus, OH

- Served as lead co-adviser of a 40 member (~80% undergraduate) student design project team competing in U.S. Department of Energy sponsored vehicle competition
- The team finished 2nd place in the first year of competition, 3rd place in the second year, and 1st place the final year of the competition

EcoCAR Challenge Hybrid Electric Vehicle Team 6/2008 – 6/2011, Ohio State University, Columbus, OH

- Served as lead co-adviser of a 40 member (~80% undergraduate) student design project team competing in U.S. Department of Energy sponsored vehicle competition
- Team won 1st, 5th, and 2nd in the three years of competition and won numerous event awards

Challenge-X Hybrid Electric Vehicle Team 8/2006 – 6/2008, Ohio State University, Columbus, OH

- Co-advised primarily undergraduate team competing in a U.S. Department of Energy sponsored advanced technology vehicle competition
- Over the course of the four year competition from 2004 – 2008, OSU placed 3rd, 4th, 4th, and 3rd respectively

Diversity Activities

Dr. Midlam-Mohler EcoCAR team has won 10 awards for support of diversity in engineering. He has mentored three SROP students (URMs) and funded two of them as graduate students as they conducted their graduate studies at OSU.

EXTERNAL SERVICE

Service to Government Agencies:

EPA Vehicle System Model Reviewer 2016, Peer Reviewer

- Conducted a ~30 hour peer review of a system model for future vehicle technology used in making policy decisions for future fuel-economy regulations

NHTSA Automotive Technology/Policy Report Reviewer 2015, Peer Reviewer

- Conducted a ~20 peer review of a studies of future vehicle technology used in making policy decisions for future fuel-economy regulations.

NHTSA Automotive Technology/Policy Report Reviewer 2014, Peer Reviewer

- Conducted a ~30 peer review of a studies of future vehicle technology used in making policy decisions for future fuel-economy regulations.

EcoCAR 2 Faculty Advisory Board, Board Member 2013-14

- Work with Department of Energy staff, Argonne National Labs Staff, General Motors staff, and four other EcoCAR faculty advisors to improve the student design experience for the EcoCAR program

Clean Fuels Ohio, Columbus, OH 2009-13, Member of the Board of Directors

- Elected to Board of Directors of Clean Fuels Ohio, a non-profit committed to cleaner transportation fuels which is part of the U.S. Department of Energy Clean Cities program
- Served as Secretary and member of the Executive Committee for the organization

EPA Automotive Technology Policy Report Reviewer, Peer Reviewer 2012

- Conducted a ~30 hour peer review of a study of future light-duty vehicle technology used in making policy decisions for future fuel-economy regulations.

EcoCAR 2 Faculty Advisory Board, Board Member 2011-12

- Work with Department of Energy staff, Argonne National Labs Staff, General Motors staff, and four other EcoCAR faculty advisors to improve the student design experience for the EcoCAR program

EPA Light-Duty Vehicle Model Reviewer, Peer Reviewer 2011

- Conducted a ~30 hour peer review of a study of future light-duty vehicles for the U.S. EPA used for guiding future fuel economy and greenhouse gas emissions regulations

EPA GEM Model Reviewer, Peer Reviewer 2010

- Conducted a ~20 hour peer review of a heavy-duty truck model developed by the U.S. EPA used for predicting fuel economy and greenhouse gas emissions

State of Indiana 2009, Proposal Reviewer

- Reviewed multi-million dollar proposal for Indiana grant program in area of internal combustion engines

Conference and Session Organization:

<u>NAFEMS 2019 Session Chair 2019</u>

- Organized session focused on modeling and simulation education

<u>E'COSM 2015 Co-Chair 2015</u>

- Worked with Chair (Giorgio Rizzoni) to host major conference at Ohio State University

Journal / Conference Publication Reviewer:

Dr. Midlam-Mohler is a reviewer for the following publications / conferences:

1. International Journal of Vehicle Design
2. International Journal of Powertrains
3. Society of Automotive Engineers World Congress
4. American Society of Mechanical Engineers - Dynamic Systems and Control Conference
5. Institute of Electrical and Electronics Engineers – American Controls Conference
6. Institute of Electrical and Electronics Engineers - Conference on Decision and Control
7. Institute of Electrical and Electronics Engineers - Transactions on Automatic Control
8. Institute of Electrical and Electronics Engineers - Transactions on Power Systems

Professional Society Membership:

- ASME
- IEEE
- SAE

SCHOLARSHIP

Dr. Midlam-Mohler maintains an active research program and has been awarded more than $10 million in research funding. He has 1200+ citations and an h-index of 19 via Google Scholar and 650+ citations and an h-index of 14 via SCOPUS. He has more than 100 peer-reviewed conference publications, journal publications, and issued US patents assigned to industry. He has been PI or co-PI on five projects which have generated intellectual property royalties via trade secret generation.

Research Grants/Funding:

Dr. Midlam-Mohler was PI or co-PI on the following research projects:

Start Date	Duration (Years)	Sponsor	Project Title
8/2005	1.9	Tenneco Automotive	Diesel Particulate Filter Regeneration with External Burner
9/2005	3.3	Tenneco Automotive	Reductant Generation for NOx Remediation
3/2007	0.8	Tenneco Automotive	Heavy-Duty Burner Prototypes and Control Development
3/2007	3.8	General Motors Corp	Development and Implementation of a Methodology, Processes, and Tools to Produce a Hierarchy of Powertrain Models that Enable a Math-Based Virtual Design Environment for Powertrain Control

Start Date	Duration (Years)	Sponsor	Project Title
9/2007	1.6	Nat Energy Tech Lab	Design and Fabrication of Diesel Fuel Atomizers
1/2008	2.0	Tenneco Automotive	Non-Catalytic Reformer Sensitivity Study and Prototype Development
4/2008	4.0	Cummins, Inc	Diesel Engine Combustion Control
9/2008	3.0	Department of Energy / General Motors	EcoCAR 1 Advanced Technology Vehicle Competition
1/2009	3.0	CAR PHEV Consortium	Fleet Studies and Transformer Modeling of PHEVs
4/2009	2.3	FirmGreen, Inc.	Landfill Gas Derived CNG Fuel Cycle Analysis
4/2009	3.4	Cummins, Inc	Cummins CIDI Engine Variability Measurements
4/2009	2.5	Stoneridge	Soot Sensor Testing and Soot Sensor Test Fixture
9/2009	1.3	Henkel Corp	Combustion Chamber Coating Evaluation
5/2010	3.8	Chrysler Group LLC	Advanced Technology Powertrains for Light-Duty Vehicles
10/2010	2.0	CAR Industrial Consortium	Lubricant Effects on Advanced Technology Vehicles
8/2011	3.0	Stoneridge	Fundamental Electrical Properties of Diesel Soot Films on a Diesel Soot Sensor
9/2011	3.0	Department of Energy / General Motors	EcoCAR 2 Advanced Technology Vehicle Competition
8/2012	2.0	Ctr for Trans. & Environment	ECO Saver IV Hybrid Electric Fuel Cell Bus Demonstration
10/2012	2.0	CAR Industrial Consortium	Gasoline Engine Particulate Matter Control
1/2013	0.3	Honda R&D Americas	Automated Vehicle Control Using Low-Cost Sensors
7/2013	0.5	American Electric Power	Plug-In Electric Vehicle Data Analyses, Insights and Reports
12/2013	2.0	Chrysler Group LLC	Model-Based Optimization and Control Methodology for the Design of Chrysler's Next Generation Powertrain Control Systems
9/2014	2.0	Honda R&D Americas	Engine Startability Simulation, Modeling, and Control
9/2014	2.0	Honda R&D Americas	Model-Based Engine Calibration Techniques

Start Date	Duration (Years)	Sponsor	Project Title
9/2014	1.5	CAR Industrial Consortium	HIL Capabilities Development
9/2014	1.5	CAR Industrial Consortium	Flexible Engine ECU Development
9/2014	2.0	Chrysler Group LLC	Model-Based Particulate Filter Diagnosis and Control
9/2014	4	Department of Energy / General Motors	EcoCAR 3 Advanced Technology Vehicle Competition
6/2015	0.3	Harley-Davidson Motorcycles	Development of a Post-Catalyst Air-to-Fuel Ratio Controller
10/2015	2	General Motors	Engine Calibration Using Eigenvariables
9/2016	2	Honda R&D Americas	APEX Phase 1 – 2030 Concept Vehicle R&D
9/2016	3	Honda R&D Americas	1D and 3D Model-Based Engine Design Techniques
9/2016	1.3	Honda R&D Americas	0D Tool Development to Improve Combustion Modeling Performance
10/2016	0.3	Schaeffler Group USA Inc.	Trailer Sway Vehicle Dynamics and Control
11/2016	0.3	Harley-Davidson Motorcycles	Fuel and Air Dynamics Modeling and Compensation for PFI IC Engines
6/2017	3	Honda R&D Americas	Traffic System Modeling for ADAS/Autonomous Vehicles
9/2017	1.5	GE Appliance	Model-Based Heat Flux Sensor Development
10/2017	1.5	Honda R&D Americas	Transmission Modeling for xIL Simulation
12/2017	0.75	Honda R&D Americas	Powertrain Optimization for the APEX Autonomous Vehicle
12/2017	0.75	Honda R&D Americas	Structural Optimization for the APEX Autonomous Vehicle
6/2018	3	Ford / Honda	Virtual V/V of Autonomous Vehicle Software for Safety
6/2018	2	Trans. Res. Center (TRC)	Development of Virtual Test Cases for AV Safety
9/2018	4	Department of Energy / General Motors	EcoCAR Mobility Challenge
6/2019	0.5	Honda R&D Americas	Human-Centric Metrics of ADAS Vehicle Drive Quality
8/2019	0.5	Honda R&D Americas	3D Modeling of GDI Combustion
9/2019	0.5	NHTSA-VRTC	Evaluation of Open Source Standards for Autonomous Vehicle Test Case Creation

Start Date	Duration (Years)	Sponsor	Project Title
6/2020	0.75	Air Force Research Lab / Perduco	Convergence Criteria Development and Application AFSIM Scenarios
8/2020	3	Department of Energy	Simulation-Driven Design Optimization and Automation for Cordwood-Fueled Room Heaters
9/2020	3	Department of Energy	NEXTCAR 2 Program

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4. Patil, M., Lybarger, A., Midlam-Mohler, S., & Stoddart, E. (2021). Driving Automation System Test Scenario Development Process Creation and Software-in-the-Loop Implementation. SAE Technical Paper.
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Patents:

In addition to the following patents, Dr. Midlam-Mohler has a number of trade secrets in use in industry around control algorithms or processes. Industry often chooses not to patent these as it offers greater protection because of the difficulty in enforcement.

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9. Y. Hu, K. Dudek, S. Midlam-Mohler, Y. Guezennec, S. Yurkovich, L. Wiggins, “System and method for determining a camshaft position in a variable valve timing engine”, U.S. Patent 8,096,271, awarded 1/17/2012.
10. S. Liu, K. Dudek, S. Rajagoplan, S. Yurkovich, Y. Hu, Y. Guezennec, S. Midlam-Mohler, “Off-line calibration of universal tracking air fuel ratio regulators”, U.S. Patent 7,925,421, awarded 4/12/2011.
11. K. Dudek, S. Rajagoplan, S. Yurkovich, Y. Hu, Y. Guezennec, S. Midlam-Mohler, L. Avallone, I. Anilovich, “Air fuel ratio control system for internal combustion engines”, U.S. Patent 7,937,209, awarded 5/3/2011.
12. S. Midlam-Mohler, B. Masterson, "System for Controlling NOx Emissions during Restarts of Hybrid and Conventional Vehicles,” U.S. Patent 7,257,493, awarded 3/21/07.
13. S. Midlam-Mohler, "System and Method for Reducing NOx Emissions after Fuel Cut-Off Events,” U.S. Patent 7,051,514, awarded 5/30/06.

Intellectual Property Royalties:

The following five research projects involved royalty payments to OSU for exclusive rights to IP from the research project. None of these projects resulted in patents, instead, the company uses the IP as a trade secret.

1. Model-based optimization and control methodology for the design of Chrysler's next generation powertrain control systems, 12/01/2013 - 11/30/2015, Co-PI
2. Model-Based Gasoline Particulate Filter System Design, Control, And Diagnosis 07/01/2014 - 07/15/2016, Sole PI
3. Engine Startability Simulation, Modeling, And Control 09/01/2014 - 02/28/2017, Sole PI
4. Engine Calibration Using Eigenvariables, 10/15/2014 - 09/15/2016, Lead PI
5. Model-Based Heat Flux Sensor Development, 09/01/2017 - 12/31/2018, Lead PI

Applied R&D Projects Judged in Juried Competitions:

The following table contains awards earned by the EcoCAR team which Dr. Midlam-Mohler advises. Entry into the competition is competitive and has included many well-regraded engineering schools.. Awards are decided by either quantitative evaluation of vehicle performance or via qualitative assessment by panels of ~6 to ~12 experts from industry, the Department of Energy, and Argonne National Lab.

<u>EcoCAR Mobility Challenge 2020</u>
Competition Sponsors: U.S. Department of Energy, General Motors, and The Mathworks

1. 1st Place Subsystem Design Report
2. Best Final Technical Report
3. Best Human-Machine Interface and User Interface Video
4. Best Execution Plan
5. Best Impact Report
6. Women in STEM Award to Team Member Kristina Kuwabara

Note: Due to Covid-19, there was no overall winner in this competition year

<u>EcoCAR Mobility Challenge 2019</u>
Competition Sponsors: U.S. Department of Energy, General Motors, and The Mathworks

1. 1st Place Overall
2. 1st place: Target Market Presentation
3. 1st place: Controls and Systems Modeling & Simulation Presentation
4. 2nd place: Connected and Automated Vehicle Systems Presentation
5. 3rd place: Propulsion System Integration Presentation
6. Best Final Technical Report
7. 2nd Place in Connected and Automated Vehicle Systems Deliverables
8. 2nd Place: NSF Excellence in Connected and Automated Vehicles
9. 1st Place NSF Diversity in Engineering Award

<u>EcoCAR 3 Competition 2018</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. 1st Place Overall
2. Best Emissions Testing Event Performance
3. NSF Best Innovation Research Papers
4. 1st TRC Best Total Energy Consumption Award
5. 1st TRC Best Wheel-to-Well Petroleum Energy Usage

6. 1st Over the Road Event
7. 1st dSPACE Embedded Success Award
8. General Motors Women in Engineering Rookie Award
9. NSF Diversity in Engineering Award
10. 1st Vehicle Design Report
11. 1st Consumer Appeal
12. 1st Innovation Presentation
13. 2nd Control and SMS Presentation
14. 2nd Mechanical Presentation
15. 2nd Mathwork Modeling Award
16. 3rd ADAS Presentation

<u>EcoCAR 3 Competition 2017</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. Overall Competition, 1st Place
2. Overall Project Management, 1st Place
3. Vehicle Design Report, 1st Place
4. Project Status Presentation, 1st Place
5. Innovation Presentation, 3rd Place
6. Consumer Appeal Event, 2nd Place
7. ECE Presentation, 1st Place
8. Mechanical Presentation, 2nd Place
9. E&EC UFW Total Energy Consumption, 1st Place
10. E&EC UFW WTW Criteria Emissions, 1st Place
11. E&EC UFW WTW GHG Emissions, 1st Place
12. E&EC UFW WTW PEU, 1st Place

<u>EcoCAR 3 Competition 2016</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. Overall Competition, 1st Place
2. Overall Project Management, 2nd Place
3. Competition Project Status Presentation, 2nd Place
4. Controls Presentation, 1st Place
5. Electrical Presentation, 1st Place
6. Final Technical Report, 2nd Place
7. Mechanical Presentation, 2nd Place
8. Vehicle Design Report, 1st Place
9. Vehicle Design Review, 3rd Place
10. WW HIL Review, 1st Place

<u>EcoCAR 3 Competition 2015</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. 1st Place Overall
2. Best Final Stakeholder Status Presentation
3. Best Winter Workshop Innovation Topic Review
4. Best Innovation Presentation
5. Best Control Systems Presentation
6. Best Trade Show Presentation

7. SMS Presentation and Demonstration
8. Best Consumer Market Research Report
9. 2nd Place Project Management
10. dSPACE Embedded Success Award, 1st Place
11. MathWorks Modeling Award, 2nd Place

<u>EcoCAR 2 Competition 2014</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. 1st Place Overall
2. Lowest Petroleum Energy Use
3. Lowest Criteria Emissions
4. Best Final Technical Report
5. Best Static Consumer Acceptability
6. Best Controls Presentation
7. Best Electrical Presentation
8. Best Progress Reports
9. ETAS ECU Excellence Award, 1st Place
10. dSPACE Embedded Success Award, 1st Place
11. MathWorks Modeling Award, 2nd Place

<u>EcoCAR 2 Competition 2013</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. 3rd Place Overall
2. Best Final Technical Report
3. Best Electrical Presentation
4. Best Progress Reports
5. Women in Engineering Award
6. MathWorks Modeling Award, 2nd Place

<u>EcoCAR 2 Competition 2012</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. 2nd Place Overall
2. Best Winter Workshop Controller HIL Evaluation, 2nd Place
3. Best Project Initiation Approval Presentation, 2nd Place
4. Best Controls Presentation, 3rd Place
5. Best Final Controller HIL Evaluation, 1st Place
6. Best Trade Show Evaluation, 2nd Place
7. dSPACE Embedded Success Awards, 1st Place
8. MathWorks Modeling Award, 1st Place
9. Women in the Winner's Circle Foundation Women in Engineer Awards

<u>EcoCAR Competition 2011</u>
Competition Sponsors: U.S. Department of Energy and General Motors

1. 2nd Place Overall
2. Best Controls Presentation
3. Freescale Innovation Award
4. The MathWorks Modeling Award, 2nd Place
5. dSPACE Embedded Success Award, 2nd Place

6. BOSCH Diversity in Engineering Award, 1st Place

EcoCAR Competition 2010
Competition Sponsors: U.S. Department of Energy and General Motors

1. 5th Place Overall
2. HIL Evaluation Event, 1st Place
3. Dynamic Consumer Acceptability, 1st Place
4. Freescale Silicon on the Move Award
5. The MathWorks Modeling Award, 1st Place
6. dSPACE Embedded Success Award, 1st Place
7. BOSCH Diversity in Engineering Award, 3rd Place
8. Women in the Winner's Circle Foundation, Women in Engineering Award

EcoCAR Competition 2009
Competition Sponsors: U.S. Department of Energy and General Motors

1. 1st Place Overall
2. Best Written Design Report
3. HIL Evaluation Event, 1st Place
4. Controls Event Presentation, 1st Place
5. Best Trade Show Display and Presentation
6. Best Technical Success Story
7. Freescale Silicon on the Move Award, 3rd Place
8. dSPACE Embedded Success Award, 1st Place
9. BOSCH Diversity in Engineering Award, 1st Place

CURRICULUM VITAE

Keshav S. Varde

Professor (Emeritus) of Mechanical Engineering
University of Michigan, Dearborn Campus, MI 48128

1. Academic Qualifications

Ph.D., Mechanical and Aerospace Sciences, University of Rochester, NY.
MSE, Mechanical and Aerospace Sciences, University of Rochester, NY

2. Technical Reviewer

Proposal reviewer for (a) Department of Energy (b) National Science Foundation, Innovation/SBIR Proposals - Phase I & II, Education Division, Chemical & Thermal, PFI, GRF (c) U.S. EPA research, SBIR Phase I and II, GROW and STAR Fellowships (d) Department of Energy ARPA-E, (e) Minnesota Technology Council, (f) National Research Council, Canada, (g) Hong Kong Research Grants Council, (h) Council of Scientific and Industrial Research, India, (i) National Research Council of Canada.

Technical paper/book reviewer: ASME J. of Power; J Energy Systems; J. Energy and Environment; J. Auto Engineering; ASME-Power; IEEE – Instrumentation, Sensors; SAE; A. Chemical Society; ABET-mechanical engineering program; ASEE; McGraw Hill and Elsevier Publishers, External reviewer for PhD theses.

3. Publications (2007-2017)

1. Chaudhary, A. and **Varde, K. S**., Hybrid Powertrain Prediction for Vehicle Fuel Economy and Emissions, Proceedings 10th International Colloquium on Fuels, Stuttgart, Germany (ISBN 978-3-943563-16-0, 189-194, 2015
2. Kalushe, K. and Varde, K. S., Exhaust Emissions from a Single Cylinder Engine Using Biodiesel Blends and Cooled EGR, 10th International Colloquium on Fuels, Stuttgart, Germany, (ISBN 978-3-943563-16-0), 413-418, 2015.
3. **Varde, K. S**. and Veeramachineni, S., A Comparative Study of Biodiesels Derived from Soy and Tallow, Paper No F2014-CET-043, FISITA, 2014.
4. **Varde, K. S**., Simulation and Validation of Spark Ignition Engine Performance on E85, 9th Symposium of Fuels and Lubricants, 9th International Colloquium on Fuels, Stuttgart, Germany, 128-134, 2013.
5. Karthikeyan, D. and **Varde, K. S**., Efficiency of a PEM Fuel Cell Stack during Transient Loading, IEEE International Meeting on Renewable Energy, March 4-7, Al-Ain, UAE, 2012.
6. Veeramachineni, S. and **Varde, K. S**, Simulation of Combustion in a DI Diesel Engine Operating on Biodiesel Blends, ASME Paper IMECE2011-64504, 2011.
7. Veeramachineni, S. and **Varde, K. S**., Exhaust Emissions from Biodiesels Derived from Vegetable Oil and Animal Fat, Proceedings *Eight Fuels Conference*, Germany, 2011,65-71.
8. **Varde, K. S**. and Manoharan, N., Characterization of Exhaust Emissions in a SI Engine using E85 and Cooled EGR, *SAE Paper 09SFL-0303*, 2009
9. **Varde, K. S**. and Frank, D., Characterization of a PEM Fuel Cell Stack Under Transient Conditions and its Use in Simulating a Fuel Cell Powertrain, *ASME Paper FUELCELL 2009-85020*, 2009.
10. **Varde, K. S**., et al, A Study of Exhaust emissions from a Single Cylinder DI Diesel Fueled on Soy Biodiesel Blends, Proc. TAE 7th *Colloquium on Alternate Fuels*, Stuttgart, 229-234, 2009.

11. Potluri, P. and **Varde, K. S**., PEM Fuel Stack Characterization and its Integration in Simulating a Fuel Cell Powertrain," *SAE Paper 2008-01-1798*, 2008.
12. **Varde, K.S**, Jones, A, Knutsen, A, Mertz, D. and Yu, P., Exhaust Emissions and Energy Release Rates from a Controlled SI Engine using Ethanol Blends, *J. Auto Eng., Part D*, Vol 221, 8, 933-941, 2007.

And 80+ more technical papers

4. Graduate Theses supervised (2007-2017)

1. Development of a variable compression ratio engine, Andrew Maxfield Mitchell, 2017
2. 1D - CFD Coupled Crankcase Flow Evaluation for an Inline Four Cylinder Engine, Brandon Holmes, 2016
3. Prediction of injection pressures and diesel engine performance with biodiesel blends, G. Gong, 2015
4. Dual Fuel Combustion Simulation using Forte-Reaction Design, N. Nachappa and Kaushik K. Prasad, 2014
5. Simulation of a HEV for Predicting Fuel Economy and Exhaust Emissions, Abhijeet Chaudhary, 2014
6. Effect of EGR on NOx and PM Emissions from a DI Diesel Engine Fueled by Biodiesel, K. Kalushe, 2013
7. Modeling of a FC Powertrain using SS characterization of a PEMFC stack, P. Potluri, 2012
8. Engine Performance and Emission Characteristics of Soybean Biodiesel Blends, S. Veeramachineni, 2010
9. Modeling a PEM Fuel Cell stack under transient conditions, D. Frank, 2009

5. Funded Grants and Contracts (2007-2017)

- 2012-2017: Combustion Research, Corporate Funding, $55,000, PI: K. S. Varde
- 2010-2012: PURSE Program, National Science Foundation (through DAPCEP), $46,000, PI: K. S.Varde
- 2008-2010: Characteristics of Biodiesel Mixtures for DI Diesel Engines, $47,350, Center Engineering Education and Practice, PI: K. S. Varde
- 2007-2008: Biodiesel for Use in Diesel Engines, $48,410, State of Michigan Energy Program, Office DLEG, State of Michigan, PI: K. S. Varde
- 2005-2008: Distributed Power Generation, $95,458, Department of Energy (a portion of $934,000 grant on Energy - primary grant $934,000, TEC UM-Ann Arbor)
- 2007-2008: Study of a PEM Fuel Cell stack, DTE Energy (through Plug Power), PI: K.S. Varde
- 2005-2007: Hydraulic Hybrid Powertrain Development Project, $38,000, DCX Corporation, PI: K. S. Varde
- 2003-2007: ITEST Program, National Science Foundation, $177,600 (DAPCEP subcontract), PI: K. S. Varde
- 2003-2007: Powertrain Simulation for a Low-Mass Vehicle, Institute for Advanced Vehicle Systems, $49,200, PI: K. S. Varde
- 2003-2007: Research in Combustion Engines and Exhaust Emissions: NSF, $185,349, PI: K. S. Varde

6. Consultant/Contracting Work

Launchpoint Technologies, California; Ford Motor Company, Michigan; EXEN, LLC, California; Lucerne Engineering Products, Michigan; Borg-Warner Inc, Michigan; Hong Kong RGC, Honk Kong; Booze, Allen and Hamilton, Virginia; Diesel Engine Controls, Michigan; EPA; SOCAL, California; Allied Signal, Michigan; Bendix, Michigan; Minnesota Technology, Inc., Minnesota

7. Scientific and Professional Societies of which a Member

- ASME; SAE; ASEE; Committees - SAE Engine Systems and Aftertreatment Committee

8. Honors and Award

Distinguished Faculty nomination by State of Michigan (2008), SAE Faculty Advisor Award (1998); One Million Dollar Grants Club Award (1996), Faculty Member of the Year Award (1995)

9. Chair/Co-Chair

Chaired or co-chaired sessions at ASEE meetings (San Juan, Nashville); Chaired session on tallow-based fuels (Dalian, China); Co-chair, session on fuels and combustion, ASME Power Conference; Chaired session at FISITA International, Seoul, S. Korea; Chaired High Pressure Spray session, FISITA 2014; Co-organizer SAE Fuels Meeting, Finland; Co-advisor, International Conference on Hydrogen Energy, New Delhi, India

10. Seminars

Presented seminars on: Engine combustion; High pressure fuel sprays; Combustion and emissions from NG & Stratified charge engine; Dual fuel diesel engine; Hydrogen engine combustion; Modeling hydrogen combustion; PEM stack characteristics.

11. Technical Learning Material

Developed specialized courses in combustion, emissions, fuel systems and fuel cells for automotive engineers

CURRICULUM VITAE

Guoyuan Wu, Ph. D.

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Email: gywu@cert.ucr.edu Phone: +1-951-781-5630 (w)
Website: https://profiles.ucr.edu/app/home/profile/guoyuanw

EDUCATION

Ph.D., Mechanical Engineering, University of California at Berkeley, 2010
Advisor: Prof. Masayoshi Tomizuka
Thesis: "Development of AVL-based Adaptive Signal Control (ASC) System and Its Applications"

M.S., Thermal Engineering, Tsinghua University, China, 2004
Advisor: Prof. Donghai Li
Thesis: "PID Controller Design for two-inputs-two-outputs (TITO) Systems in Thermal Processes" (in Chinese)

B.S., Energy Engineering, Zhejiang University, China, 2001
Advisor: Prof. Junhu Zhou
Thesis: "Research on Characteristics of Desulphurization Sorbents" (in Chinese)

EMPLOYMENT

07/2022 – Present University of California at Riverside
Adjunct Professor in Electrical and Computer Engineering (ECE) Department and Researcher in College of Engineering – Center for Environmental Research & Technology (CE-CERT)

07/2018 – Present University of California at Riverside
Associate Adjunct Professor in Electrical and Computer Engineering (ECE) Department and Associate Researcher in College of Engineering – Center for Environmental Research & Technology (CE-CERT)

08/2014 – Present Cal Poly Pomona
Lecturer (Part-time) in Civil Engineering Department

07/2016 – 06/2018 University of California at Riverside
Assistant Adjunct Professor in ECE Department

07/2012 – 06/2018 University of California at Riverside
Assistant Researcher in CE-CERT

07/2010 --- 06/2012 University of California at Riverside
Postdoctoral fellow in CE-CERT

08/2005 --- 05/2010 University of California at Berkeley (Mechanical Engineering)
Graduate Student Researcher in California PATH Program

06/2005 --- 05/2007 University of California at Berkeley (Civil and Environmental Engineering)
Graduate Student Researcher in NASA Ames Research Center, Moffett Field

RESEARCH INTRERESTS

- Emerging sustainable and intelligent transportation systems, including connected and automated vehicles (CAVs), transportation electrification, mobility-as-a-service (MaaS), and active transportation
- Cooperative automated driving especially in a mixed and multi-modal traffic environment

- Simulation, testing, and evaluation of connected and automated vehicles
- Application of machine learning technique to modeling and control of transportation systems

HONORS AND AWARDS

- 2021 SAE International Arch T. Colwell Merit Award
- 2021 Certificate of Appreciation – TRB ACP30 Committee
- 2020 SAE International Vincent Bendix Automotive Electronics Engineering Award
- 2016 Honorable Mention – "Create the Future" Design Contest
- 2016 Finalist of Best of ITS America Awards – "Wheels and Things"
- 2005 Fellowship, Mechanical Engineering at UC Berkeley
- 2002 Guanghua Outstanding Graduate Scholarship, Tsinghua University, China
- 2001 Outstanding Graduate of Zhejiang Province, China
- 2001 Outstanding Graduate, Zhejiang University, China
- 2001 Chinese Academy of Sciences Scholarship, China

PUBLICATIONS

Patents

P1. Systems and Methods for Cooperative Smart Lane Selection, US Patent 10,916,125

P2. Systems and Methods for Anticipatory Lane Change, US Patent App. 15/965,345

P3. System and Method for Lane Level Hazard Prediction, US Patent App. 15/981,222

Book Chapter

B1. G. Wu and M. Barth. Design of Systems with Automated and Electric Vehicles. IET (in press)

B2. M. A. S. Kamal, M. Ramezani, G. Wu, C. Roncoli, J. Rios-Torres, and O. Orfila. Partially Connected and Automated Traffic Operations in Road Transportation (Editorial). Journal of Advanced Transportation, 2020

B3. P. Hao, G. Wu, Kanok. Boriboonsomsin, Matthew Barth. Connected and Automated Vehicle Research and Development in the United States. IET Transportation Series 25, 2019

B4. X. Qi, M. Barth, G. Wu, K. Boriboonsomsin, P. Wang. Energy Impact of Connected Eco-driving on Electric Vehicles. Springer, 2016

B5. M. Barth, G. Wu, K. Boriboonsomsin. Intelligent Transportation Systems and Greenhouse Gas Reductions. Current Sustainable/Renewable Energy Reports on Transportation, MV Chester (Section Ed.), DOI 10.1007/s40518-015-0032-y, Springer International Publishing, 2015.

B6. M. Barth, K. Boriboonsomsin and G. Wu. Vehicle Automation and Its Potential Impacts on Energy and Emissions. Springer, 2014

Refereed Journal Publications

*: Corresponding author

J1. X. Shan, C. Wan, P. Hao, G. Wu, X. Zhang. "Connected Eco-Driving for Electric Buses along Signalized Arterials with Bus Stops", IET Intelligent Transport Systems, 2022 (accepted)

J2. X. Zhao, X. Liao, Z. Wang, G. Wu*, et al., "Co-Simulation Platform for Modeling and Evaluating Connected and Automated Vehicles and Human Behavior in Mixed Traffic," SAE Intl. J CAV 5(4):2022, https://doi.org/10.4271/12-05-04-0025.

J3. Z. Bai, G. Wu*, X. Qi, Y. Liu, K. Oguchi, M. Barth. IEEE Cyber Mobility Mirror for Enabling Cooperative Driving Automation in Mixed Traffic: A Co-Simulation Platform. IEEE ITS Magazine, 2022 (accepted)

J4. B. Ciuffo, et al. Robotic Competitions to Design Future Transport Systems: The Case of JRC AUTOTRAC 2020. Transportation Research Record, 2022, https://doi.org/10.1177/03611981221110566

J5. F. Un-Noor, G. Wu, H. Perugu, S. Collier, S. Yoon, M. Barth, K. Boriboonsomsin. Off-Road Construction and Agricultural Equipment Electrification: Review, Challenges, and Opportunities. Vehicles. 2022 (accepted)

J6. N. Williams, P. Darian, G. Wu*, P. Closas, M. Barth. Impact of Positioning Uncertainty on Connected and Automated Vehicle Applications. SAE International Journal of Connected and Automated Vehicles (accepted)

J7. N. Williams, A. Vu, G. Wu*, M. Barth, K. Zhou. Using RTCM Corrections in a Consumer-Grade Lane-Level Positioning System for Connected Vehicles. SAE International Journal of Connected and Automated Vehicles (accepted)

J8. L. Yang, M. Han, S. Fang, G. Wu, H. Sheng, H. Wei, X. Zhao. Differentiated Trajectory Planning for Connected and Automated Electric Vehicles at Signalized Intersections Considering Wireless Power Transfer. Journal of Advanced Transportation. 2022 (accepted)

J9. L. Yang, Y. Yang, G. Wu, X. Zhao, S. Fang, X. Liao, R. Wang, M. Zhang. A Systematic Review of Autonomous Emergency Braking Technology: Impact Factor, Technology and Performance Evaluation. Journal of Advanced Transportation. ID 1188089, 2022 (accepted)

J10. L. Yang, S. Fang, G. Wu, H. Sheng, Z. Xu, M. Zhang, X. Zhao. Physical model versus Artificial Neural Network (ANN) model: A comparative study on modeling car-following behavior at signalized intersections. Journal of Advanced Transportation. ID 8482846, 2022 (accepted)

J11. X. Zhao, A. Abdo, X. Liao, M. Barth, G. Wu*. Evaluating Cybersecurity Risks of Cooperative Ramp Merging in Mixed Traffic Environments. IEEE ITS Magazine, 2022 (accepted)

J12. Z. Gao, T. LaClair, K. Nawaz, G. Wu, P. Hao, K. Boriboonsomsin, M. Todd, M. Barth, A. Goodarzi. Comprehensive Powertrain Modeling for Heavy-duty Applications: A Study of Plug-in Hybrid Electric Buses. Energy Conversion and Management, Volume 252, January 2022, 115071

J13. N. Williams, M. Barth, and G. Wu. Position Uncertainty-Tolerant Cooperative Merging Application for Mixed Multilane Traffic. IEEE Transactions on Intelligent Vehicles, 7(1), 2022, pp. 143-153

J14. X. Liao, X. Zhao, Z. Wang, K. Han, P. Tiwari, M. Barth, G. Wu*. Game Theory-Based Ramp Merging for Mixed Traffic with Unity-SUMO Co-Simulation. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 2021 (early access)

J15. X. Liao, Z. Wang, X. Zhao, K. Han, P. Tiwari, M. Barth, G. Wu*. Cooperative Ramp Merging Design and Field Implementation: A Digital Twin Approach based on Vehicle-to-Cloud Communication. IEEE Transactions on Intelligent Transportation Systems, 23(5), 2022, pp. 4490 - 4500

J16. Z. Zhao, G. Wu*, and M. Barth. Corridor-Wise Eco-Friendly Cooperative Ramp Management System for Connected and Automated Vehicles. Sustainability. 2021, 13 (15), 8557

J17. H. Min, Y. Fang, X. Wu, G. Wu, X. Zhao. On-Ramp Merging Strategy for Connected and Automated Vehicles Based on Complete Information Static Game. Journal of Traffic and Transportation Engineering, 8(4), 2021, pp. 582 – 595

J18. W. Li, G. Wu*, D. Yao, Y. Zhang, M. Barth, K. Boriboonsomsin. Stated Acceptance and Behavioral Responses of Drivers towards Innovative Connected Vehicle Applications. Accident Analysis and Prevention, 2021, 155, 106095

J19. P. Hao, D. Esaid, G. Wu, Z. Wei, F. Ye, K. Boriboonsomsin, M. Barth. Machine Learning-based Eco-Approach and Departure: Real-Time Trajectory Optimization at Connected Signalized Intersections. SAE International Journal of Sustainable Transportation, Energy, Environment, & Policy, 2021 (in press)

J20. L. Zhu, Z. Zhao, G. Wu. Shared Automated Mobility with Demand-side Cooperation: A Proof-of-Concept Microsimulation Study. Sustainability. 2021, 13(5), 2483

J21. Y. Chen, G. Wu, R. Sun, A. Dubey, A. Laszka, P. Pugliese. A Review and Outlook of Energy Consumption Estimation Models for Electric Vehicles. SAE International Journal of Sustainable Transportation, Energy, Environment, & Policy, 2(1), 2021, pp. 79 – 96

J22. J. Hu, Z. Zhang, L. Xiong, H. Wang, G. Wu. Cut Through Traffic to Catch Green Light: Eco Approach with Overtaking Capability. Transportation Research Part C. Vol. 123, February 2021, 102927

J23. F. Un-Noor, G. Scora, G. Wu, K. Boriboonsomsin. Operational Feasibility Assessment of Battery Electric Construction Equipment Based on In-Use Activity Data. Transportation Research Record, 2021, 03611981211004581

J24. P. Hao, K. Boriboonsomsin, C. Wang, G. Wu, M. Barth. Connected Eco-Approach and Departure (EAD) System for Diesel Trucks, International Journal of Commercial Vehicles, 14(2), 2021, pp. 217-227.

J25. G. Wu, P. Hao, Z. Wang, Y. Jiang, K. Boriboonsomsin, M. Barth, M. McConnell, S. Qiang, J. Stark. Eco-Approach and Departure along Signalized Corridors. SAE International Journal of Sustainable Transportation, Energy, Environment, & Policy, 2021, 2(1): 25-40, 2021, https://doi.org/10.4271/13-02-01-0002.

J26. L. Yang, X. Zhao, G. Wu*, Z. Xu, M. Barth, F. Hui, P. Hao, M. Han, Z. Zhou, S. Fang, S. Jing. Review of Cooperative Eco-driving Strategies based on Connected and Automated Vehicles. Journal of Traffic and Transportation Engineering, 2020 (in Chinese).

J27. Z. Wang, X. Liao, C. Wang, D. Oswald, G. Wu, K. Boriboonsomsin, M. Barth, K. Han, B. Kim, and P. Tiwari. Driver Behavior Modeling using Game Engine and Real Vehicle: A Learning-Based Approach. IEEE Transactions on Intelligent Vehicles, 5(4), 2020, pp. 738 – 749

J28. Z. Wang, Y. Bian, S. Shladover, G. Wu, S. Li, and M. Barth. A Survey on Cooperative Longitudinal Motion Control of Multiple Connected Automated Vehicles. IEEE Intelligent Transportation Systems Magazine. 12(1), 2020, pp. 4 – 24

J29. C. Wang, P. Hao, G. Wu, X. Qi, and M. Barth. Intersection and Stop Bar Position Extraction from Vehicle Positioning Data. IEEE Transactions on Intelligent Transportation Systems. 2020, DOI: 10.1109/TITS.2020.3039357 (Early Access)

J30. D. Tian, G. Wu*, C. Wang, K. Boriboonsomsin, M. Barth. An Innovative Framework to Evaluate the Performance of Connected Vehicle Applications: from the Perspective of Speed Variation-Based Entropy (SVE). IEEE Intelligent Transportation Systems Magazine, Vol. 13, No. 4, 2020, pp. 45 - 63

J31. Z. Wang, G. Wu*, M. Barth. Cooperative Eco-Driving at Signalized Intersections in a Partially Connected and Automated Vehicle Environment. IEEE Transactions on Intelligent Transportation Systems. 21(5), 2020, pp. 2029 - 2038

J32. Z. Wang, G. Wu*, K. Boriboonsomsin, M. Barth, K. Han, B. Kim, P. Tiwari. Cooperative Ramp Merging System: Agent-Based Modeling and Simulation using Game Engine. SAE International Journal of Connected and Automated Vehicles, 2(2), 2019, pp. 115 – 128

J33. Z. Gao, T. LaClair, S. Ou, S. Huff, G. Wu, P. Hao, K. Boriboonsomsin, M. Barth. Evaluation of Electric Vehicle Component Performance Over Eco-Driving Cycles. Energy, Vol. 172, 2019, pp. 823 – 839

J34. J. Luo, G. Wu, Z. Wei. K. Boriboonsomsin, M. Barth. Developing an Aerial-Image-based Approach for Creating Digital Sidewalk Inventories. Transportation Research Record, 2673 (8), 2019, pp. 499 – 507

J35. D. Tian, G. Wu*, P. Hao, K. Boriboonsomsin, M. Barth. Connected Vehicle-Based Lane Selection Assistance Application. IEEE Transactions on Intelligent Transportation Systems, 20(7), 2019, pp. 2630 – 2643

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C81. X. Qi, G. Wu*, K. Boriboonsomsin, M. Barth. A Novel Blended Real-time Energy Management Strategy for Plug-in Hybrid Electric Vehicle Commute Trips. 2015 IEEE Conference on Intelligent Transportation Systems

C82. X. Qi, G. Wu*, K. Boriboonsomsin, M. Barth. Evolutionary Algorithm Based On-Line PHEV Energy Management System with Self-Adaptive SOC Control. 2015 IEEE on Intelligent Vehicles Symposium, Seoul, Korea. June 28 – July 1.

C83. P. Hao, G. Wu, K. Boriboonsomsin, M. Barth. Developing a Framework of Eco-Approach and Departure Application for Actuated Signal Control. 2015 IEEE on Intelligent Vehicles Symposium, Seoul, Korea. June 28 – July 1.

C84. G. Wu, K. Boriboonsomsin and M. Barth. Comparative Analysis of Empirical Capacities between Freeways with Different Types of High-Occupancy Vehicle (HOV) Access Control. 94th Transportation Research Board Annual Meeting, Washington D.C., January 11-15, 2015

C85. K. Boriboonsomsin, G. Wu, P. Hao and M. Barth. Fusion of Vehicle Weight and Activity Data for Improved Vehicle Emission Modeling. 94th Transportation Research Board Annual Meeting, Washington D.C., January 11-15, 2015

C86. X. Qi, G. Wu*, K. Boriboonsomsin, M. Barth. Comparative Study of Lane Changing Characteristics on Different Types of HOV Facilities Using Smoothed Aerial Photo Data. 94th Transportation Research Board Annual Meeting, Washington D.C., January 11-15, 2015

C87. P. Hao, G. Wu*, P. Saikaly. Evaluation of sampling strategies for vehicular emission estimation using probe vehicles. 94th Transportation Research Board Annual Meeting, Washington D.C., January 11-15, 2015

C88. X. Qi, G. Wu*, K. Boriboonsomsin, M. Barth. An On-Line Energy Management Strategy for Plug-in Hybrid Electric Vehicles Using Estimation Distribution Algorithm. 2014 IEEE on Intelligent Transportation Systems Conference, Qingdao, China.

C89. D. Kari, G. Wu*, M. Barth. Development of an Agent-Based Online Adaptive Signal Control Strategy Using Connected Vehicle Technology. 2014 IEEE on Intelligent Transportation Systems Conference, Qingdao, China.

C90. P. Hao, K. Boriboonsomsin, G. Wu, M. Barth. Probabilistic Model for Estimating Vehicle Trajectories Using Sparse Mobile Sensor Data. 2014 IEEE on Intelligent Transportation Systems Conference, Qingdao, China.

C91. D. Kari, G. Wu* and M. Barth. Eco-Friendly Freight Signal Priority Using Connected Vehicle Technology: A Multi-Agent System Approach. 2014 IEEE on Intelligent Vehicles Symposium, Dearborn, Michigan, USA.

C92. Q. Jin, G. Wu*, K. Boriboonsomsin and M. Barth. Improving Traffic Operations Using Real-Time Optimal Lane Selection with Connected Vehicle Technology. 2014 IEEE on Intelligent Vehicles Symposium, Dearborn, Michigan, USA.

C93. G. Wu, K. Boriboonsomsin and M. Barth. Supplementary Benefits from Partial Vehicle Automation in an Eco-Approach/Departure Application at Signalized Intersections. 93rd Transportation Research Board Annual Meeting, Washington D.C., January, 2014

C94. Y. Du, G. Wu*, K. Boriboonsomsin and C-Y Chan. Empirical Study on Lane Changing Behaviors Along Different Types of High-Occupancy vehicle Lanes in California. 92nd Transportation Research Board Annual Meeting, Washington D.C., January 13-17, 2013

C95. Q. Jin, G. Wu*, K. Boriboonsomsin, M. Barth. Platoon-Based Multi-Agent Intersection Management for Connected Vehicles. 2013 IEEE Conference on Intelligent Transportation Systems.

C96. Q. Yang, G. Wu*, K. Boriboonsomsin, M. Barth. Arterial Roadway Travel Time Distribution Estimation and Vehicle Movement Classification Using a Modified Gaussian Mixture Model. 2013 IEEE Conference on Intelligent Transportation Systems.

C97. H. Xia, G. Wu, K. Boriboonsomsin, M. Barth. Development and Evaluation of an Enhanced Eco-Approach Traffic Signal Application for Connected Vehicles. 2013 IEEE Conference on Intelligent Transportation Systems.

C98. G. Wu, K. Boriboonsomsin, M. Barth. Development and Evaluation of Intelligent Energy Management Strategy for Plug-in Hybrid Electric Vehicle. 92nd Transportation Research Board Annual Meeting, Washington D.C., January 13-17, 2013

C99. L. Zhang and G. Wu. Dynamic Lane Grouping at Isolated Intersections: Problem Formulation and Performance Analysis. 91st Transportation Research Board Annual Meeting, Washington D.C., January 22-26, 2012

C100. Q. Jin, G. Wu*, K. Boriboonsomsin, M. Barth. Multi-Agent Intersection Management for Connected Vehicles using an Optimal Scheduling Approach. ICCVE 2012, Beijing, China.

C101. G. Wu, K. Boriboonsomsin, L. Zhang, M. Barth. Simulation-Based Benefit Evaluation of Dynamic Lane Grouping Strategies at Isolated Intersections. 2012 IEEE Conference on Intelligent Transportation Systems.

C102. Q. Jin, G. Wu*, K. Boriboonsomsin, M. Barth. Advanced Intersection Management for Connected Vehicles Using a Multi-Agent Systems Approach. 2012 IEEE on Intelligent Vehicles Symposium.

C103. Y. Du, G. Wu*, K. Jang, C-Y Chan. Empirical Evaluation of the Impacts of High-Occupancy Vehicle (HOV) Lane Collision on Different Types of Lane Configuration in California. 91st Transportation Research Board Annual Meeting, Washington D.C., January 22-26, 2012

C104. G. Wu, Y. Du, K. Jang, C-Y Chan, and K. Boriboonsomsin. Preliminary Evaluation of Operational Performance between Different Types of HOV Facilities in California: Continuous-Access vs. Limited-Access. 90th Transportation Research Board Annual Meeting, Washington D.C., January, 2011

C105. K. Boriboonsomsin, G. Wu, G. Scora, and M. Barth. Impacts of Goods Movement Pricing on Traffic Congestion and Air Pollution: A Case Study of the Ports of Los Angeles and Long Beach. 52nd Annual Transportation Research Forum, Mar. 10-12, 2011

C106. G. Wu, K. Boriboonsomsin, W-B Zhang, M. Li and M. J. Barth. Energy and Emission Benefit Comparison between Stationary and In-vehicle Advanced Driving Alert Systems. 89th Transportation Research Board Annual Meeting, Washington D.C., January, 2010

C107. J-Q Li, N. Zou and G. Wu. The Models and Algorithm for Investigating the Impacts of Signal Timing on Vehicle Emissions. INFORMS Annual Meeting 2010, Austin, Texas, Nov. 7 – 10, 2010

C108. M. Li, M-K Song, and G. Wu. Online Performance Measurement Method Based on Arterial Infrastructure Data. 88th Transportation Research Board Annual Meeting, Washington D.C., January 11-15, 2009

C109. G. Wu, M. Tomizuka, L. Zhang, M. Li and W-B Zhang. System Performance Optimization at Urban Rail-Highway Grade Crossings Using Online Adaptive Priority Strategy. 88th Transportation Research Board Annual Meeting, Washington D.C., January 11-15, 2009

C110. G. Wu, W-B Zhang, and M. Li, et al. Traffic Emission Reduction at Signalized Intersections: A Simulation Study of Benefits of Advanced Driver Information. 15th World Congress on Intelligent Transport Systems, Nov.16-20, 2008

C111. M. Li, G. Wu, Y. Li, F. Bu, and W-B Zhang. Active Signal Priority for Light Rail Transit at Grade Crossings. 86th Transportation Research Board Annual Meeting, Washington D.C., January, 2007

C112. Y. Li, F. Bu, M. Li, G. Wu, W-B. Zhang, and K. Zhou. Application of Advanced Detection Data in the Development of an Active Signal Priority System. 86th Transportation Research Board Annual Meeting, Washington D.C., January, 2007

C113. C. Robelin, D. Sun, G. Wu, and A. Bayen. MILP control of aggregate Eulerian network airspace models, American Control Conference, pp. 5257-5262, Minneapolis, MN, Jun. 14-16, 2006

C114. C. Robelin, D. Sun, G. Wu, and A. Bayen. En-Route Air Traffic Modeling and Strategic Flow Management using Mixed Integer Linear Programming, INFORMS Annual Meeting 2005, New Orleans / San Francisco, Nov. 13-16, 2005

Non-proceedings Conferences

A1. X. Liao, G. Wu*, M. Barth, A. Smolyak. A Data-Driven Approach to Estimating Environmental Impacts of Traffic Incident Management Strategies. Urban Complex Systems 2021.

A2. X. Zhao, X. Liao, G. Wu*, Z. Wang and K. Han. Integrated Unity-SUMO-AWS Platform for Evaluating Personalized Human Behaviors in Mixed Traffic. 28th ITS World Congress, Hamburg, October 11 – 15, 2021

A3. G. Scora, K. Boriboonsomsin, F. Un-Noor, G. Wu, et al. Characterizing In-Use Activity of Construction Equipment in California. The 30th CRC Workshop.

A4. H. Jung, X. Wang, A. Chen, M. Zhang, M. Shiraiwa, M. Princevac, G. Wu, et al. Real-World Tire and Brake-Wear Emissions. The 30th CRC Workshop.

A5. X. Zhao, X. Liao, G. Wu*, Z. Wang and K. Han. Integrated Unity-SUMO-AWS Platform for Evaluating Personalized Human Behaviors in Mixed Traffic. 2021 ITS World Congress

A6. G. Wu, L. Zhu, Z. Zhao. Improving Transportation Sustainability through Shared and Automated Mobility (SAM) with Demand-side Cooperation. Conference on Sustainability and Emerging Transportation Technology, October 2020

A7. Z. Wang, K. Han, X. Liao, X. Zhao, and G. Wu. Cooperative Ramp Merging Experimental Evaluation: A Vehicle-to-Cloud Digital Twin Approach. ITS World Congress, Los Angeles, October 2020

A8. L. Zhu, Z. Zhao, G. Wu. Vehicle Dispatching Considering Demand-Side Cooperation for On-demand Shared Automated Mobility: An Online Microscopic Simulation Framework and Modeling. ASCE ICTD2020

A9. J. Luo, A. Moretti, G. Wu, B. Feenstra, K. Boriboonsomsin, M. Barth. Performance Evaluation of Low-cost Air Quality Sensors at Near-road Air Quality Monitoring Stations. CARTEEH Symposium, February 2019

A10. A. Moretti, J. Luo, G. Wu, B. Feenstra, K. Boriboonsomsin, M. Barth. Understanding Air Quality Data, Traffic, and Weather Parameters Collected from Near-Road Stations. CARTEEH Symposium, February 2019

A11. F. Ye, G. Wu*, K. Boriboonsomsin, M. Barth, S, Rajab, S. Bai. Traffic Abnormality Predication Application for Connected Automated Vehicles (CAVs) in a Mixed Traffic Environment. Automated Vehicle Symposium, July 2018

A12. Y. Lin, G. Wu*, J. Huang. An Innovative Street Design to Embrace Low-speed Automated Mobility in a Mixed Traffic Environment ---- A Case Study in Berkeley, CA. Automated Vehicle Symposium, July 2018

A13. N. Williams, G. Wu*, K. Boriboonsomsin, M. Barth, S. Rajab, S. Bai. Anticipatory Model for Safer Automated Lane Changes. Automated Vehicle Symposium, July 2018

A14. Z. Gao, T. LaClair, S. Ou, G. Wu, M. Barth. Electric Vehicle Performance Enhancement over Eco-Driving Cycles Employing CAV Technologies. SAE World Congress 2018

A15. P. Hao, X. Shan, K. Boriboonsomsin, G. Wu, M. Barth. Sensitivity Analysis of Buffer Length in Partially Limited Access Design of HOV Facilities. Transportation Research Board Annual Meeting, 2018 (poster)

A16. C. Wang, P. Hao, G. Wu, M. Barth. Developing an Eco-Cooperative Real-time Taxi Allocation System. IEEE SusTech 2017 (poster)

A17. Z. Wang, G. Wu*, P. Hao, M. Barth. Developing a Distributed Cooperative Eco-Approach and Departure System at Signalized Intersections Using V2X Communication. Automated Vehicle Symposium, July 2017

A18. P. Hao, Z. Wang, G. Wu, K. Boriboonsomsin, M. Barth. Intra-Platoon Vehicle Sequence Optimization for Eco-Cooperative Adaptive Cruise Control. Automated Vehicle Symposium, July 2017

A19. C. Wang, F. Ye, G. Wu*, M. Barth. Data-Driven Analysis of Approach and Departure Driving Behaviors at Signalized Intersections. The 8th International Conference on Applied Human Factors and Ergonomics (AHFE 2017), July 2017, Los Angeles

A20. F. Ye, C. Wang, G. Wu*, M. Barth. Modeling the Real-World Human Driving Behaviors Along Signalized Intersections. The 8th International Conference on Applied Human Factors and Ergonomics (AHFE 2017), July 2017, Los Angeles

A21. D. Kari, G. Wu*, K. Boriboonsomsin, M. Barth. Exploring the Opportunity: Managed Lane as a Testbed for Cooperative Adaptive Cruise Control (CACC). Transportation Research Board Annual Meeting, 2017 (poster)

A22. G. Wu, P. Hao, D. Kari, K. Boriboonsomsin, and M. Barth. Developing an Eco-Cooperative Adaptive Cruise Control (Eco-CACC) System. Automated Vehicle Symposium, July 2016

A23. F. Ye, P. Hao, G. Wu, K. Boriboonsomsin, and M. Barth. Eco-Approach and Departure Strategy in Mixed Connected Vehicle Environment. Automated Vehicle Symposium, July 2016

A24. X. Qi, G. Wu*, P. Wang, K. Boriboonsomsin, and M. Barth. Estimating Energy and Mobility Benefits from Eco-approach/Departure System for Electric Vehicles. Automated Vehicle Symposium, July 2016

A25. X. Qi, G. Wu*, K. Boriboonsomsin, and M. Barth. Evolutionary Algorithm Based On-Line Energy Management System for Plug-in Hybrid Electric Vehicles. GECCO 2016, Denver, July 21 – 23

A26. G. Wu, M. Barth, K. Boriboonsomsin. GlidePath: Eco-Friendly Automated Approach/Departure at Signalized Intersections. Automated Vehicle Symposium, July 2015

A27. P. Su, B. Park, G. Wu. Improving Managed Lane Operations through a Lane-Changing Assistance System. Automated Vehicle Symposium, July 2015

A28. G. Wu, Q. Jin and K. Boriboonsomsin. Improve Traffic Operation at Signalized Intersections Using Four Quadrant Connection Roadways. The Transportation Research Board's 2014 Alternative Intersections & Interchanges Symposium, Salt Lake City UT, July 20-23, 2014.

A29. M. Barth, K. Boriboonsomsin and G. Wu. The Potential Role of Vehicle Automation in Reducing Traffic-Related Energy and Emissions. IEEE on ICCVE 2013, Las Vegas, USA.

A30. G. Wu, K. Boriboonsomsin and M. Barth. Fusion of Vehicle Weight and Activity Data for Improved Vehicle Emission Modeling. 2013 Sustainable Goods Movement Symposium, Palm Desert, November

Research Report/Technical Note

R1. J. A. Farrell, G. Wu, W. Hu, D. Oswald, P. Hao. Lane-Level Localization and Map Matching for Advanced Connected and Automated Vehicle (CAV) Applications. Final Report for NCST. April 2022, 68 p.

R2. G. Wu, Z. Wei, D. Oswald, P. Hao, M. Barth. Assessing Roadway Infrastructure for Future Connected and Automated Vehicle Deployment in California. Final Report for UC-ITS Program, December 2021, 54 p

R3. G. Wu, Z. Zhao, M. Barth. Connected Vehicle-based Advanced Detection of "Slow-Down" Events on Freeways. Final Report for Honda Research Institute-US, March 2021, 27 p

R4. G. Wu, Z. Bai, M. Barth. Preliminary Evaluation of Roadside Sensing based Real-time Cyber Mobility Mirror (CMM) Prototype in Simulation. Final Report for TOYOTA ITC project (Pre-phase), February 2021, 27 p

R5. G. Wu, X. Liao, X. Zhao, M. Barth. Developing Situation Awareness Capability for Connected Vehicle (CV) Applications in Mixed Traffic using "Digital Twin" Framework. Final Report for TOYOTA ITC project (Year 3), January 2021, 31 p

R6. G. Wu, Z. Zhao, Z. Wang, M. Barth. Development of Eco-Friendly Ramp Control for Connected and Automated Electric Vehicles. February 2020, 41 p

R7. G. Wu, Z. Wang, X. Liao, K. Boriboonsomsin, M. Barth. Evaluating Connected Vehicle Applications in a Mixed Traffic Environment using a "Digital Twin" Approach. Final Report for TOYOTA ITC project (Year 2), January 2020, 34 p

R8. J. Luo, A. Moretti, G. Wu. Quantifying Traffic Congestion--Induced Change of Near--Road Air Pollutant Concentration. Final Report for CARTEEH project, June 2019, 26 p

R9. G. Wu, F. Ye, P. Hao, D. Esaid, K. Boriboonsomsin, M. Barth. Deep Learning-based Eco-driving System for Battery Electric Vehicles. Final Report for NCST project, February 2019, 35 p

R10. Z. Wang, G. Wu*, K. Boriboonsomsin, M. Barth. Evaluating Connected Vehicle Applications in a Mixed Traffic Environment using a "Digital Twin" Approach. Final Report for TOYOTA ITC project (Year 1), January 2019, 22 p

R11. K. Boriboonsomsin, G. Wu, P. Hao, H. Xia, and N. Williams. Calibration of Traffic Microsimulation Models for Microscopic Vehicle Emission Modeling. Final Report for UCTC project, 2018, 37 p

R12. G. Wu, D. Tian, K. Boriboonsomsin, and M. Barth. Traffic Jam Prevention (TJP) Application Effectiveness Analysis. Final Report for Honda's V2X project (Phase III), March 2018, 23 p

R13. G. Wu, D. Tian, N. Williams, F. Ye, K. Boriboonsomsin, and M. Barth. Connected and Automated Vehicle (CAV) Applications Effectiveness Analysis. Final Report for Honda's V2X project (Phase II), February 2018, 83 p (including Appendix)

R14. D. Tian, W. Li, G. Wu*, M. Barth. Examining the Safety, Mobility and Environmental Sustainability CoBenefits and Tradeoffs of Intelligent Transportation Systems, NCST Report, 2017

R15. G. Wu, D. Tian, M. Barth, W. Li, and K. Boriboonsomsin. V2X Connected Vehicle Early Deployment Application Analysis. Final Report for Honda's V2X project (Phase I), September 2016, 85 p

R16. G. Wu. Boosting MPG of Plug-in Hybrid Electric Vehicles via Reliable Information. NCST Policy Brief, August 2016

R17. G. Wu, X. Qi, M. Barth and K. Boriboonsomsin. Advanced Energy Management Strategy Development for Plug-in Hybrid Electric Vehicles. NCST Report, May 2016, 44 p

R18. M. Barth, G. Wu, K. Boriboonsomsin. Intelligent Transportation Systems Show Promise in Reducing Energy Consumption and Greenhouse Gas Emissions. NCST Policy Brief, March 2016

R19. G. Wu, M. Barth, K. Boriboonsomsin and et al. GlidePath Prototype Development (UCR part). FHWA DTFH61-12-D-00020, December 2015, 32 p

R20. M. Barth, G. Wu, P. Hao and et al. Advanced Traffic Signalization: Extending the Eco-Approach and Departure Application Research to Actuated Traffic Signals (UCR part). FHWA Exploratory Advanced Research (EAR) Program, December 2015, 100 p

R21. G. Wu, X. Qi, D. Kari, and M. Barth. Development of Agent-Based On-line Adaptive Signal Control (ASC) Framework Using Connected Vehicle (CV) Technology. UCCONNECT working paper, December 2015, 24 p

R22. M. Barth, G. Wu, D. Kari and K. Boriboonsomsin. AERIS: Eco-Lanes Operational Scenario Modeling Report. December 2014, 128 p

R23. M. Barth, G. Wu, H. Xia and K. Boriboonsomsin. AERIS: Eco-Signal Operations Operational Scenario Modeling Report. May 2014, 241 p

R24. M. Barth, G. Wu, H. Xia and K. Boriboonsomsin. AERIS: Identification and Evaluation of Transformative Environmental Applications and Strategies Project – Connected Eco-Driving Application Modeling Results. March 2014, 45 p

R25. K. Boriboonsomsin, G. Scora, G. Wu and M. Barth. Deployment of Prior HOV Lanes Research Results in Developing Analysis Tools for New Managed Lanes Projects. Final report to California Department of Transportation, May 2014, 49 p

R26. G. Wu, M. Barth, K. Boriboonsomsin. Eco-Routing Navigation System for Electric Vehicles. Final report for California Energy Commission, 11-01 TE, May 2014, 38 p

R27. M. Barth, G. Wu, H. Xia and K. Boriboonsomsin. AERIS: Identification and Evaluation of Transformative Environmental Applications and Strategies Project – Eco-Approach and Departure at Signalized Intersections Application Modeling Results. October 2013, 56 p

R28. K. Boriboonsomsin, G. Wu, M. Barth. High Occupancy Vehicle (HOV) System Analysis Tools – District 8 HOV Facility Performance Analysis. For Caltrans, 2012

R29. G. Wu, K. Boriboonsomsin, M. Barth. Development and Evaluation of Intelligent Energy Management Strategies for Plug-in Hybrid Electric Vehicles. UCTC-FR-2012-09

R30. L. Zhang, K. Zhou, J-Q Li, W-B Zhang, M. Li, G. Wu, S. Sun. Development of an Integrated Adaptive Transit Signal Priority (ATSP) and Dynamic Passenger Information (DPI) System. UCB-ITS-PRR-2011-, PATH at UC Berkeley, August 2011.

R31. K. Boriboonsomsin, G. Scora, G. Wu, M. Barth. Improving Vehicle Fleet, Activity, and Emissions Data for On-Road Mobile Sources Emissions Inventories. Prepared for Federal Highway Administration, August 2011.

R32. M. Li, L. Zhang, M-K Song, G. Wu, W-B Zhang, L. Zhang, Y. Yin. Improving Performance of Coordinated Signal Control Systems Using Signal and Loop Data. UCB-ITS-PRR-2010-07, PATH at UC Berkeley, March 2010.

R33. G. Wu, Y. Li, W-B Zhang, S. Johnston, M. Li, K. Zhou. Grade Crossing/Traffic Signal Optimization Study. TECH NOTE 2010-01, PATH at UC Berkeley, April 2010

R34. M. Li, K. Zhou, W-B Zhang, Y. Li, G. Wu, F. Bu, S. Sun, K. Leung, J. Lau. Field Operational Tests of Adaptive Transit Signal Priority Systems. UCB-ITS-PRR-2010-35, PATH at UC Berkeley, June 2010.

R35. M. Barth, K. Boriboonsomsin, G. Wu, G. Scora, M. Todd. Congestion and Air Quality Evaluation of Goods Movement Pricing. Prepared for Federal Highway Administration, September 2010.

R36. M. Li, G. Wu, S. Johnston, and W-B Zhang. Analysis toward Mitigation of Congestion and Conflicts at Light Rail Grade Crossings and Intersections. UCB-ITS-PRR-2009-09, PATH at UC Berkeley, January 2009

R37. G. Wu, Y. Li, W-B Zhang, S. Johnston, M. Li and K. Zhou. SPRINTER Rail: Grade Crossing/Traffic Signal Optimization Study. UCB-ITS-PRR-2009-21, PATH at UC Berkeley, March 2009

TEACHING EXPERIENCE

1. Spring/2022 EE246 Intelligent Transportation System at UC Riverside (co-instructor)
2. Spring/2021 CE4990/5990 at Cal Poly Pomona (lecturer)
3. Spring/2021 EE246 Intelligent Transportation System at UC Riverside (co-instructor)
4. Spring/2020 CE5990 at Cal Poly Pomona (lecturer)
5. Spring/2020 EE246 Intelligent Transportation System at UC Riverside (co-instructor)
6. Fall/2018 EE246 Intelligent Transportation System at UC Riverside (co-instructor)
7. Spring/2016 EE246 Intelligent Transportation System at UC Riverside (co-instructor)

8. Spring/2016 CE695 at Cal Poly Pomona (lecturer)
9. Winter/2016 CE695 at Cal Poly Pomona (lecturer)
10. Fall/2015 CE695 at Cal Poly Pomona (lecturer)
11. Summer/2015 CE695 at Cal Poly Pomona (lecturer)
12. Spring/2015 CE695 at Cal Poly Pomona (lecturer)
13. Winter/2015 CE695 at Cal Poly Pomona (lecturer)
14. Fall/2014 CE695 at Cal Poly Pomona (lecturer)
15. Winter/2014 EE246 Intelligent Transportation System at UC Riverside (co-instructor)
16. Spring/2013 EE246 Intelligent Transportation System at UC Riverside (co-instructor)
17. Spring/2012 EE246 Intelligent Transportation System at UC Riverside (co-instructor)

INVITED PRESENTATION

1. G. Wu. Roadside Sensing to Enable Cooperative Automated Driving in Mixed Traffic. ITS America, September 2022
2. G. Wu. Cyber Mobility Mirror: Cyber Mobility Mirror: A Roadside Sensor Enabling Technology for Cooperative Driving Automation in a Mixed Traffic Environment. AAEOY Annual Conference, August 2022
3. G. Wu. CAV-enabled Cooperative Ramp Merging Management. National Infrastructure Owner/Operator Meeting, September 2020
4. G. Wu. New Simulation Tools for Training and Testing Automated Vehicles. AVS 2020, July, panelist.
5. G. Wu. Distributed Consensus-Based Cooperative Highway On-Ramp Merging Using V2X Communications, Workshop at IEEE IV'18, June 2018, Changshu, Jiangsu Province, China
6. G. Wu. An Introduction of Environmentally-Friendly Connected and Automated Transportation Systems (EFCATS) Research at CE-CERT, Horiba Annual Conference, January 2018
7. G. Wu. A Glimpse at the Environmentally Friendly Connected and Automated Transportation System (EFCATS), Tongji University, October 2017
8. G. Wu. Eco-Approach/Departure: A Promising Connected & Automated Vehicle Application in the Urban Environment, CTE Association Meeting, February 2017
9. G. Wu. The Environment Implications of Connected/Automated Vehicles (CAVs) and Infrastructure. UCCONNECT Summer Training Program, June 2016
10. G. Wu. Embracing the Era of Connected/Automated Vehicles. Caltrans D12 CAV Course Planning, May 2016
11. G. Wu. An Introduction of Environmentally-Friendly Connected & Automated Transportation System (CATS) – A Glimpse at ITS. 2016 UCCONNECT Annual Student Conference, February
12. G. Wu. Development and Evaluation of Intelligent Energy Management Strategies for Plug-in Hybrid Electric Vehicles. SYSU-CMU Joint Institute of Engineering, October 2015
13. G. Wu. A Brief Introduction on Connected Vehicles (CV). Chinese Academy of Sciences – Shanghai Advanced Research Institute, October 2015

14. G. Wu. Connected/Automated Vehicles (CAVs) and Their Impacts on Environment. UCCONNECT Summer Training Program, June 2015
15. G. Wu. A Short Course on Connected Vehicles (CV) — In the Era of Internet of Things (IoT). UC Riverside MBA Program, May 2015
16. G. Wu. Connected/Automated Vehicle (C/AV) Technology and Its Impacts on the Environment. UC Riverside ECE Department Colloquium, April 2015
17. G. Wu. Eco-Lanes: Preliminary Modeling Results. 94th Transportation Research Board Annual Meeting, Washington D. C., January 2015
18. G. Wu. What We May Gain in the Driverless World – From the Energy/Emission Perspective. PacTrans Annual Conference, Seattle, WA, October 2014
19. G. Wu. Summary of California D8 HOV Facilities Operational Performance Analysis. 92nd Transportation Research Board Annual Meeting, Washington D. C., January 2013
20. G. Wu. D8 HOV Facilities Operational Performance Analysis and Tools Development. Research Connect, Caltrans, Sacramento, December 2012
21. G. Wu. Using ITS to Improve Energy Efficiency. ITS California, Sacramento, September 2012
22. G. Wu. Develop Eco-Driving Assistance Systems – Value of Traffic Signal Status Information. CERT-RUSD Series Seminar, October 2011
23. G. Wu. Congestion and Air Quality Evaluation of Goods Movement Pricing. Board of Advisor Meeting at CE-CERT, UC Riverside, March 2011

PROJECTS INVOLVED

Note: PI (including proposal drafter) ~ $4,438,752; Co-PI ~ $3,735,767

- 04/2022 – 06/2023 Enhancing the Modeling of Emission Dispersion from Idling and Slowly Moving Vehicles (as PI, CARTEEH UTC, $160,000)
- 03/2022 – 02/2023 Upscaled Cyber Mobility Mirror System: Multi-intersection Camera-based Cooperative Perception (as Co-PI, Toyota Motor North America, $60,000)
- 10/2021 – 09/2022 Enhanced Personalized Advanced Driving Assistance System (E-PADAS) using the "Digital Twin" Approach (as PI, Toyota Motor North America, $80,000)
- 10/2021 – 09/2022 Connectivity-Based Cooperative Ramp Merging in Multimodal and Mixed Traffic Environment (as PI, UTC Pacific Southwest Region, $99,999)
- 04/2021 – 06/2022 Develop a Performance Metric to Quantify the Inhalation of Traffic-related Air Pollutants at Both Mesoscale and Macroscale (as Co-PI, CARTEEH UTC, $80,000)
- 02/2021 – 06/2022 Quantifying the Environmental and Health Impacts of Curbside Management for Emerging Multi-modal Mobility Services (as PI, CARTEEH UTC, $80,000)
- 04/2021 – 03/2022 Lane-Level Localization and Map Matching for Advanced Connected and Automated Vehicle (CAV) Applications (as Co-PI, National Center for Sustainable Transportation, $85,000)
- 01/2021 – 04/2021 Connected Vehicle-based Advanced Detection of "Slow-Down" Events on Freeways (as PI, Honda Research Institute, $44,079)
- 12/2020 – 02/2022 Preliminary Evaluation of Roadside Sensing based Real-time Cyber Mobility Mirror (CMM) Prototype in Simulation (as Co-PI, Toyota Motor North America, $80,000)
- 10/2020 – 09/2021 Developing a Personalized ADAS for Mixed Traffic Scenarios by Leveraging the Digital Twin Framework (as PI, Toyota Motor North America, $80,000)

- 1/2020 – 06/2021 Estimating the Impacts of Automatic Emergency Braking (AEB) Technology on Traffic Energy and Emissions (as PI, UTC Pacific Southwest Region, $99,995)
- 10/2019 – 09/2020 Developing Situation Awareness Capability within the "Digital Twin" Framework – Activating/Deactivating Connected Vehicle (CV) Applications in Mixed Traffic (as PI, Toyota Motor North America, $80,000)
- 9/2019 – 12/2021 Assessing Roadway Infrastructure for Future Connected and Automated Vehicle Deployment in California (as PI, UC-ITS Program, $89,920)
- 4/2019 – 09/2021 Hybridization and Full Electrification Potential in Off-Road Applications (as Co-PI, California Air Resource Board, $300,000)
- 4/2019 – 09/2021 Real-World Tire and Brake Wear Emissions (as Co-PI, California Air Resource Board, $400,000)
- 2/2019 – 06/2021 Alternative HOV Lane Operational Strategies for Congestion Mitigation in California (as Co-PI, Caltrans, $400,000)
- 11/2018 – 10/2019 Evaluating Connected Vehicle Applications in a Mixed Traffic Environment using a "Digital Twin" Approach (as PI, Toyota Motor North America, $50,000)
- 11/2018 – 10/2019 Development of Eco-Friendly Ramp Control based on Connected and Automated Vehicle Technology (as PI, National Center for Sustainable Transportation, $78,355)
- 02/2018 – 01/2019 Quantifying Traffic Congestion-Induced Change of Near-road Air Pollutant Concentration (as Co-PI, CARTEEH UTC, $80,000)
- 01/2018 – 03/2018 Simulation Study on the Impact of Traffic Jam Assistance Application (as PI, Honda R&D America, $45,000)
- 10/2017 – 03/2020 Evaluating Energy Efficiency Opportunities from Connected and Automated Vehicle Deployments coupled with Shared Mobility in California (as co-PI and proposal writer, US DOE VTO, ~$1,200,000)
- 10/2017 – 09/2018 Deep Learning based Eco-driving system for Battery Electric Vehicles (as PI, National Center for Sustainable Transportation, $70,000)
- 06/2017 – 12/2018 Development of Connected and Automated Vehicle Algorithms and Support at the FHWA's TFHRC (as PI, FHWA & Leidos, ~$170,000)
- 04/2017 – 03/2020 An Innovative Vehicle-Powertrain Eco-Operation System for Efficient Plug-In Hybrid Electric Buses (as co-PI and proposal writer, US DOE ARPA-E, $2,800,000)
- 03/2017 – 08/2018 California One: Connected Vehicle Pilot Deployment (CVPD) Support (as co-PI, Caltrans, ~$150,000)
- 03/2017 – 02/2019 Traffic Optimization for Signalized Corridors Small Scale Test & Evaluation Project (as co-PI, FHWA & CAMP, ~$340,000)
- 02/2017 – 01/2018 Connected and Automated Vehicle (CAV) Applications Effectiveness Analysis (as PI, Honda R&D America, ~$270,000)
- 01/2017 – 12/2017 Developing an Interactive Machine Learning based Approach for Sidewalk Digitalization (as co-PI, National Center for Sustainable Transportation, ~$80,000)
- 08/2016 – 07/2017 Evaluating ITS in terms of Safety, Mobility and Environmentally Sustainability (as co-PI, National Center for Sustainable Transportation, ~$50,000)
- 08/2015 – 12/2016 Connected Cities Research Program (independent Consultant, ~$10,000)
- 08/2015 – 07/2016 Eco-Approach and Eco-Departure Planning Study (as co-PI, National Center for Sustainable Transportation, ~$50,000)
- 08/2015 – 09/2016 V2X Connected Vehicle Early Deployment Application Analysis (as co-PI, Honda R&D America, ~$150,000)
- 07/2015 – 06/2017 Optimized Natural Gas Hybrid-Electric Drayage Truck Demonstration (as co-PI, California Air Resource Board, ~$300,000)

- 01/2015 – 12/2018 Evaluating Alternative Design of Geometric Configuration for High-Occupancy Vehicle (HOV) Facilities in California (as co-PI, Caltrans, ~$400,000)
- 01/2015 – 12/2015 Agent-Based Adaptive Signal Control Using Connected Vehicle Technology (as PI, UC-CONNECT, $100,000)
- 10/2014 – 12/2015 Fundamental Research in Freeway Lateral Maneuvers (as co-PI, Caltrans, ~$150,000)
- 04/2014 – 01/2016 GlidePath Algorithm, Documentation, Evaluation and Integrity (as co-PI, FHWA & Leidos, ~$150,000)
- 10/2013 – 09/2015 Advanced Energy Management Strategy Development for Plug-in Hybrid Electric Vehicles (as PI, UC-CONNECT UTC, ~$100,000)
- 10/2012 – 12/2014 Assessment of Traffic Simulation Calibration for Micro-Scale Emissions Modeling (as co-PI, UC-CONNECT UTC, ~$100,000)
- 10/2012 – 05/2014 Eco-Routing Navigation System for Electric Vehicles (as PI, California Energy Commission, ~$100,000)
- 06/2012 – 05/2014 Deployment of Prior HOV Lanes Research Results in Developing Analysis Tools for New Managed Lanes Projects (as co-PI, Caltrans, ~$300,000)
- 05/2012 – 01/2015 Applications for the Environment: Real-Time Information Synthesis (AERIS) (as key researcher, US DOT)
- 07/2010 – 01/2013 High Occupancy Vehicle (HOV) System Analysis Tools: District 8 HOV Facility Performance Analysis (as key researcher, Caltrans)
- 01/2011 – 04/2012 Development and Evaluation of Intelligent Energy Management Strategies for Plug-in Hybrid Electric Vehicles (PHEV) (as key researcher, UC-CONNECT UTC)
- 07/2011 – 08/2011 Improving Vehicle Fleet, Activity, and Emissions Data for On-Road Mobile Sources Emissions Inventories (as key researcher, California Air Resource Board)
- 08/2010 – 09/2010 Congestion and Air Quality Evaluation of Goods Movement Pricing (as key researcher, Air Quality Management District)
- 09/2009 – 06/2010 High Occupancy Vehicle (HOV) System Analysis Tools: Statewide HOV Facility Performance Analysis (as key researcher, Caltrans)
- 06/2008 – 03/2010 Relieve Congestion and Conflicts Between Highway and Railroad at Grade-Crossing Intersections (Part II: Lab Testing and Field Testing) (as key researcher, SANDAG)
- 04/2008 – 04/2009 Audi Clean Air (Traffic Network Simulation) (as key researcher, VW)
- 03/2007 – 02/2009 SPRINTER Rail: Grade Crossing/Traffic Signal Optimization Study (as key researcher, SANDAG)
- 12/2006 – 03/2007 Field Operational Tests of Adaptive Transit Signal Priority (ATSP) System (Transit Data Analysis and Communication Channel Capacity Simulation) (as key researcher, Caltrans)
- 05/2005 – 12/2006 Relieve Congestion and Conflicts Between Highway and Railroad at Grade-Crossing Intersections (Part I: System Development, Simulation Study and Data Analysis) (as key researcher, SANDAG)
- 05/2005 – 09/2006 Nationwide Air Traffic Management Using Aggregate Eulerian Flow Models (as key researcher, NASA)
- 09/2003 – 07/2004 Simulation and Optimization of the Heating Network in Huhehaote, Inner Mongolia (as key researcher, Inner Mongolia Heating Company)

PROFESSIONAL ACTIVITIES

- Senior Member, Institute of Electrical and Electronics Engineers (IEEE)
- Member, Standing Committee of AJE35 in Transportation Research Board (TRB) 2022 - present
- Member, Standing Committee of ACP30 in Transportation Research Board (TRB) 2016 – present

- Paper Review Coordinator, Standing Committee of ACP30 in Transportation Research Board (TRB) 2018 – present Member, SAE International
- Member, IEEE Control System Society Technical Committee on Smart Cities
- Member, Chinese Overseas Transportation Association (COTA)
- Member, Chinese Institute of Engineers (CIE) – SoCal Chapter
- Session Co-chair, Automated Vehicle Symposium or ARTS (2020, 2021)
- Reviewer for DOE VTO Annual Merit Review (2019, 2020, 2021)
- Member, SAE MobilityRxiv® advisory board
- Member, SAE International On-Road Automated Driving Committee
- Member, SAE International Cooperative Driving Automation (CDA) Committee
- Member, SAE International Shared and Digital Mobility Committee
- Session Chair/Co-chair, IEEE Conference on Intelligent Transportation Systems 2017, 2018, 2020
- Session Chair/Co-chair, IEEE Intelligent Vehicle Symposium 2017, 2018, 2020
- Panelist, FHWA CARMA
- Member, The First World Transport Convention Technical Committee 2017
- Panel member, Review group for FHWA's Urban Street ATDM project
- Member, Organization committee for 2017 TRB Annual Meeting ML Workshop
- Session Chair, IEEE International Conference on Connected Vehicle Expo (ICCVE) 2015
- Member, Intelligent Planet via Informatics and Cybernetics (IPIC) 2015 Program Committee

SERVICE AS EDITOR/REVIEWER

- Associate Editor for IEEE Transactions on Intelligent Transportation Systems (2021 – present)
- Associate Editor for IEEE Open Journal of Intelligent Transportation Systems (2019 – present)
- Associate Editor for SAE International Journal of Connected and Automated Vehicles (2017 – present)
- Associate Editor, IEEE Intelligent Vehicle Symposium 2020
- Associate Editor, IEEE Conference on Intelligent Transportation Systems, 2018, 2019
- Guest Editor, SAE International Journal of CAVs - Special Issue on Emerging Simulation Tools and Technologies for Testing and Evaluating Connected and Automated Vehicles, September 2021
- Guest Editor, Journal of Advanced Transportation - Special Issue on Partially Connected and Automated Traffic Operations in Road Transportation, June 2018
- International Journal of Intelligent Transportation Systems Research (2012 – present)
- Journal of Intelligent Transportation Systems (2012 – present)
- Journal of Transportation Engineering (2012 – present)
- IEEE Transactions on Intelligent Transportation Systems (2010 – present)
- Transportation Research Board Annual Meeting (2009 – present)
- IEEE Intelligent Transportation Systems Conference (2011 – present)
- International Conference of Chinese Transportation Professionals (2011 – present)
- World Congress on Intelligent Transport Systems (2008 – present)
- 2011 Intelligent Vehicles Symposium (2011 – present)
- 2011 IEEE Forum on Integrated and Sustainable Transportation Systems (2011)
- The Open Transportation Journal (2013 – present)
- Transportmetrica A (2014 – present)
- Transportation Research: Part D (2014 – present)
- Transportation Research: Part B (2014 – present)
- Transportation Research: Part C (2015 – present)

- International Journal of Intelligent Transportation and Urban Planning (ITUP) (2014 – present)
- International Association of Chinese Geotechnical Engineers (IACGE) Annual Conference (2015 – present)
- Urban Rail Transit (2015 – present)
- Energies – Open Access Journal (2015 – present)
- Sensors – Open Access Journal (2015 – present)
- IEEE Transactions on Vehicular Technology (2015 – present)
- IEEE Transactions on Intelligent Vehicles (2016 – present)
- IEEE Transactions on Industrial Electronics (2016 – present)
- Transportation Letters (2016 – present)
- International Journal of Sustainable Transportation (2016 – present)
- Journal of Traffic and Transportation Engineering (2016 – present)
- IEEE Intelligent Transportation Systems Magazine (2017 – present)
- IEEE Transactions on Advances in Mechanical Engineering (2017 – present)
- Journal of Advanced Transportation (2017 – present)
- World Transport Convention (2017 – present)
- Proposal Review (LU) (08/2020, 07/2021)

SERVICE AS THESIS COMMITTEE MEMBER

Note: With exception as a research faculty

- 09/2022 Saswat Nayak's Oral Exam Co-chair (UCR)
- 09/2022 Luis Enriquez-Contreras's Oral Exam Co-chair (UCR)
- 04/2022 Zhengwei Bai's Oral Exam Co-chair (UCR)
- 09/2021 Shangrui Liu's Master Thesis Defense Chair (UCR)
- 03/2021 Xishun Liao's Oral Exam Co-chair (UCR)
- 09/2020 Yu Jiang's Master Thesis Defense Chair (UCR)
- 09/2020 Zhouqiao Zhao's Oral Exam Co-chair (UCR)
- 08/2020 Fuad's PhD Oral Exam Committee (UCR)
- 02/2020 Dr. Chao Wang's PhD Thesis Defense Committee (UCR)
- 11/2019 Dr. Nigel Williams' PhD Thesis Defense Co-Chair (UCR)
- 09/2019 Rumana Binte Faruque's PhD Oral Exam Committee (UCR)
- 05/2019 Dr. Ziran Wang's PhD Thesis Defense Co-Chair (UCR)
- 11/2018 Dr. Danyang Tian's PhD Thesis Defense Co-Chair (UCR)
- 10/2018 Sonya Ragothaman's Master Thesis Defense Committee (UCR)
- 2017 Nigel Williams's PhD Oral Exam Committee (UCR)
- 2016 Ziran Wang's PhD Oral Exam Committee (UCR)
- 2016 Kristoffer Mendoza's Master Thesis Defense Committee (CPP)
- 2016 Kevin Lu's Master Thesis Defense Committee (CPP)
- 2016 Chao Wang's PhD Oral Exam Committee (UCR)
- 2016 Dr. Xuewei Qi's PhD Thesis Defense Co-Chair (UCR)
- 2015 Dr. Qiu (Apple) Jin's PhD Thesis Defense Co-Chair (UCR)
- 2015 Fei Ye's PhD Oral Exam Committee (UCR)
- 2015 Danyang Tian's PhD Oral Exam Committee (UCR)
- 2014 Xuewei Qi's PhD Oral Exam Committee (UCR)

STUDENT SUPERVISION

- 2022 – Chuheng Wei (PhD)
- 2022 – Dongbo Peng (PhD)
- 2020 – Xuanpeng Zhao (PhD)
- 2020 – Zhengwei Bai (PhD)
- 2020 – Jiahe Cao (Master)
- 2019 – 2020 Dr. Lan Yang (Visiting Scholar, Chang’an University, female)
- 2019 – Xishun Liao (PhD)
- 2019 – 2021 Shangrui Liu (Master)
- 2019 – Pingbo Ruan (Master)
- 2019 – 2020 Daniel Esaid (Senior)
- 2019 – 2020 Xiaofeng Zhang (Senior)
- 2019 – 2020 Runze Wang (Senior)
- 2019 – 2020 Zicheng Shan (Senior)
- 2019 – 2020 Boyu Hou (Senior, female)
- 2018 – Zhouqiao Zhao (PhD)
- 2018 – 2020 Yu Jiang (Master)
- 2018 – 2019 Yu Wang (Master)
- 2018 – 2019 Yue You (Senior)
- 2017 Summer Tingxu Lv (Intern, UCD)
- 2015 – 2021 Nigel Williams (PhD)
- 2015 – 2019 Ziran Wang (PhD)
- 2015 – 2017 Weixia Li (Visiting Student, Tsinghua University, female)
- 2015 – 2016 Kristoffer Mendoza (Master)
- 2015 – 2016 Kevin Lu (Master)
- 2015 Summer Raphaël Meudec (ENSTA ParisTech)
- 2014 – 2016 Peng Hao (Postdoc)
- 2014 – 2019 Fei Ye (PhD, female)
- 2014 – 2019 Danyang Tian (PhD, female)
- 2014 Summer Pierre Saikaly (Intern, ENSTA ParisTech)
- 2013 – 2017 Xuewei Qi (PhD)
- 2011 – 2015 Qiu Jin (PhD, female)

APPENDIX D

PEER REVIEWER CONFLICT OF INTEREST STATEMENTS

Attachment 2
Conflict of Interest Certification
(REV 04/2019)
Order Conflict of Interest Certification (EPA Prime Contracts)
REV 12/2017)

Subcontractor/Consultant: Thomas D. Durbin

EPA Contract No. 68HE0C18C0001

Order No.: WA 4-16

In accordance with EPAAR 1552.209-71 (Organizational Conflicts of Interest), EPAAR 1552.209-73 (Notification of Conflicts of Interest Regarding Personnel), and the terms and conditions of the subcontract agreement for services, before submitting this certification, Subcontractor/Consultant shall search its records accumulated, at a minimum, over the past three years immediately prior to receipt of the order to determine if any conflicts exist. Subcontractor/Consultant makes the following certifications/warranties:

ORGANIZATIONAL AND PERSONAL CONFLICTS OF INTEREST:

X To the best of our knowledge and belief, no actual or potential organizational conflicts of interest exist. In addition, none of the individuals proposed for work under this order has any personal conflicts of interest.

This is to certify that our personnel who perform work under this order, or relating to this order, have been informed of their obligation to report personal and organizational conflicts of interest. Subcontractor/Consultant recognizes its continuing obligation to search for, identify, and report to the ERG Technical Contract Manager any actual or potential organizational or personnel conflicts of interests that may arise during the performance of this work order or work relating to this order.

Thomas Durbin

Authorized Signature

Thomas Durbin

Printed Name/Title

12/2/22

Date

Attachment 2
Conflict of Interest Certification
(REV 04/2019)

Order Conflict of Interest Certification (EPA Prime Contracts)
(REV 12/2017)

Subcontractor/Consultant:	Shawn Midlam-Mohler
EPA Contract No.	68HE0C18C0001
Order No.:	WA 4-16

In accordance with EPAAR 1552.209-71 (Organizational Conflicts of Interest), EPAAR 1552.209-73 (Notification of Conflicts of Interest Regarding Personnel), and the terms and conditions of the subcontract agreement for services, before submitting this certification, Subcontractor/Consultant shall search its records accumulated, at a minimum, over the past three years immediately prior to receipt of the order to determine if any conflicts exist. Subcontractor/Consultant makes the following certifications/warranties:

ORGANIZATIONAL AND PERSONAL CONFLICTS OF INTEREST:

☒ To the best of our knowledge and belief, no actual or potential organizational conflicts of interest exist. In addition, none of the individuals proposed for work under this order has any personal conflicts of interest.

OR:

☐ To the best of our knowledge and belief, all actual or potential organizational and personal conflicts of interest have been reported to the ERG Technical Contract Manager. This disclosure statement must include a summary of the potential conflict with respect to the work proposed to be performed, any reasons why Subcontractor/ Consultant does not believe the potential work would be a conflict, and/or a proposed strategy for mitigating any potential conflict of interest.

This is to certify that our personnel who perform work under this order, or relating to this order, have been informed of their obligation to report personal and organizational conflicts of interest. Subcontractor/Consultant recognizes its continuing obligation to search for, identify, and report to the ERG Technical Contract Manager any actual or potential organizational or personnel conflicts of interests that may arise during the performance of this work order or work relating to this order.

Shawn Midlam-Mohler
Authorized Signature

Shawn Midlam-Mohler Owner, ModelTek, LLC
Printed Name/Title

12/15/22
Date

Attachment 2

Conflict of Interest Certification

(REV 04/2019)

Order Conflict of Interest Certification (EPA Prime Contracts)

(REV 12/2017)

Subcontractor/Consultant: Keshav S. Varde

EPA Contract No. 68HEOC18C0001

Order No.. WA 4-16

In accordance with EPAAR 1552.209-71 (Organizational Conflicts of Interest), EPAAR 1552.209-73 (Notification of Conflicts of Interest Regarding Personnel), and the terms and conditions of the subcontract agreement for services, before submitting this certification, Subcontractor/Consultant shall search its records accumulated, at a minimum, over the past three years immediately prior to receipt of the order to determine if any conflicts exist. Subcontractor/Consultant makes the following certifications/warranties:

ORGANIZATIONAL AND PERSONAL CONFLICTS OF INTEREST:

☒ To the best of our knowledge and belief, no actual or potential organizational conflicts of interest exist. In addition, none of the individuals proposed for work under this order has any personal conflicts of interest.

This is to certify that our personnel who perform work under this order, or relating to this order, have been informed of their obligation to report personal and organizational conflicts of interest. Subcontractor/Consultant recognizes its continuing obligation to search for, identify, and report to the ERG Technical Contract Manager any actual or potential organizational or personnel conflicts of interests that may arise during the performance of this work order or work relating to this order.

KVarde

Authorized Signature

Keshav Varde

Printed Name/Title

12/15/2022

Date

Attachment 2
Conflict of Interest Certification
(REV 04/2019)

Order Conflict of Interest Certification (EPA Prime Contracts)
(REV 12/2017)

Subcontractor/Consultant:	Guoyuan Wu
EPA Contract No.	68HE0C18C0001
Order No.:	WA 4-16

In accordance with EPAAR 1552.209-71 (Organizational Conflicts of Interest), EPAAR 1552.209-73 (Notification of Conflicts of Interest Regarding Personnel), and the terms and conditions of the subcontract agreement for services, before submitting this certification, Subcontractor/Consultant shall search its records accumulated, at a minimum, over the past three years immediately prior to receipt of the order to determine if any conflicts exist. Subcontractor/Consultant makes the following certifications/warranties:

ORGANIZATIONAL AND PERSONAL CONFLICTS OF INTEREST:

☒ To the best of our knowledge and belief, no actual or potential organizational conflicts of interest exist. In addition, none of the individuals proposed for work under this order has any personal conflicts of interest.

OR:

☐ To the best of our knowledge and belief, all actual or potential organizational and personal conflicts of interest have been reported to the ERG Technical Contract Manager. This disclosure statement must include a summary of the potential conflict with respect to the work proposed to be performed, any reasons why Subcontractor/ Consultant does not believe the potential work would be a conflict, and/or a proposed strategy for mitigating any potential conflict of interest.

This is to certify that our personnel who perform work under this order, or relating to this order, have been informed of their obligation to report personal and organizational conflicts of interest. Subcontractor/Consultant recognizes its continuing obligation to search for, identify, and report to the ERG Technical Contract Manager any actual or potential organizational or personnel conflicts of interests that may arise during the performance of this work order or work relating to this order.

Authorized Signature

Guoyuan Wu
Printed Name/Title

12/16/2022
Date