

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TESLA, INC.,

Petitioner,

v.

iQAR INC.,

Patent Owner.

Case No. IPR2024-00545

Patent No. 8,972,161 B1

DECLARATION OF CRAIG J. HOFF

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I, Craig, J. Hoff, declare as follows:

I. INTRODUCTION

1. I have been retained by iQar Inc. (“iQar”) as an independent expert consultant in this proceeding before the United States Patent and Trademark Office (“PTO”). I am not an employee of iQar or any affiliate or subsidiary of iQar.
2. I have been asked to consider whether certain references teach or suggest the features recited in certain claims of U.S. Patent No. 8,972,161, which I refer to herein as the “’161 patent.”
3. My opinions and the bases for my opinions are set forth below.
4. I am being compensated at my ordinary and customary rate of \$350 per hour for my work, plus reimbursement for any reasonable expenses. My compensation is based solely on the amount of time that I devote to activity related to this case and is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other financial interest in this proceeding.

II. EDUCATION BACKGROUND, PROFESSIONAL EXPERIENCE, AND OTHER QUALIFICATIONS

5. My curriculum vitae (“CV”) is attached hereto and provides an accurate identification of my background and experience.
6. I received a B.S. in Mechanical Engineering in 1979 from Michigan State University, East Lansing, Michigan.

7. I earned my M.S. in Mechanical Engineering in 1981 from Michigan State University, East Lansing, Michigan. My master's thesis focused developing a mathematical model of the thermodilution method of measuring cardiac output.

8. I obtained my Ph.D. in Mechanical Engineering in 1992 from the University of Michigan, Ann Arbor, Michigan. My Ph.D. dissertation focused on the understanding the effects of distributed leakage on pulse propagation in viscoelastic arteries using *in vitro* (physical) models and *in sitio* (computational) models. My research work was a joint project of the University of Michigan and the Cardiovascular Research Lab at Henry Ford Hospital.

9. I am currently a Professor of Mechanical Engineering at Kettering University, Flint, Michigan. I joined Kettering University as an Associate Professor in the Department of Mechanical Engineering in 1999. I was promoted to Professor in 2005, became the Department Head of Mechanical Engineering in 2012, and was appointed as the Founding Dean of the College of Engineering in 2016 and served in that role until 2022.

10. In my role as a professor, I have taught numerous graduate and undergraduate courses related to mechanical and automotive engineering. More specifically, I teach courses in the areas of energy systems and automotive powertrains. The automotive courses include: "Introduction to Automotive Powertrains" (MECH 544), "Hybrid Electric Vehicle Propulsion" (MECH 545), and

“Introduction to Automotive HVAC Systems.” In these courses, I emphasize experiential learning, integrating theoretical knowledge with practical applications through laboratory work and real-world projects.

11. In addition to teaching academic courses, I teach professional development courses in the area of conventional and electric powertrains to practicing engineers. I’ve taught courses for the Society of Automotive Engineers International (SAE), U.S. Army, Toyota, and the Shanghai Automotive Industry Corporation (SAIC). (Both GM/SAIC and VW/SAIC).

12. I have also served as a faculty advisor to student competition teams including the US Department of Energy FutureCar Challenge, where students design, build and compete with a hybrid-electric Ford Taurus, the Formula SAE competition, where students design, build, and compete with a small open-wheel racecar, and the SAE AutoDrive Challenge, where students design, build, and compete with a fully autonomous vehicle.

13. My research has focused primarily on conventional and hybrid automotive powertrains, alternative fuels, Proton Exchange Membrane (PEM) fuel cells, and sustainability. My work includes developing in-vehicle data acquisition systems, developing conventional, electric, and hybrid electric vehicles, creating mathematical models for the same, and establishing vehicle testing facilities. During my time at Kettering University, I have secured over \$2,000,000 in external funding

from agencies such as the Department of Defense, Department of Energy, National Science Foundation, and various industry sponsors. I have supervised six master's thesis students and served on over 15 master's thesis committees.

14. Modeling conventional, electric, and hybrid-electric powertrains requires a detailed understanding of the operation of the various components in the system (engines, motors, transmissions, chassis) and the control of those components.

15. Additionally, modeling automotive powertrains uses techniques called 'design optimization' to improve the design. The goal of optimization techniques is to minimize a 'cost function.' In automotive powertrain studies optimization is applied to components sizes and control algorithms to minimize fuel use and emissions. Optimization techniques can also be applied to path planning for autonomous vehicles (i.e. finding the best safe route to a destination) in order to minimize fuel use, emissions, travel time or travel distance.

16. My research has led to the development of a "Green Mobility Laboratory" which allows small electric vehicle powertrains to be tested, utilizing Department of Energy (DOE) grant funds. I have also developed a chassis dynamometer facility for testing the performance of small electric vehicles. And I have been instrumental in the development of the GM/Kettering University Mobility

Research Center (MRC), a 25 acre facility for automotive testing. I continue to be the main technical advisor to the facility.

17. Throughout my career at Kettering University, I have received several awards and recognitions. I was honored with the Carroll Smith Mentor's Cup by the Sports Car Club of America in 2015 for my work with Formula SAE racing teams and was named the Outstanding Educational Scholar by the Kettering University Center for Education, Teaching, and Learning in 2007. Additionally, I received the SAE Forest R. McFarland Award for my contributions to the dissemination of technical information and the SAE Ralph R. Teetor Award for my significant contributions to teaching, research, and student development in automotive engineering. My contributions to the field have been recognized through various awards and honors which are fully listed in my CV.

18. I have authored more than 30 peer-reviewed journal articles and conference papers. My publications cover a wide range of topics, including combustion and emissions in dual-fuel engines, hybrid electric vehicle design, and environmentally sustainable engineering education. I have also presented numerous invited talks and conference presentations on automotive engineering and sustainability.

19. In addition to my academic and research activities, I have served as a consultant for various organizations, including Ford Motor Company, Society of

Automotive Engineers, and the U.S. Army Tank and Automotive Command (TACOM). My consulting work has involved developing technical solutions for hybrid and fuel-cell vehicles, providing expert testimony in patent cases involving hybrid and electric vehicle control strategies, and conducting technical assessments for automotive and engineering companies.

20. I have been actively involved in professional societies, including the American Society of Mechanical Engineers (ASME), the Society of Automotive Engineers (SAE), and the American Society of Engineering Educators (ASEE). I have served on several committees, including the SAE International Scholarship Committee, the SAE International Engineering Education Board, and the NextEnergy Alternative Energy Education Board. I have also organized and chaired technical sessions at various conferences and served as an external reviewer for graduate programs at other universities.

21. I continue to actively engage in research, teaching, and professional service to advance the field of mechanical and automotive engineering.

22. In my roles as Dean of the College of Engineering, technical adviser to the Mobility Research Center (MRC) and Head of the Department of Mechanical Engineering one of my responsibilities was to regularly engage with university shareholders including alumni and engineering companies that hired our students and graduates to learn about industry trends and needs. Most of the university's

shareholders are involved in the automotive industry. As a result of these interactions and through my research, I have developed a knowledge of topics such as Advanced Driver-Assistance Systems (ADAS) and Vehicle Autonomy. These technologies involve the use of navigation systems (which includes Global Positioning Systems (GPS), Inertial Navigation Systems (INS), along with mapping and route planning systems), vehicle communication systems (such as Vehicle to Vehicle (V2V) and Vehicle to Grid (V2G) systems), in-vehicle data acquisition systems, Controller Area Network (CAN) and Artificial Intelligence (AI) systems.

23. Because of my background in automotive engineering and my connection to Kettering University¹, an institution that is well-known and regarded in the automotive industry, I was asked to join the Smart Belt Coalition² (SBC). SBC is a collaboration between the Departments of Transport in Michigan, Ohio, Indiana, New Jersey, and Pennsylvania, the Turnpike authorities in Ohio, Indiana, New Jersey and Pennsylvania, two large automotive test facilities (the American Center for Mobility, the Transportation Research Center), and the University of Michigan, the Ohio State University, Penn State University, Carnegie Mellon University, Purdue University and Kettering University. The goal of the coalition is to prepare

¹ Kettering University was once owned and operated by the General Motors Corporation as General Motors Institute (GMI).

² <https://www.michigan.gov/smartbelt/about>

the transportation agencies for the integration of electric, connected and automated vehicle technologies. In working with the SBC, I have gained further knowledge on the advanced automotive technologies that I've mentioned previously.

24. Because of my various roles I regularly attended conferences held by the Society of Automotive Engineers International (SAE), the Institute of Electrical and Electronics Engineers (IEEE) Vehicular Technology Society (VTS), and the Intelligent Transportation of America (ITS). I also attended events at automotive suppliers and mobility research centers, where new technology was being demonstrated. At these conferences and events, I both attended and presented numerous technical presentations on the topics that I've discussed previously.

25. I am familiar with the subject matter of this case, and consider myself an expert in, among other things, intelligent transportation systems, vehicle information and communications systems, automotive powertrains and energy systems, and navigation systems

III. ASSIGNMENT AND MATERIALS CONSIDERED

26. I have been asked to assess the '161 patent, including the state of the art when the application underlying the '161 patent was filed. I have been asked to consider, analyze, and explain certain prior art to the '161 patent, including how that art relates to the challenged claims of the '161 patent and to provide my opinion on the validity of certain of the claims in the '161 patent.

27. The opinions expressed in this declaration are not exhaustive of opinions I may offer in the future regarding the unpatentability of the claims of the '161 patent. Therefore, the fact that I do not address a particular point should not be understood to indicate an agreement on my part that any claim complies with the requirements of any applicable patent or other rule.

28. I reserve the right to amend and supplement this declaration in light of additional evidence, arguments, or testimony presented during this IPR or related proceedings on the '161 patent.

29. In forming the opinions set forth in this declaration, I have considered and relied upon my education, knowledge of the relevant field, knowledge of scientific and engineering principles, and my experience. I have also reviewed and considered the '161 patent (Ex. 1001), its prosecution history (Ex. 1002), the Petition (Paper 2), the Board's institution decision in this proceeding (Paper 7) and the following additional materials:

Exhibit	Description
Ex. 1003	Declaration of Dr. Papanikolopoulos, Ph.D.
Ex. 1005	U.S. Publication No. 2004/0068359 ("Neiss")
Ex. 1006	U.S. Patent No. 6,161,072 ("Clapper")
Ex. 1007	W. C. Morchin, "Energy management in hybrid electric vehicles," 17th DASC. AIAA/IEEE/SAE. Digital Avionics Systems Conference. Proceedings, Bellevue, WA, USA, 1998, pp. I41/1-I41/6 vol.2 ("Morchin")

Ex. 1008	U.S. Patent No. 6,658,344 (“Hirasago”)
Ex. 1009	U.S. Patent No. 6,005,494 (“Schramm”)
Ex. 1011	U.S. Patent No. 6,836,719 (“Andersson”)
Ex. 1012	U.S. Patent No. 5,584,208 (“Ha”)
Ex. 1013	U.S. Patent No. 5,129,475 (“Kawano”)
Ex. 1014	U.S. Patent No. 4,225,007 (“Voges”)
Ex. 1015	Excerpt from Random House Webster’s Unabridged Dictionary, Second Edition (2001)
Ex. 1016	Excerpt from Collins English Dictionary Complete and Unabridged, Sixth Edition (2003)
Ex. 1017	Excerpt from The New Oxford American Dictionary (2001)
Ex. 1018	U.S. Patent No. 8,271,166 (“Wolf”)
Ex. 1019	Japanese Patent Pub. No. 11220807 (“Hosoda Original”)
Ex. 1020	Certified Translation of Japanese Patent Pub. No. 11220807 (“Hosoda”)
Ex. 1021	U.S. Patent No. 6,314,347 (“Kuroda”)
Ex. 1022	U.S. Patent No. 7,013,205 (“Hafner”)
Ex. 2001	Excerpt from The American Heritage College Dictionary (2000)

IV. UNDERSTANDING OF THE LAW

30. I am not an attorney, but I have been informed of several legal principles concerning patent validity, which I have employed in forming my opinions in this declaration.

31. I have been informed and understand that each patent claim is considered separately for purposes of validity and that a dependent claim that depends from another claim includes all of the limitations of the claim it depends from.

32. I understand that the first step in comparing an asserted claim to the prior art is for the claim to be properly construed. I address how a person of ordinary skill in the art (POSITA) would have understood the claims of the alleged invention in Section VII below.

33. I understand that a patent claim is “obvious” when the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains.

34. In making an obviousness determination, I understand that there are several factors to consider: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art at the time the invention was made; (3) the differences between the claimed invention and the prior art, if any, and (4) objective considerations, if any exist, such as any commercial success, copying, prior failure by others, licenses, longstanding need, and unexpected results.

35. I understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently

known in the prior art, whether those references were set forth in a single reference or in a combination of references. Instead, it must have been obvious to arrange those elements in the same way as the elements in the claim.

36. I understand that either a single reference or multiple references may be the basis for finding that a claim is obvious. A patent challenger, however, must show that there is a reason, suggestion, or motivation that would lead one of ordinary skill in the art to either modify the single reference or combine prior art references to arrive at the claimed subject matter.

37. I understand that there is no single way to define the line between true inventiveness on the one hand (which is patentable) and the application of common sense and ordinary skill to solve a problem on the other hand (which may not be patentable). Thus, when assessing obviousness, a number of different inquiries can be made and considered. For instance, market forces or other design incentives may be what produced a change in the technology of the prior art, rather than true inventiveness. I further understand that explicit teachings or suggestions in the prior art to make the modification or combination of elements claimed in the patent may be evidence of obviousness. Further, an innovation may be obvious if it applies a known technique that had been used to improve a similar device or method in a similar way. I understand that a claimed invention may be found to be obvious to try if the claimed innovation was one of a relatively small number of possible

approaches to the problem with a reasonable expectation of success by those skilled in the art.

38. However, I also understand that it is improper to engage in hindsight when trying to determine the obviousness of a patent claim. Many true inventions might seem obvious with the benefit of hindsight. I understand that the obviousness inquiry must be conducted from the standpoint of a person of ordinary skill in the field at the time the claimed invention was made. What is known today, and what is learned from the teachings and disclosures of the patent itself containing the claim under analysis, should not be considered. Nor should one use the patent claim as a guide to picking out elements of the prior art for combination.

39. I understand that if a claim is not obvious, then the claims that depend from it are not obvious.

40. I provide my opinions in this declaration based on the guidelines set forth above.

V. LEVEL OF SKILL IN THE ART

41. I have been informed and understand that the level of ordinary skill in the relevant art at the time of the invention is relevant to inquiries such as the meaning of claim terms, the meaning of disclosures found in the prior art, and the reasons a POSITA may have for combining references.

42. I have been informed and understand that factors that may be considered in determining the level of ordinary skill include: (1) the education of the inventor; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology; and (6) education level of active workers in the relevant field. I have been further informed and understand that a person of ordinary skill in the art (POSITA) is also a person of ordinary creativity.

43. In my opinion, a POSITA in the field of the '161 patent would have had a bachelor's degree in mechanical engineering, computer engineering or an equivalent field, along with 3-4 years of professional experience working with automotive applications including vehicle control and powertrain systems, or an equivalent level of skill, knowledge, and experience.

44. Based on my education, training, and professional experience in the field of the claimed invention, as discussed in Section II, I was a person of more than the ordinary level of skill in the art as of November 17, 2005

45. In forming my opinion, I have drawn on my academic background and professional experience, including experience hiring and managing engineers engaged in development, research, and consulting projects applying the technologies and applications described in the '161 patent, as well through teaching and managing

graduate students working on the same. My opinions herein, however, were formed taking into account the perspective of an ordinarily skilled artisan.

46. I have also reviewed the definition of a POSITA provided by Dr. Papanikolopoulos. See Ex. 1003, ¶ 25. In my opinion, I believe my definition is more representative of the appropriate level of skill possessed by a POSITA. Regardless, I have considered both my definition and that proposed by Dr. Papanikolopoulos and would have arrived at the same conclusions regarding the claims of the '161 patent under either definition.

VI. THE '161 PATENT

A. Effective Filing Date

47. I understand that the application leading to the '161 patent was filed on October 24, 2013 and was a continuation of a chain of continuation patents stemming from U.S. Patent Application No. 11/238,137 which was filed on November 17, 2005. This chain of continuations is referenced on the face of the '161 patent. I have been instructed to assume that the patent is entitled to the benefit of this November 17, 2005 date. I understand that Petitioner and Dr. Papanikolopoulos have done the same.

48. My opinions in this declaration were formed from the perspective of a POSITA as of November 17, 2005, including both the knowledge of a POSITA at that time as well as how a POSITA would have understood the prior art.

B. Overview

49. The '161 patent discloses a system and method to manage and optimize a vehicle's power consumption. Ex. 1001, 2:15-17.

50. According to the patent, precise control of fuel consumption can optimize a car's energy efficiency. *Id.*, 1:16-24. Before the '161 patent's invention, drivers would resort to manual and imprecise techniques like slowing down, braking lightly, and carrying lighter loads. These methods proved largely ineffective in significantly increasing most cars' energy efficiency. *Id.*

51. The '161 patent introduces a solution for managing energy efficiency. Ex. 1001, 1:60-2:6. Specifically, it discloses a power management logic employed by a motor control mechanism to efficiently control the application of power applied by a vehicle engine as it navigates a route to its destination. *Id.*, 2:34-37.

52. A key aspect of the '161 patent is that, in one embodiment, it breaks down the route into segments or intermediate destinations, and then calculates one or more parameters for each segment to determine the optimal power applied for that respective segment. *Id.*, 5:8-31. For instance, one can visualize various possible segments in Fig. 3A:

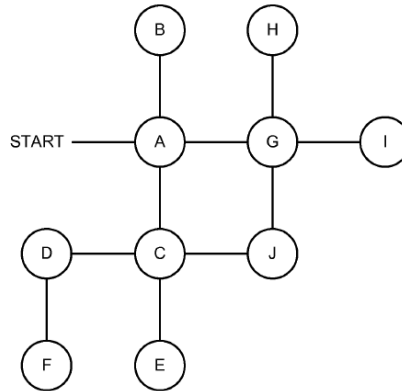


FIG. 3A

Id., Fig. 3A.

53. If the vehicle starts at START, one potential route destination is location C. *Id.*, 12:44-13:38. In this scenario, the route from START to C can be segmented by considering location A as an intermediate stop. *Id.* Thus, the route START→A→C consists of two segments: START→A and A→C. *Id.*

54. Once the route has been received and segmented into segment destinations, an efficient speed for the vehicle to travel between each pair of segment destinations can be determined. This is achieved by calculating various energy values consumed by the vehicle along the route, based on different target speeds between pairs of segment destinations. *Id.*, 11:10-16:64 (“Optimization of Engine Efficiency” is carried out by the steps of: “1. Determine Route,” “2. Segment Route,” and then “3. Calculate Energy for the Route.”).

55. In doing so, the ’161 patent identifies multiple target speeds that achieve a best summation of energy values across the entire route. The vehicle’s

operator can then be notification of these efficient speeds, or the system can directly adjust the power to maintain the optimal speeds between segment destinations. *See, e.g., id.*, 5:8-14 (“The step of calculating an applied power may include determining a route, segmenting the route into one or more segment (or intermediate) destinations, calculating an energy-efficient speed for the vehicle to travel to the segment destination, determining an optimized speed for the vehicle to travel to the segment destination, and calculating the applied power from the optimized speed for all of the segments.”); *see also* 11:10-29, 14:33-49, 18:57-19:17, Figs. 4A-B.

C. Claims

56. For reference, claims 1-18 of the '161 patent are reproduced below. Of these, claims 1 and 10 are independent.

1. A method of managing a power consumption of a vehicle, comprising the steps of:

- (a) receiving a route at a computer of said vehicle;
- (b) segmenting said route into a plurality of segment destinations;
- (c) calculating a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations;
- (d) determining a plurality of efficient speeds that achieve a best summation of said energy values; and
- (e) notifying an operator of said vehicle about said efficient speeds to travel between each of said segment destinations.

2. The method of claim 1, further comprising the step of:
continuously calculating said efficient speeds until a final destination is reached.
3. The method of claim 1, wherein said determining of said efficient speeds is based on (i) an aerodynamic drag of said vehicle, (ii) a rolling resistance of said vehicle and (iii) a change in potential energy of said vehicle due to a road gradient.
4. The method of claim 1, further comprising the step of:
notifying said operator of a range of said variations in said target speed.
5. The method of claim 1, wherein said determining of said efficient speeds is based on at least one of (i) an acceleration of said vehicle to one or more of said efficient speeds and (ii) a deceleration of said vehicle to one or more of said efficient speeds.
6. The method of claim 1, wherein said calculating of said energy values is based on a current location of said vehicle as determined by global positioning system information.
7. The method of claim 1, wherein said calculating of said energy values is based on a plurality of speed limits between said segment destinations.

8. The method of claim 1, further comprising the step of:
calculating said target speed in response to a position of a gas pedal of said vehicle.

9. The method of claim 1, further comprising the step of:
shifting gears of an automatic transmission in said vehicle based on said efficient speeds.

10. A method of managing a power consumption of a vehicle, comprising the steps of:

- (a) receiving a route at a computer of said vehicle;
- (b) segmenting said route into a plurality of segment destinations;
- (c) calculating a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations;
- (d) determining a plurality of efficient speeds that achieve a best summation of said energy values; and
- (e) applying power corresponding to said efficient speeds to an engine of said vehicle to travel between each of said segment destinations.

11. The method of claim 10, further comprising the step of:

continuously calculating said efficient speeds until a final destination is reached.

12. The method of claim 10, wherein said determining of said efficient speeds is based on (i) an aerodynamic drag of said vehicle, (ii) a rolling resistance of said vehicle and (iii) a change in potential energy of said vehicle due to a road gradient.

13. The method of claim 10, further comprising the step of:
notifying an operator of the vehicle about said efficient speeds to travel between each of said segment destinations.

14. The method of claim 10, wherein said determining of said efficient speeds is based on at least one of (i) an acceleration of said vehicle to one or more of said efficient speeds and (ii) a deceleration of said vehicle to one or more of said efficient speeds.

15. The method of claim 10, wherein said calculating of said energy values is based on a current location of said vehicle as determined by global positioning system information.

16. The method of claim 10, wherein said calculating of said energy values is based on a plurality of speed limits between said segment destinations.

17. The method of claim 10, further comprising the step of:
calculating said target speed in response to a position of a gas pedal of said vehicle.

18. The method of claim 10, further comprising the step of:
shifting gears of an automatic transmission in said vehicle based on said efficient speeds.

VII. CLAIM CONSTRUCTION

57. I am not a legal expert or an attorney and offer no opinions on the law. I understand that claim construction is a matter of law.

58. However, I have been informed by counsel of the legal standards that apply to claim construction in an inter partes review, and I have applied them in forming my opinions. I understand that during an inter partes review, the same claim construction standard used in federal district court is applied when addressing the meaning of claim terms.

59. I have been informed that the words of a claim are generally given the ordinary and customary meaning that the term or phrase would have to POSITA at the time of the invention in view of the surrounding claim language, the specification and the file history (collectively, the “intrinsic evidence” or “intrinsic record”).

60. I also understand that courts may consider extrinsic evidence, such as expert and inventor testimony, dictionaries, and learned treatises (collectively, the “extrinsic evidence” or the “extrinsic record”), but that such extrinsic evidence should be given less weight than the intrinsic evidence.

61. In my opinion, the terms of the ’161 patent’s claims do not require further construction and can be afforded their plain and ordinary meaning for purposes of the analysis of the prior art that I am conducting in this declaration.

62. However, in my opinion both the Petition and Dr. Papanikolopoulos do improperly apply overbroad understandings of claim terms such as “receiving a route,” “segmenting said route,” and “determining a plurality of efficient speeds” that depart from those terms’ ordinary meanings. I have discussed what a POSITA would have understood the ordinary meaning of these elements to be in greater detail below.

VIII. THE CLAIMS OF THE ’161 PATENT ARE NOT OBVIOUS

63. As stated above, I understand that, under the law, in order for a patent to be found invalid as obvious, the differences between the claimed subject matter and the prior art are such that the subject matter as a whole must have been obvious at the time the invention was made to a POSITA.

64. As I discuss below it is my opinion that as of the effective filing date of the ’161 patent, a POSITA would have considered claims 1-18 of the ’161 patent to

be non-obvious and patentable, including over the prior arts identified by the Petition and Dr. Papanikolopoulos.

A. Identified Prior Art

65. The following paragraphs provide an overview of the main prior art references I discuss throughout this declaration.

1. “Neiss” (U.S. Patent Publication No. 2004/0068359)

66. I understand that the Petitioner presents, and the ‘161 patent’s IPR was instituted under, a first ground to Neiss.

67. Neiss discloses a basic form of vehicular cruise control. The system incorporates an onboard computer, referred to by Neiss as a “Predictive Cruise Control (PCC),” which aims “to replace or supplement the set speed of a conventional cruise control with a speed band.” Ex. 1005, ¶ [0031]. In Neiss’s PCC “[f]orward-looking terrain information is used to determine, as a function of position, a desired speed inside the speed band [] in order to maximize fuel savings.” *Id.*

68. Neiss “iteratively calculates and stores in a memory vehicle control parameters that optimize the vehicle operating cost function for a predetermined Prediction Horizon along the route ahead of the vehicle.” *Id.*, Abstract.

69. In doing so, Neiss merely adjusts the cruise control in response to the immediate geography ahead of the vehicle. For instance, when a vehicle encounters

a hill, it “slows down as it moves uphill until it reaches a minimum speed on top of the hill, and regains speed on the downhill part, thus completely converting the potential energy into kinetic energy[.]” *Id.*, ¶ [0031].

70. This concept is illustrated in Neiss’s Figure 2, which I have included below:

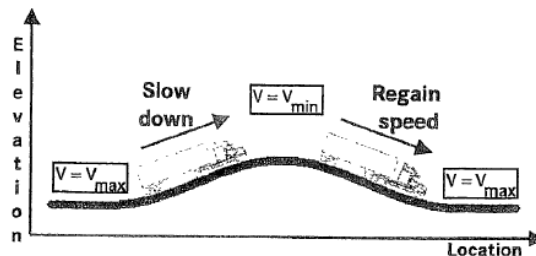


Fig. 2

Id., Fig. 2. Further, I understand Neiss discloses that as the vehicle “approaches a curve, the speed can automatically be reduced as shown in FIG. 3.”

Id., ¶ [0032]. This concept is illustrated in Figure 3 below:

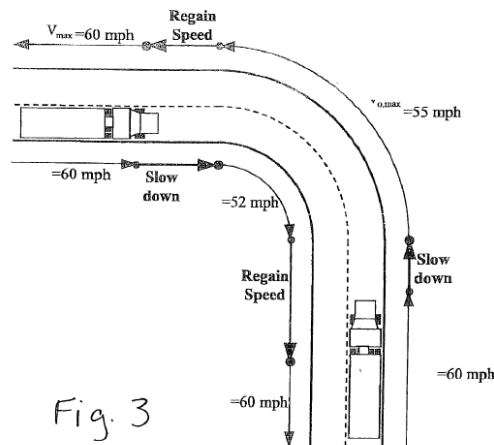


Fig. 3

Id.

71. Neiss also teaches that the “Prediction Horizon” encompasses merely “an area around the current vehicle positioned [sic].” *Id.*, ¶¶ [0161]-[0162].

72. The PCC in Neiss deliberately confines its analysis to this limited area to avoid a system “in which the stored values are determined in advance,” since performing only the bare minimum calculations ensures that “[l]ess memory is needed,” and “[t]here is no need for a previous 'record drive.'” *Id.*, ¶¶ [0163], [0164], [0166]. Further, Neiss stresses that his algorithm is implemented in a manner designed to “reduce the computational burden.” *Id.*, ¶ [0169] This highlights that Neiss avoids methods requiring increased calculations.

2. “Schramm” (U.S. Pat. No. 6,005,494)

73. I understand that the Petitioner presents, and the ‘161 patent’s IPR was instituted under, a second ground to a Schramm in view of Clapper (see below for a discussion of Clapper).

74. Schramm relates to a vehicle with an onboard computer that determines the energy-optimum route for a vehicle to travel from an origin to a destination. Ex. 1009, Abstract.

75. To achieve this, the computer processes several inputs, including the vehicle's starting point “A,” destination point “B,” and the specific speed the user wishes to maintain between these two points. This concept is illustrated in Figure 2:

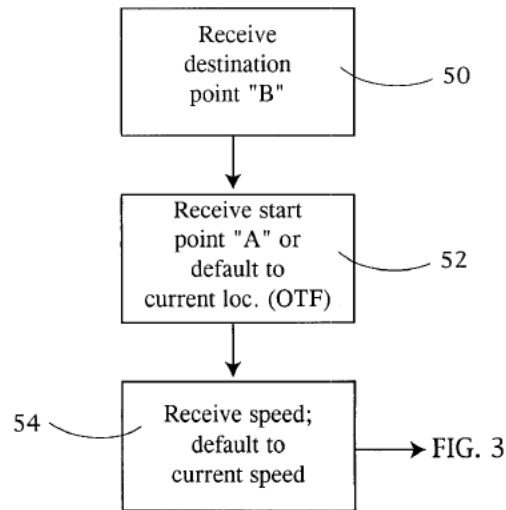


FIG. 2

Id., Fig. 2; *see also id.*, 5:1-20.

76. Notably, the speed in this process is a fixed input specified by the user, with no expectation of variation. *See, e.g.*, Ex. 1009, 5:14-20 (“the logic receives the desired average speed at which the operator intends to drive vehicle to the destination point 'B'”); *see also* 5:45-49 (mentioning use of “the speed that was input at block 54 of FIG. 2”); 6:44-49 (stating that the vehicle computer determines if the “vehicle 12 has sufficient energy to travel from the origination point 'A' to the destination point 'B' at the desired speed.”); 7:40-42; 5:61-6:7; 7:18-25; 7:47-50 (all similar); Figs. 2, Fig. 6.

77. Schramm's system utilizes these inputs—the starting point, destination point, and specific desired speed—to determine potential routes and assess the energy consumption of each. *See, e.g., Id.*, 3:2-12 (“Each possible route is

characterized by an energy consumption, and the computer accesses the topographic information and the vehicle energy consumption source to determine a select route having a minimum energy consumption among the possible routes.”); *see also Id.*, 3:25-27, 4:24-27, 5:21-52, 6:11-18; 6:29-32.

78. This evaluation process is illustrated in Schramm’s Fig. 3, which I have included below:

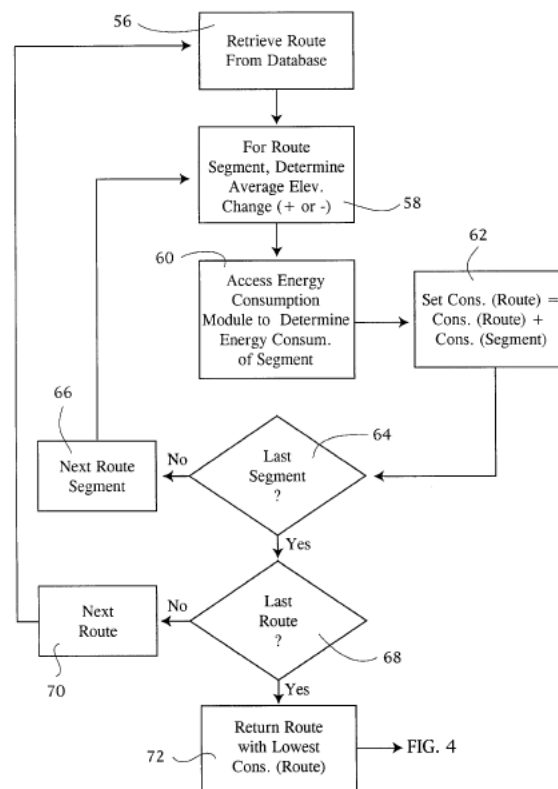


FIG. 3

Id., Fig. 3.

79. In the “Access Energy Consumption Module” of Fig 3, in step 60 the process accesses energy consumption data from a stored table such as shown in Fig. 6, reproduced below. Schramm teaches that “the default values [in the table] are

empirically determined (i.e. found from experimental measurements), preferably on a vehicle model-by-model basis.” Ex. 1009, 6:5-8. This implies that the default energy data in the table recorded during the vehicle’s calibration phase of development.

Segment Δ Elev. (Aug.)		Δ Elev. Factors, For Speed =			
		1	2	For Speed =	
-x		.8	.8	k	.
.		.	.	.	.
.		.	.	.	.
.		.	.	.	.
(base energy	0	1	1.01	.	.
consumption)	1	1.01	1.02	.	.
	2	1.02	1.03	.	.
.		.	.	.	.
.		.	.	.	.
.		.	.	.	.
+x		n	m	k	.

FIG. 6

80. Schramm goes on to explain how the energy consumption table of Fig. 6 can be updated as “the energy consumption module ‘learns’ about the actual energy consumption of the particular vehicle. Ex. 1009, 6:7-10. He further explains that after driving the route segments multiple times (he suggests a minimum of 5) the values in the table are updated with the average values. Ex. 1009, 7:40-54.

81. When using the energy consumption table of Fig. 6, the energy consumption block (labeled 60) of Fig. 3 uses the average elevation change for the route segment under consideration and the average speed input by the driver.

Thus, the step shown at block 60 of FIG. 3 is undertaken in one embodiment by selecting, from the table shown in FIG. 6, the energy consumption value in the row corresponding to the average elevation change determined at block 58 of FIG. 3 and the column corresponding to the speed that was input at block 54 of FIG. 2.

Ex. 1009, 5:64-6:2.

82. In essence, Schramm's system selects the most efficient route a vehicle can take between two locations at a fixed speed set by the user using empirical data stored in memory.

83. If the vehicle's energy reserve is sufficient for the energy consumption of that optimal route, the logic signals that the vehicle "has sufficient energy to travel from the origination point 'A' to the destination point 'B' at the desired speed." *Id.*, 6:44-49.

3. "Clapper" (U.S. Pat. No. 6,161,072)

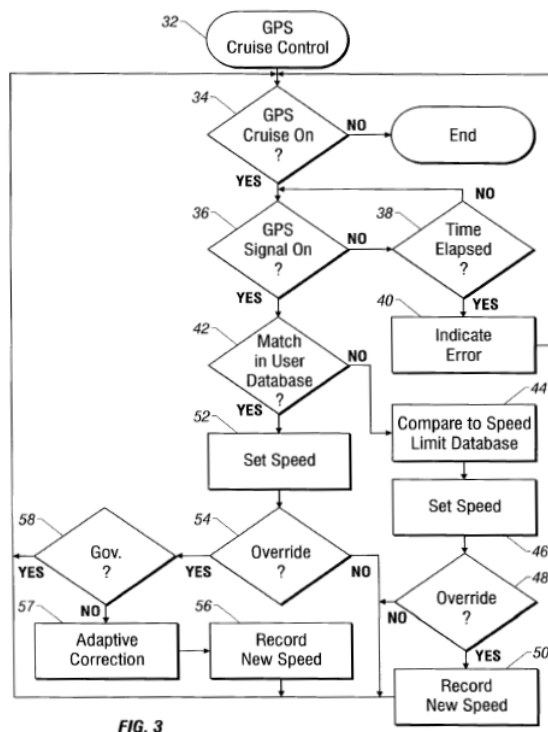
84. As stated above under Schramm, I understand that the Petitioner presents, and the '161 patent's IPR was instituted under, a second ground to a Schramm in view of Clapper.

85. Clapper is generally directed to an automatic cruise control system that uses stored information about speeds the vehicle has used at its current location in

the past to control the present speed of the vehicle at that same current location. Ex. 1006, Abstract.

86. Per Clapper, for locations where prior driving history is not available, the system can refer to a database of speed limits for that location. *Id.*

87. For example, as depicted in Figure 3, which I have included below, Clapper discloses that “[b]ased on prior history and detected current position, the automatic cruise control 20 may set the vehicle’s speed based on the speed that the driver used previously at the same location.” *Id.*, 1:53-56.



Id., Fig. 3; 1:20-25; *see also Id.* Fig. 4 (referencing use of “current speed,” “previous speed,” and a “database speed”); 1:50-53, 2:30-44, 2:45-60, 3:38-45.)

B. Ground 1: Neiss Does Not Render the Claims Obvious

88. It is my opinion that the purported prior art, including Neiss, is missing numerous limitations claimed by the '161 patent and does not render the '161 patent's claims as obvious.

89. The '161 patent claims necessitate “receiving a route” Claim 1(a) and subsequently “segmenting said route into segment destinations.” Claim 1(b). Neiss does neither. Instead, it intentionally disregards the vehicle's overall route, focusing solely on the area surrounding the current vehicle position—termed the “Prediction Horizon”—to minimize memory usage and computational burden. As Neiss states, this Prediction Horizon pertains merely to the terrain immediately ahead of the vehicle. It is unrelated to the vehicle's route. Furthermore, Neiss intentionally keeps the Prediction Horizon small because it cannot and does not predict whether the vehicle will actually traverse the terrain within the horizon. This strategy avoids unnecessary calculations if the vehicle were to change direction and encounter different terrain.

90. Second, it is also my opinion that a POSITA would not find it obvious to modify Neiss to predict across an entire route. Neiss intentionally restricts the Prediction Horizon to simplify operations and avoid calculations in the face of potential unforeseen events, such as encountering slow drivers or different terrain. Modifying Neiss in such a way would be opposite to Neiss's teachings.

91. Each of these conclusions are discussed in greater detail below.

1. Neiss Does Not Teach “Receiving a Route at a Computer of Said Vehicle” and “Segmenting Said Route into a Plurality of Segment Destinations”

92. Both claims 1 and 10 require the steps of “receiving a route at a computer of said vehicle” Claim 1(a) and subsequently “[s]egmenting said route into a plurality of segment destinations.” Claim 1(b)

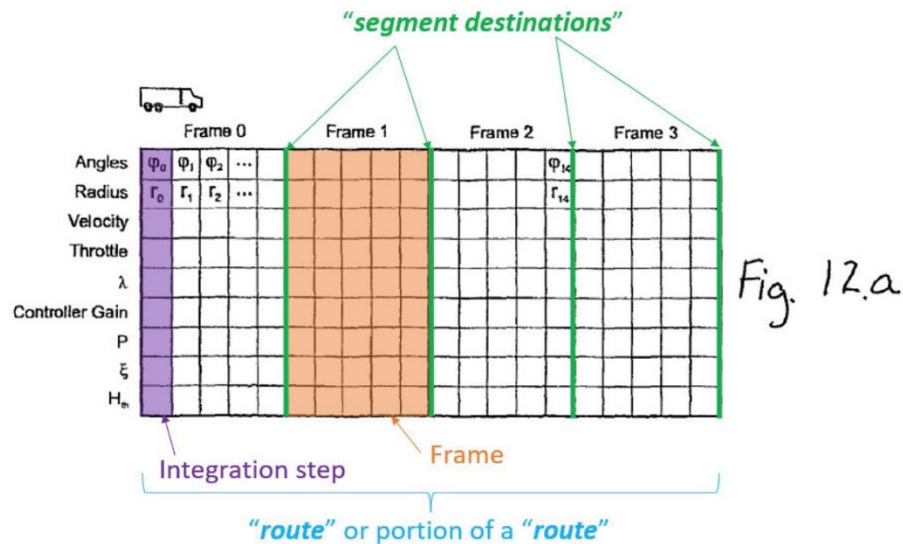
93. I understand that the Petitioner asserts that Neiss's optimization algorithm “iteratively calculat[es]...vehicle control parameters that optimize/minimize the vehicle operating cost function for a predetermined distance (referred to as a Prediction Horizon) along the route ahead of the vehicle.” Petition at 13-14.

94. I also understand that the Petition contends that this “Prediction Horizon” supposedly “corresponds to a route because it constitutes a path traveled by the vehicle.” Petition at 13-14.

95. Furthermore, I understand that the Petition mentions that in Neiss, “[e]ach Prediction Horizon...‘is separated into Frames.’” *Id.* at 19 (quoting Ex. 1005, ¶ [0170]).” Each frame is composed of multiple “integration steps” which “correspond to a ‘small distance[]’ along its frame.” Petition at 19 (quoting Ex. 1005, ¶¶ [0162], [0170]).

96. I also understand the Petition then attempts to correlate the “frame endpoints” with the claimed “segment destinations.” *Id.* at 20-21.

97. This is illustrated in the annotated figure from the Petition which I have included below:



Id. at 21. In my opinion, a POSITA would not find that this is what the ‘161 Patent’s claims require.

a. *Neiss Performs the Claimed Steps Out of Order*

98. In my opinion, a POSITA would have understood claims 1 and 10 to require a specific, sequential two-step process. Initially, a “route” must be “receiv[ed] ... at a computer of said vehicle.” Following this, the already received route must be “[s]egment[ed]... into a plurality of segment destinations.” It is my opinion that even if Neiss performs these steps at all, it does so in a different order.

99. I understand from counsel that a method claim requires an ordering of steps when the claim language, as a matter of logic or grammar, requires that the steps be performed in the order written, or the specification directly or implicitly requires such an ordering.

100. In my opinion, claims 1 and 10 require this type of ordering.

101. Both claims necessitate “receiving a route.” Following that, the claims provide that “said route,” *i.e.*, the same “route” that was initially “receiv[ed]” by the vehicle's computer [and] must be “segment[ed].”

102. I note that a route cannot be segmented if it has not first been “received” by the vehicle's computer performing the segmenting. Therefore, based on the claim language, the steps of “receiving” and “segmenting” must be executed in order.

103. In my opinion, the '161 patent's specification confirms what the claims themselves say: the claimed steps must be carried out sequentially.

104. For example, as illustrated in Figure 2, which I have included below, the '161 patent's method first establishes a route at step 201 and then subsequently divides this established route into segments at step 203:

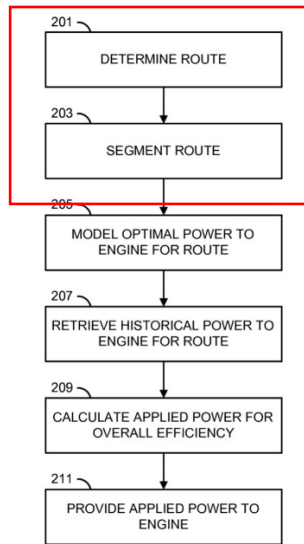


FIG. 2

Ex. 1001, Fig. 2; *see also Id.*, 11:15-17 (noting that “a route is determined 201 from the starting position and an actual or estimated ending position” then “the route is segmented 203 into one or more segments”).

105. Similarly, the specification clarifies that when a route is “segmented,” it is “broken up[,]” “divided up,” or “split into” separate “segments.” *Id.*, 13:44-47; 13:51-58; 14:5-12; 14:65-15:7.

106. Thus, per the specification, “segmenting” is a process or step applied to an existing, received route to divide it into pieces before any further processing and calculation. *See id.* The route is not pieced together from segments. Instead, it is the route itself that undergoes segmentation. *See Id.*

107. Further, in the ’161 patent, the energy calculations are performed for every route segment **prior** to making a determination of the desired target speeds.

See the illustrative example provided at Ex. 1001 14:66-15:46. Here, the exemplar route is segmented into five segments, 17 possible speed patterns are considered that would achieve the desired average speed, the energy requirement for each possibility is calculated and the desired speed profile is selected to be the one with the lowest energy consumption.

108. It is my opinion that a POSITA would not read Neiss as teaching what the claims require.

109. Even if one were to mistakenly consider Neiss's Prediction Horizon as a “route” as the Petition suggests (which it is not for reasons that I will discuss in greater detail below), Neiss does not “segment” an already existing Prediction Horizon of road data. Instead, Neiss does the opposite. Its system starts by filling its integration steps with road and vehicle data, and then it aggregates these steps into a Prediction Horizon.

110. Specifically, Neiss explains that “sensors about the vehicle detect environment and vehicle operating parameters, including at least vehicle speed and position relative to the road map.” Ex. 1005, ¶ [0015].

111. “As the vehicle proceeds, an onboard computer iteratively calculates and stores in a memory” both road data and “vehicle control parameters that optimize the vehicle operating cost function for a predetermined distance (referred to as a 'Prediction Horizon') along the route ahead of the vehicle.” *Id.*

112. The stored road and vehicle operation data is “continuously updated and replaced by new data as the vehicle ... moves along...” *Id.*

113. Neiss’s road and vehicle data are stored in a ring buffer. *Id.*, ¶ [0162].

114. The “Prediction Horizon” is simply a “parameter” that specifies the size—in storage cells—of this ring buffer. *Id.*, ¶¶ [0170], [0192]; *see also Id.*, ¶¶ [0027]-[0029], [0162], [0176]-[0179], [0191] (repeatedly using “Prediction Horizon” and “ring buffer” interchangeably).

115. Furthermore, Neiss explains that “[t]he initialization of the ring buffer ... must be completed before the vehicle reaches the start point on the road where the PCC system is triggered.” *Id.*, ¶ [0178].

116. To achieve this ring buffer initialization, “[f]irst the ring buffer memory is filled with angle and radius values from cell zero up to the last cell for the next to last frame.” *Id.*, ¶ [0179]. Calculations are then performed on this data. *Id.*, ¶ [0180].

117. A new series of cell-by-cell (or integration step-by-integration step) calculations are initiated when the vehicle “reaches the end of the first frame.” *Id.*, ¶ [0188]. These new calculations replace the old data previously stored at the beginning of Neiss’s ring buffer. *Id.*, ¶ [0191] (“when the vehicle is driving in frame 2[,]” frame no. 0 is filled with road data and starting value estimates”).

118. In summary, Neiss’s procedure begins with an empty ring buffer (or “Prediction Horizon”) that contains no data. *See, e.g., id.*, Fig. 11. This empty ring buffer (or “Prediction Horizon”) is then iteratively filled with road data one integration step or cell at a time as the vehicle moves, until the number of ring buffer cells equals the Prediction Horizon parameter. *See id.*, ¶ [0179].

119. An empty ring buffer, even if its number of cells is defined by the Prediction Horizon parameter, does not yet constitute a “route.” It lacks any road-specific data.

120. Therefore, even if one were to consider Neiss’s Prediction Horizon as a “route” and its frames as “segments” as the Petition (incorrectly) argues, no “route” exists that can be “received” by Neiss’s vehicle computer until after Neiss populates a Prediction Horizon worth of integration steps or buffer cells with road-specific angle, radius, and other data.

121. Plainly, because it assembles its “Prediction Horizon” one frame at a time, Neiss determines what the Petition refers to as “segments” first, and then combines these “segments” into what the Petition terms a “route.” *See id.*

122. However, as I have explained, it is my opinion that the claims here necessitate the opposite: the vehicle computer must first “receiv[e] a route” and then “segment[] said route.” *See id.*

123. I recognize that Neiss does mention that “[t]he whole Prediction Horizon is separated into Frames” and “integration steps h.” Ex. 1005, ¶ [0170].

124. However, in my opinion this does not imply that a known portion of the road over which a vehicle is traveling is fed into Neiss’s system and then divided up for calculation.

125. Rather, a POSITA would have understood that it merely describes how the data that Neiss will gather (but has not yet gathered) will be stored and organized.

b. *Neiss’s Prediction Horizon Is Not a “Route”*

126. It is also my opinion that Neiss’s “Prediction Horizon” does not qualify as a route at all.

127. A POSITA would have understood the term “route” in its ordinary sense to mean a road, path, or course from one place to another. *See, e.g.*, Ex. 2001 at 1189 (defining “route” as “[a] road, course, or way for travel from one place to another”).

128. In essence, a “route” is not merely the terrain directly ahead of the vehicle. It is the path the vehicle is taking to move from its current location to its destination. Determining a route requires planning.

129. Based on my review, this is precisely how the ’161 patent interprets the term “route.”

130. The patent consistently describes a “route” as having a starting point, an ending point, and a path connecting the two (from start to end). For example, according to the patent, a “route” extends “from the” vehicle’s “initial position to a destination (e.g., a final destination or an intermediate destination).” Ex. 1001, 14:20-22; *see also Id.*, 11:13-17 (a “route” is “determined ... from the starting position” to “an actual or estimated ending position”); 11:31-32 (similar).

131. Figure 1B, which I have included below, provides an example of this. As shown, the vehicle’s “route” or “trip” (using the words of the figure) stretches “from point A to point B.” *Id.*, 6:55-56.

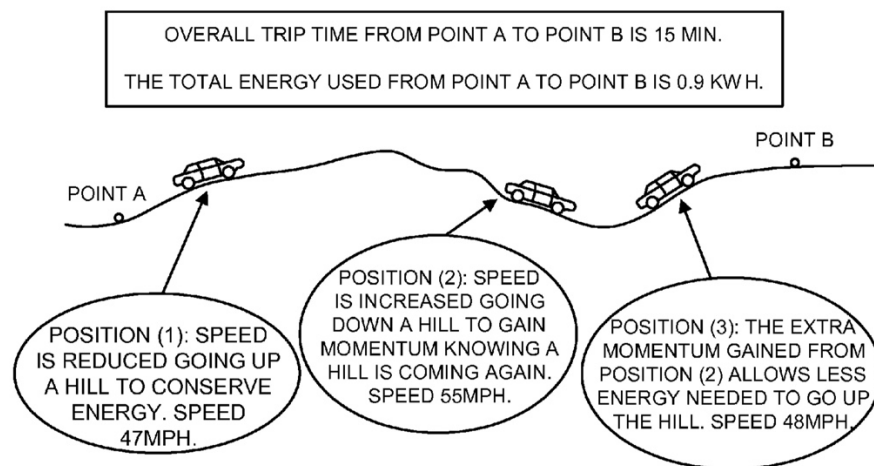


FIG. 1B

Id., Fig. 1B.

132. Figure 3A, which I have included below, offers another example, depicting a “schematic route” with “10 junctions (A to J).” *Id.*, 12:46-47. Each route in the schematic has a starting point (i.e., “START”), at least one intermediate

junction (i.e., A), and a destination. *Id.* One such route, the “trip” “start→A→G→J→C→E,” is highlighted below:

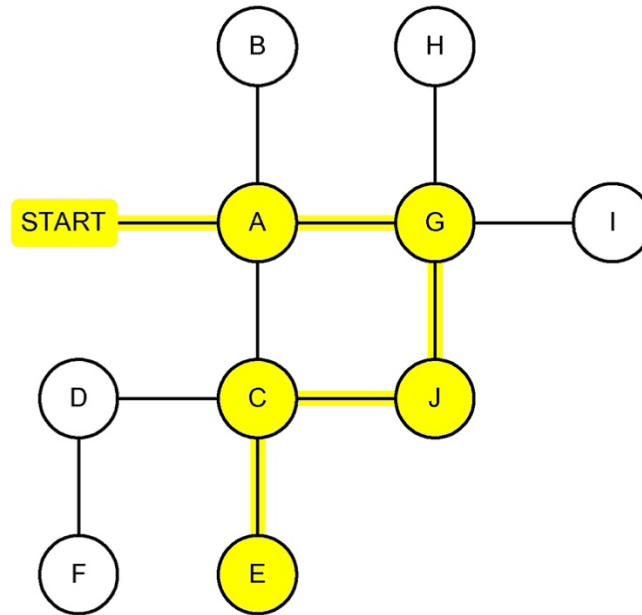


FIG. 3A

Id., Fig. 3A (annotated); *see also Id.*, 12:58-13:2 (listing the various “trips” depicted in Fig. 3A).

133. In every instance, the ’161 patent’s routes are “for” a “destination.” *Id.*, 5:19-21.

134. And each route comprises a “starting location and any intermediate locations” along with a “destination.” *Id.*, 9:10-15, 17:6-8.

135. The ’161 patent does not use the term “route” to refer generically to the vehicle’s direction of travel. The “route” always is inclusive to the path the vehicle is taking to reach a destination.

136. In my opinion, the '161 patent's claims themselves reinforce this interpretation.

137. Not only do the claims mention a “route,” but they also specify that this “route” is “segment[ed] ... into a plurality of segment destinations.” It would make little sense to define the term “route” without implying a known destination at its end, especially when the claim requires dividing this route into segments, each with its own segment destination.

138. I understand that when instituting the IPR, the Board referred to a passage in the '161 patent that describes a route as “typically include[ing] a starting position..., an ending position,..., and any intermediate positions between the initial and the final position.” Institution Decision at 13-14 (quoting Ex. 1001, 13:40-44).

139. In my opinion, this passage does not redefine the term “route.” Instead, it simply acknowledges the various ways a route to a destination can be structured in the '161 patent.

140. For example, a route may be “based on the current position of the vehicle and a final destination position.” *E.g.*, Ex. 1001, 11:30-44.

141. The route can also encompass multiple “intermediate positions between the initial and the final position.” *Id.*, 13:40-44. This allows the operator to specify not only the “final destination,” but also the “preferred route” the vehicle should take to reach that destination. *Id.*, 11:40-44.

142. Alternatively, the route may extend only to an “intermediate destination” rather than the final destination. *Id.*, 9:33-35, 12:23-26, 12:40-44.

143. As shown, in all instances, the vehicle is traveling towards a destination—be it a known final destination, a predicted destination, or an intermediate destination.

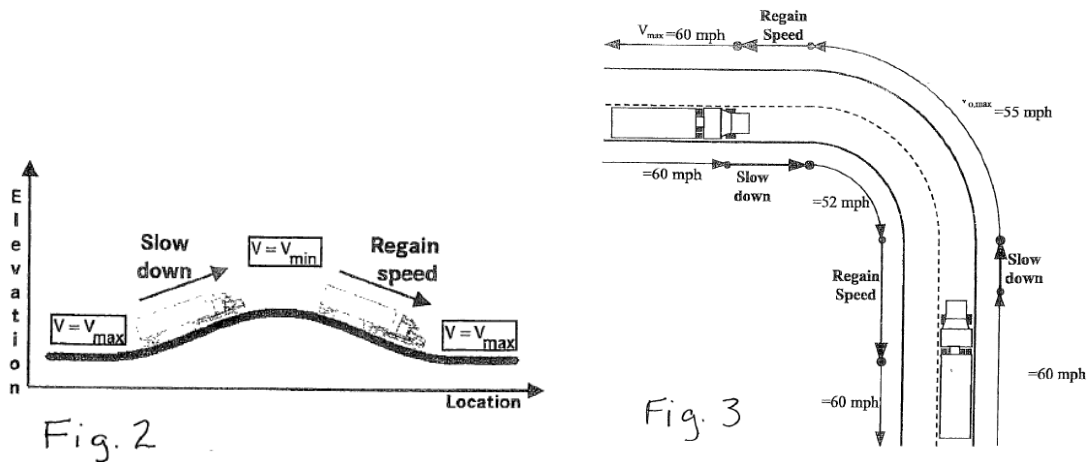
144. The ’161 patent never describes general travel without a specific identified destination as a route.

145. It is my opinion that Neiss’s Prediction Horizon is not a “route” when considering the term's ordinary meaning.

146. The Prediction Horizon has no connection to the vehicle’s destination. Neiss’s system neither knows nor determines the vehicle’s destination. In fact, the term “destination” doesn't even appear in Neiss’s disclosure.

147. Rather than being a route, the Prediction Horizon is just the terrain or road immediately ahead of and visible from the vehicle’s current location. *See, e.g.*, Ex. 1005, ¶¶ [0015] (the “Prediction Horizon” is a “predetermined distance” ahead of the vehicle); [0048] (stating that the “Prediction Horizon” is the “approaching road”); [0162] (defining “Prediction Horizon” as “an area around the current vehicle position[]”).

148. For instance, as illustrated in Figure 2, which I have included below, Neiss's system can recognize that the vehicle is approaching a hill. Or, as shown in Figure 3, which I have included below, the system identifies an upcoming turn:



Id., Figs. 2, 3.

149. Neiss has numerous other disclosures that also confirms that the Prediction Horizon does not qualify as a “route.”

150. For instance, Neiss explains that its Prediction Horizon is calculated “online” in “real time” and spans a relatively short distance ahead of the vehicle, allowing for a “change [in] the route while driving.” *Id.*, ¶ [0165]. In other words, Neiss acknowledges that a vehicle might not traverse the terrain corresponding to the Prediction Horizon and might instead take a different route, necessitating the system to “adapt.” *See Id.*, ¶¶ [0163]-[0169].

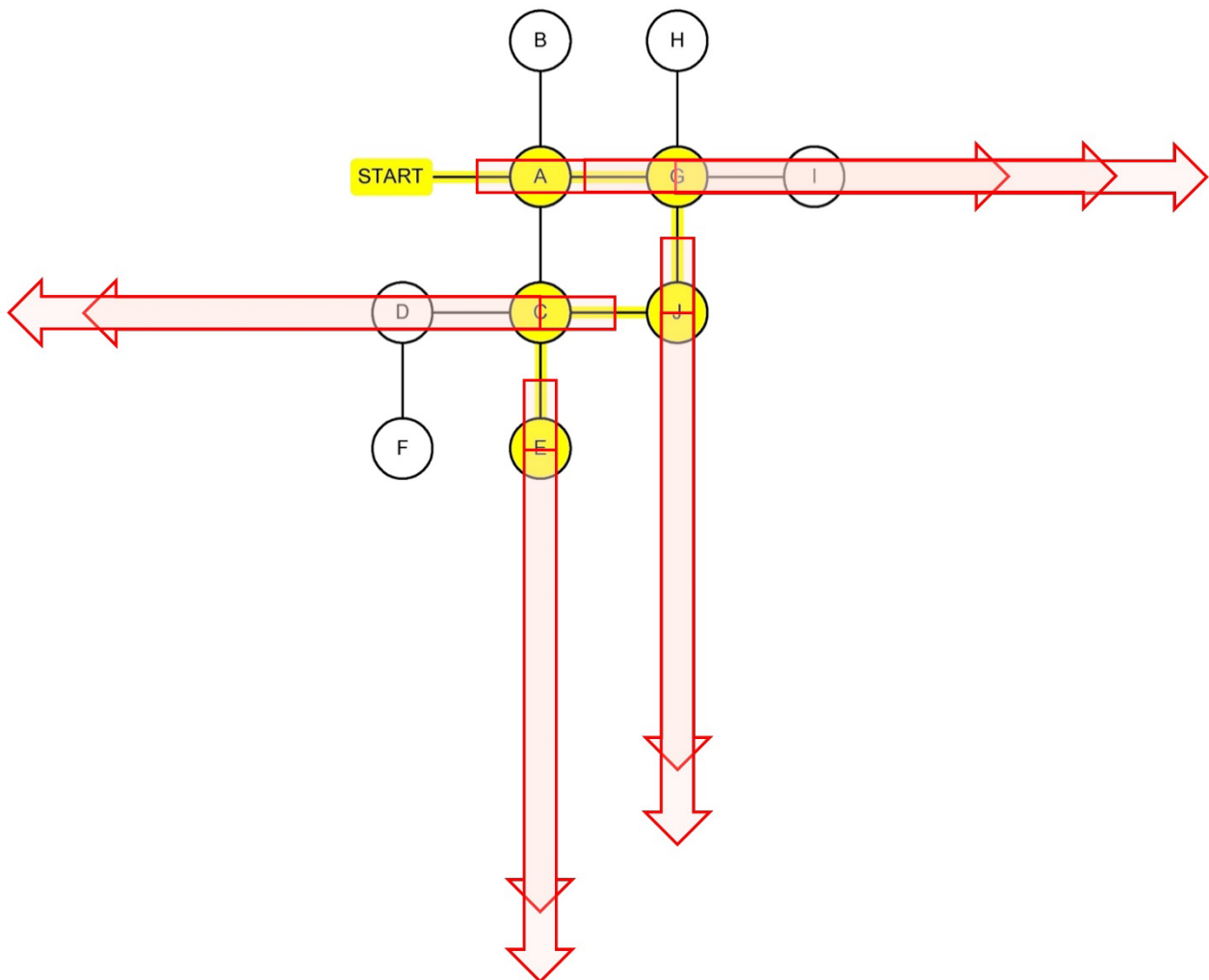
151. Neiss also states that a realistic value for its Prediction Horizon could be 4000 meters long. *See Id.*, ¶ [0192]. Over this distance, a vehicle can follow

countless different routes by making various turns or changes to the route. However, Neiss remains indifferent to whether the vehicle actually follows the Prediction Horizon. The system is designed such that calculations are “adapted” whenever the route the vehicle actually follows deviates from the positions used in the calculations for the Prediction Horizon.

152. The below example highlights the differences between the ’161 patent and Neiss. This example is based on Figure 3A of ’161. As shown, the ’161 patent determines (and then segments) a route highlighted in yellow from Start→A→G→J→C→E. For purposes of this example, it is assumed that each of the destinations shown in Figure 3A is 1 km apart. 4km-long “Prediction Horizons” from Neiss are overlayed on top of Figure 3A. The “Prediction Horizons” are represented by overlapping red arrows. The first arrow after START represents the 4 km “Prediction Horizon” when it is first initialized. The “Prediction Horizon” moves with the vehicle, always extending 4 km in front of the vehicle. The last overlaid arrow shows the extent of the “Prediction Horizon” when the vehicle reaches a turn.

153. Note that as Neiss explains, speed control does not restart immediately after the start or a turn. Its ring buffer must first be initialed. Thus, for purposes of this example, the first “Prediction Horizon” does not begin exactly at START. The gap between START and the arrow indicates the distance travelled while the ring

buffer is being initialized. When the vehicle reaches a turn, for example at point ‘G’, the “Prediction Horizon” extends 4 km past the turning point. After the vehicle turns, it will take some time after turning until the new “Prediction Horizon” will be filled with data that allows for vehicle speed control. The “Prediction Horizon” will then once again extend 4 km ahead, including past the next turn:



154. According to '161, the power management system starts by determining the route, either by the driver entering the destination explicitly or by the system inferring a destination based on previous driving patterns. The power

management system then segments the route, based on a number of criteria. For illustrative purposes five route segments are selected as shown in yellow above. The system then considers “a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in target speed of said vehicle between pairs of said segment destinations.” Ex. 1001, Claim 1(c). The power management system then determines “a plurality of efficient speeds [one for each of the route segments] that achieve *a best summation* [i.e. lowest energy consumption] of said energy values.” Ex. 1001, Claim 1(d). The vehicle then drives the route using the determine speed profile.

155. According to Neiss the Predictive Cruise Control system considers information about the road directly in front of the vehicle (up to 4 km). He terms this distance the “Prediction Horizon.” The prediction horizon is divided up into frames. Each frame is populated with information about the road ahead (within the Prediction Horizon). The information is stored in a ring buffer and updated as the vehicle drives along. The Neiss system does not know the vehicle’s destination.

156. At ‘A’ the ring buffer is full of data for the next 4 km of road immediately ahead of the vehicle in its direction of travel (indicated by the red line). But, as shown, the driver decides to change directions upon reaching point G, heading to point J instead of point I. The ring buffer must then be repopulated with information for the road in the direction of point J. This will take some time. The

Neiss cruise control continues to evaluate the 4 km prediction horizon directly in front of the vehicle (taking time to refill the ring buffer each time the vehicle changes direction). As shown, this has multiple effects: (1) each time the driver changes directions (at G, J, and C) the information in the ring buffer extending past the intersection must be discarded and the ring buffer repopulated with information for the new direction. And (2) each time the driver changes directions (again at G, J, and C), there will be a portion of the road where there is no calculated speed as this portion of the road was not ahead of the vehicle until the turn and it will take time for the ring buffer calculations to be performed after the turn.

157. Eventually, the driver will reach their destination. At the time the vehicle arrives at the destination, the ring buffer is still filled with information about the road for 4 km (the prediction horizon) beyond the final destination. The Petition seeks to claim that end of the last frame in the ring buffer is the end of a route segment, but the last frame in the ring buffer always represents a point that is 4 km *past* the current location of the vehicle.

158. Thus, as shown, Neiss's "Prediction Horizon" is not a "segment" of the vehicle route. It is simply a portion of the road ahead, regardless of whether the vehicle will actually travel over that portion of the road. Moreover, because Neiss's "Prediction Horizon" is disconnected from the route, Neiss will not "achieve the best [i.e. lowest] summation of said energy values" on route between the starting point

and the destination. Knowing the route between the start and the final destination is essential to minimizing overall energy use. Consideration of discontinuous pieces of road ahead will not minimize the total energy consumption over the route. Neiss's system is incapable of "achiev[ing] a best summation of [] energy values" as the '161 patent does, because the system has no idea of the final destination.

159. I recognize that the Board also noted in its institution decision that if the claimed "route" necessitates a destination, Neiss's final Prediction Horizon can still be analogized with such a "route" because "the last prediction horizon of the journey would include the final destination and, thus, qualify as a 'route'...." *See* Institution Decision at 14-15.

160. Put another way, although Neiss does not determine the vehicle's final destination, it appears that the Board has taken the position that Neiss inherently teaches such a determination because the end of the final Prediction Horizon would necessarily correspond with the end of the vehicle's route.

161. However, in my opinion, this is not the case.

162. First, for the final Prediction Horizon to include the vehicle's destination, the vehicle would need to actually follow the terrain corresponding to the Prediction Horizon without turning or deviating from it. As explained, this is not guaranteed to happen because Neiss does not, and is unable, to take this into

account. In fact, Neiss acknowledges that the vehicle may “change ... route while driving.” Ex. 1005, ¶ [0165].

163. Second, even if the vehicle did follow the Prediction Horizon exactly, the overall route would need to be an exact multiple of Neiss’s frame length for the end of the Prediction Horizon to match the end of the route.

164. As the vehicle moves, Neiss updates the Prediction Horizon one frame at a time. *See Id.*, ¶¶ [0015]; [0188]-[0191]. If the route is not a multiple of the frame length, the final Prediction Horizon will either end before or after the vehicle’s destination.

165. For example, Neiss explains that one Prediction Horizon can be 4000 m (or 4 km) long and include 200 frames. *See* Ex. 1005, ¶ [0192]; *see also Id.*, ¶ [0170] (noting that the “Prediction Horizon” is a “multiple of the Frame Length”). In this case, each frame is 20 m (or 0.05 km) long.

166. If a given route is 9.93 km long, the final frame will end either at 9.90 or 9.95 km, not at the route’s destination.

167. Thus, Neiss’s final Prediction Horizon does not necessarily include the final destination or end at that destination.

168. This would only happen if a series of relatively unlikely events occur (*i.e.*, the vehicle precisely follows the Prediction Horizon and the route distance is a multiple of the frame length).

169. I also understand that Petitioner asserts that “[i]f it is determined that the present limitation requires receiving an entire route (e.g., an end-to-end route between a starting point and a final destination) at once, it would have been obvious to modify Neiss so that its onboard computer receives the entire route at once, instead of receiving it iteratively.” Petition at 16.

170. I understand that Petitioner claims it was “well-known” that a vehicle could receive an “entire end-to-end route,” and that performing calculations in advance for an entire route would somehow be more “computationally efficient.” *Id.* at 17. Based on my review, it appears that Petitioner’s expert merely echoes this without providing further explanation. *See* Ex. 1003, ¶¶ 70-71.

171. In my opinion, this argument is fundamentally at odds with what Neiss actually teaches and requires.

172. First, as I discussed above, Neiss intentionally avoids performing calculations for an entire route in advance.

173. While Neiss acknowledges that some prior art systems do store data for entire routes, it identifies this approach as problematic. *See* Ex. 1005, ¶¶ [0007]-[0008].

174. Specifically, Neiss explains that vehicle can encounter various “unforeseeable driving situations” such as a “slower vehicle ahead.” *Id.*, ¶ [0008].

175. A POSITA would have recognized that numerous other unforeseen events could occur along a route, including adverse weather conditions causing reduced speeds, construction detours, congestion, yielding to emergency vehicles, or giving right of way to cyclists or pedestrians. Further, drivers frequently change their mind on the direction they want to go, change plans, make pitstops to use the restroom, or run unexpected errands.

176. Neiss further explains that when such situations arise, “it is necessary to adjust the subsequent driving parameters” from those previously calculated “to achieve optimum vehicle operation.” Ex. 1005, ¶ [0008].

177. This is why Neiss confines its calculations to the Prediction Horizon. By performing calculations in “real time” and for only a limited area ahead of the vehicle, Neiss ensures that its system can swiftly “adapt” to changing conditions and maintain an “optimal” speed, even when the vehicle encounters unforeseen circumstances. *Id.*, ¶¶ [0163]-[0168].

178. It is my opinion that modifying Neiss as Petitioner suggests would nullify this advantage. Neiss’s system would lose its adaptability, as speed calculations would be performed in advance rather than in real time as the vehicle travels.

179. These precomputed calculations would not account for the various unforeseeable circumstances—like slow cars, poor conditions, construction,

emergency vehicles, pedestrians, pit stops, or drivers' decisions—that vehicles routinely encounter during a drive.

180. So, as modified by Petitioner and its expert, Neiss's system would lose and be deprived of its primary benefit and advantage: it would no longer perform real-time calculations and would be unable to adapt the vehicle's speed to take into account unforeseen events along the route. In my opinion, a POSITA would not have been motivated to make this sort of fundamental change that departs from Neiss's teachings.

181. Second, Petitioner is mistaken in arguing that modifying Neiss to perform calculations for an entire route would be more “computationally efficient.”

182. Neiss explicitly states the opposite when it says that “it is necessary to adjust the subsequent driving parameters” whenever an unforeseeable event—such as a slow driver—is encountered. Ex. 1005, ¶ [0008].

183. As I explained above, Neiss's “Prediction Horizon” encompasses merely “an area around the current vehicle positioned [sic].” *Id.*, ¶¶ [0161]-[0162].

184. The PCC in Neiss deliberately confines its analysis to this limited are to avoid a system “in which the stored values are determined in advance,” since performing only the bare minimum calculations ensures that “[l]ess memory is needed,” and “[t]here is no need for a previous 'record drive.'” *Id.*, ¶¶ [0163], [0164], [0166]; *see also Id.*, ¶ [0169] (highlighting that Neiss avoids methods requiring

increased calculations). This also allows the system to be adaptable and respond when unexpected events occur.

185. Modifying Neiss to perform route-wide calculations would run afoul of Neiss's teaching that full route calculations are not to be done in advance. It would also be highly inefficient. In Petitioner's proposed version of Neiss, optimal speeds would be calculated at the start for the entire route. Each time an unforeseen event occurs, calculations would have to be redone for the entire remaining route increasing the computational burden for the system.

186. Assuming this is even feasible without overloading Neiss's system, it would likely necessitate constant recalculations. Every time an unforeseen event happens—which can be frequent during a typical drive—all previous calculations would be discarded, and new ones would need to be performed. This kind of repeated, redundant calculation is the antithesis of efficiency. Neiss's current system avoids this by performing real-time calculations for only a limited area ahead of the vehicle, thereby avoiding unnecessary calculations and swiftly adapting to changing conditions.

187. Petitioner's suggested modification would, once again, undermine this functionality and degrade Neiss's performance and in any case does not render the '161 patent obvious.

188. Further, Neiss’s system is intentionally designed to minimize the load on its vehicle computer.

189. It employs a ring buffer that stores only a single Prediction Horizon of real-time data to keep memory requirements low. *See* Ex. 1005, ¶¶ [0163]-[0164].

190. Additionally, the optimization algorithm and calculation frequency are specifically tailored to reduce the system’s computational burden. *See Id.*, ¶ [0169].

191. However, I find that Petitioner overlooks these design considerations and suggests a modification to Neiss that would (1) significantly increase storage requirements, (2) necessitate repeated and wasteful recalculations, and (3) transform Neiss’s limited-scope calculations for a Prediction Horizon into more expansive and computationally demanding calculations for an entire route.

192. In other words, instead of minimizing the burdens on Neiss’s system, Petitioner’s reading would maximize them. A POSITA would have no reason or motivation to implement such a drastic change that departs from Neiss’s teachings, abandons its guidance, and deprives it of its intended benefits.

2. Neiss Does Not Teach “Segmenting Said Route into a Plurality of Segment Destinations”

193. Both independent claims, Claims 1 and 10, also mandate “segmenting said route into a plurality of segment destinations.”

194. The Petition refers to Neiss’s frames as “segments” and the end of each frame as a “segment destination.” *See, e.g.*, Petition at 20.

195. However, since Neiss's Prediction Horizon does not constitute a "route," its frames cannot be considered "segments" and thus also lack "segment destinations."

196. The frames, much like the Prediction Horizon, are merely the area or terrain immediately ahead of the vehicle. They are unrelated to the vehicle's route or destination.

C. Ground 2: Schramm and Clapper Do Not Render the Claims Obvious

197. It is my opinion that Schramm and Clapper also do not render the '161 patent's claims as obvious.

198. Neither Schramm nor Clapper determine a plurality of efficient speeds that optimize energy usage along a route. Schramm's route assessment system merely treats speed as a fixed input provided by the driver, without making any speed determinations itself. Clapper employs a lookup table of speed values to ascertain the speed at which the vehicle should travel at a specific location, but this isn't done for efficiency reasons. The lookup table only contains (1) previously driven speeds or (2) speed limits for that particular location.

199. It is my opinion that a POSITA would not find either of these approaches to be the same as, or obvious to, what the '161 patent claims to, nor they would be efficient. My basis for arriving at this conclusion is discussed in greater detail below.

200. Claims 1 and 10 both require “determining a plurality of efficient speeds that achieve a best summation of said energy values.”

201. As the claim language makes clear, this requirement requires a “plurality” of speed “determin[ations].”

202. Moreover, these determined speeds must be “efficient speeds that achieve a best summation of said energy values.”

203. The ’161 patent consistently describes how its system calculates multiple efficient or optimal speeds for the vehicle to travel. *See, e.g.*, Ex. 1001, 3:18-20 (indicating that the patent’s system determines the optimal speeds to drive throughout the route); 5:25-27 (stating that “[e]nergy efficient speeds for current and upcoming route segments can ... be calculated”); 16:51-54 (“optimized speeds are calculated”); 18:26-27 (“probable optimal speeds may be identified for the entire route”); 19:12-15 (“efficient speeds” are determined); 25:14-19 (referencing the selection of “optimum speeds to drive the segments of the route”).

204. It is my opinion that POSITA would not find this concept taught by or be obvious from Schramm and Clapper.

205. Instead of teaching a method for determining efficient speeds, Schramm’s system merely uses the speed from the driver as a preset input.

206. Specifically, according to Schramm, during operation, its system’s “logic receives the desired average speed at which the operator intends to drive [the]

vehicle to the destination point ‘B’.” Ex. 1009, 5:14-20; *see also Id.*, 5:45-49 (mentioning the use of “the speed that was input”), and uses that input speed for reading from the energy consumption table, 6:1-2 (using “the column corresponding to the speed that was input), 6:44-49 (stating that “energy consumption” determinations are made for travel “at the desired speed”), 7:40-42 (similarly referencing calculations performed “for the particular speed”), Figs. 2, 6.

207. Because Schramm does not make any speed determinations, the Petition points to Clapper and contends that a POSITA “would have adjusted Schramm’s” route “optimization process, per Clapper, to account for different per-segment speeds,” such as the “driver’s previous speed[s]” or “speed limits on existing roads and highways” that are “stored” in Clapper’s databases. Petition at 59.

208. However, ’161 patent’s claims require the determination of a “plurality of efficient speeds that achieve a best summation of said energy values.”

209. Clapper’s speeds are unrelated to efficiency and are not designed to achieve a best summation of energy values.

210. As the Petition acknowledges, Clapper’s system stores—and then outputs—either “speeds used at given locations in the past” or “a speed limit.” Ex. 1006, 1:50-56, 3:13-15; *see also Id.*, 2:52-60 (mentioning the storage and use of an

“existing speed from prior trips”); Fig. 4 (showing a “previous speed” database 55 and a speed limit database 50).

211. It is my opinion that Clapper’s database-stored speeds can be—and often are—highly inefficient.

212. A particular driver might consistently drive at either excessively high or very low speed. These speeds will be recorded in Clapper’s database, and Clapper’s system will output them for use by its cruise control when the driver traverses the same locations again, regardless of whether those speeds are efficient. While Clapper does discuss “moderat[ing]” stored speeds to account for current conditions like the weather (Ex. 1003, 2:8-10), the moderated speeds are still based on the driver’s own speeds. Moreover, this moderation is done for safety, not efficiency, purposes.

213. Similarly, if there is no stored driver data, Clapper defaults to using the speed limit. However, stored speed limits also have little to do with efficiency. For instance, if the speed limit on a highway is 75 mph, Clapper’s system will use this value even if it would be more efficient to travel at a slower speed. Or, if the speed limit for a road that goes up and then down a mountain is a constant 45 mph, Clapper’s system will use this value even though it might be more efficient to ascend the mountain at a slower speed and descend at a faster speed.

214. Because it simply employs the driver's own past speed or the speed limit, Clapper has no understanding or use of efficient speed(s), much the less an efficient speed(s) for particular route(s).

215. Combining Clapper with Schramm does not, in my opinion, fix this disclosure issue.

216. When Clapper's teachings are applied to Schramm, the combined system will merely use the speeds provided by Clapper—whether they are inefficient stored driver speeds or speed limits—as inputs for its route calculation. The merged system won't calculate or determine any efficient speeds, much less the “plurality of efficient speeds” required by the claim here.

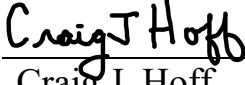
217. I find that the Petition—and Petitioner's expert—fails to offer any explanation to the contrary.

218. Thus, it is my opinion that a POSITA would not consider the combination of Clapper and Schramm to teach what the '161 patent's claims require.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willfully false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1101 of Title 18 of the United States Code.

Date: 11/13/2024

Location: Grand Blanc, MI

Signature: 
Craig J. Hoff

ATTACHMENT

CRAIG J. HOFF, Ph.D., P.E.

EDUCATION

- **Ph.D., Mechanical Engineering**, University of Michigan, Ann Arbor, MI (1992)
- **M.S., Mechanical Engineering**, Michigan State University, East Lansing, MI (1981)
- **B.S., Mechanical Engineering**, Michigan State University, East Lansing, MI (1979)

CERTIFICATION/LICENSURE

- Registered Professional Engineer, State of Michigan No. 31637
- SME Certified Manufacturing Engineer (CMfgE)

PRIMARY EMPLOYMENT HISTORY

- **2016 - Present: Founding Dean, College of Engineering**, Professor, Mechanical Engineering, Kettering University, Flint, MI.
- **2012 - 2016: Department Head, Mechanical Engineering**, Professor, Mechanical Engineering, Kettering University, Flint, MI.
- **2005 - 2012: Professor, Mechanical Engineering**, Kettering University, Flint, MI.
- **1999 - 2005: Associate Professor, Mechanical Engineering**, Kettering University, Flint, MI.
- **1995 - 1999: Department Chair, Mechanical Engineering**, Associate Professor, Mechanical Engineering, Lawrence Technological University, Southfield, MI.
- **1992 - 1995: Associate Professor, Mechanical Engineering**, Lawrence Technological University, Southfield, MI.
- **1985 - 1992: Assistant Professor, Mechanical Engineering**, Lawrence Technological University, Southfield, MI.
- **1981 - 1985: Lecturer, Mechanical Engineering**, Lawrence Technological University, Southfield, MI.
- **1979 – 1981: Michigan State University**, East Lansing, MI, Department of Mechanical Engineering. Part-time graduate teaching assistant.

ADMINISTRATIVE EXPERIENCE

- **Founding Dean, College of Engineering, Kettering University, Flint, MI**
 - Administered academic programs in Computer Engineering, Electrical Engineering, Industrial Engineering, and Mechanical Engineering for 1400 undergraduate students and 100 graduate students. Supervised 61 full-time faculty and 12 staff members.

- Lead efforts in strategic planning, curriculum development, faculty development, student engagement, international programs, industry engagement, and fundraising,
- **Department Head, Mechanical Engineering**, Kettering University, Flint, MI.
 - Administered academic program for 1000 undergraduate students and 80 graduate students and \$4M annual budget. Supervised 34 full-time faculty and 6 staff members.
 - Lead efforts in curriculum development, faculty development, student engagement, strategic planning, and assessment.
 - Prepared the department's successful 2015 ABET accreditation report.
- **Chair, Department of Mechanical Engineering**, Lawrence Technological University, Southfield, MI.
 - Administered day and evening programs for 800 undergraduate students and 100 graduate students. Supervised 16 full-time faculty, 30 adjunct faculty and 6 staff members.
 - Prepared the department's successful 1997 ABET accreditation report.

TEACHING EXPERIENCE

- **Professor, Department of Mechanical Engineering**, Kettering University, Flint, MI, 48504 (June 2006 – Present)
 - Teaching:
 - Strong proponent of experiential learning as a necessary complement to classroom education
 - Developed and taught graduate/undergraduate courses in automotive engineering, including: Introduction to Automotive Powertrains, Hybrid Electric Vehicle Propulsion, and Introduction to Automotive HVAC Systems
 - Cooperatively developed and taught an NSF funded, team-delivered multidisciplinary course: Environmentally Benign Design and Manufacturing
 - Undergraduate courses in thermal design, including: Thermodynamics, Fluid Mechanics, Heat Transfer, and Energy Systems Lab
 - Undergraduate courses in mechanical design, including: Statics, Dynamics, Solid Mechanics, and Design of Mechanical Components.
 - Developed and delivered courses in distance-learning format
 - Research:
 - Research Areas: Conventional Automotive Powertrains, Hybrid Automotive Powertrains, Alternative Fuels, PEM Fuel Cells, and Sustainability
 - Over \$2,000,000 in external funding (DOD, DOE, NSF, State of Michigan, and Industry sponsorships), in collaboration with colleagues
 - Supervised six master's thesis students and served on over 15 master thesis committees
 - Directed the development of a "Green Mobility Laboratory" which allows small electric vehicle powertrains to be simulated, utilizing DOE grant funds
 - Created an Electric Vehicle Testing facility, utilizing NextEnergy grant funds

- Developing an Electric Vehicle Testing Laboratory that can handle full-size vehicles
- Service:
 - Supervised over 120 undergraduate co-op student thesis projects
 - Served on numerous departmental and university committees, including chairing the Promotion and Tenure Committee and Academic Review Committee
 - Served on numerous professional society committees, particularly for the Society of Automotive Engineers (SAE)
 - Served as the faculty advisor to the Formula SAE race team (1985-present)
- **Visiting Professor, Fakultät Technik (TEC)**, Reutlingen University, Reutlingen, Germany (Fall 2011). Graduate course on Hybrid Electric Vehicle propulsion.
- **Associate Professor, Department of Mechanical Engineering**, Kettering University, Flint, MI, 48504 (April 1999 – June 2006).
- **Associate Professor of Mechanical Engineering**, Lawrence Technological University, Southfield, MI, 48075 (July 1995 – March 1999). Undergraduate courses in manufacturing, mechanical design and thermal design.
- **Associate Professor of Mechanical Engineering**, Lawrence Technological University, Southfield, MI, 48075 (July 1992 – July 1995).
- **Assistant Professor of Mechanical Engineering**, Lawrence Technological University, Southfield, MI, 48075 (1985 – 1992).
- **Instructor of Mechanical Engineering**, Lawrence Technological University, Southfield, MI, 48075 (1981 – 1985).
- **Graduate Teaching Assistant, Michigan State University**, East Lansing, MI (1979 – 1981). Undergraduate courses in Engineering Graphics, Introduction to Control Systems, Fluid Mechanics Laboratory.

RESEARCH / CONSULTING / ENTREPRENEURIAL

- **Ford Motor Company**, Dearborn, MI (2014 – Present). Expert witness in a patent case involving hybrid electric vehicle control strategies.
- **Accelerated Engineering, LLC**, Grand Blanc, MI (2008 – 2011). In collaboration with a former graduate student, started a company providing design and prototyping services to startup companies.
- **Society of Automotive Engineers**, Warrendale, PA (2003 – Present). Developed and regularly teach a professional seminar *Powertrain Selection for Acceleration and Fuel Economy*.
- **Select Engineering Service**, Layton, UT (2005 – 2012). Technical expert on multiple projects for U.S. Army TACOM, including:
 - Developed a data acquisition system for a fuel-cell powered tow tractor.
 - Converted a diesel-electric hybrid tow tractor into a fuel-cell powered tow tractor.

- Developed a mathematical model for a diesel-electric hybrid tow tractor using Argonne National Lab's Powertrain System Analysis Toolkit (PSAT) and validated it against experimental data.
- Developed a remote data acquisition for a fleet of Ford Escape Hybrids equipped with hydrogen internal combustion engines.
- Acted as lead technical expert for SES & Ricardo, LLC on the design of TACOM's Fuel Efficient Demonstrator (FED) vehicle.
- Developed remote data acquisition systems for the FED-Alpha and FED-Beta vehicles.
- **Weinstein, Kitchenoff & Asher, LLC**, Philadelphia, PA. (2012) Technical expert for product liability case on automotive HVAC control systems.
- **BAE Systems**, Troy, MI (2010). Developed and taught a review course in Fluid Mechanics for practicing engineers.
- **Dickinson Wright PLLC**, Ann Arbor, MI (2009). Technical expert in the development of patent for a novel engine concept.
- **Oblon, Spivak, McClelland, Maier & Neustadt, P.C.**, Alexandria, VA (2007). Technical expert for a patent case on automatic transmission design.
- **Welsh & Katz/ArvinMeritor**, Troy, MI (2004 – 2007). Technical expert/expert witness in a patent case involving heavy truck transmissions.
- **Convergence, LLC**, Howell, MI (2003 – 2007). Founding member and technical expert on technical advisory board of a fuel cell start-up company, working to develop fuel cells for residential applications.
- **Toyota Motor Company**, Torrance, CA (2004 & 2005). Prepared and delivered a custom seminar *Powertrain Selection for Acceleration and Fuel Economy*.
- **Welsh & Katz/Molon Electric Motors**, Chicago, IL (2005). Technical expert in a patent case involving worm gears.
- **Laboratory Assessment Bureau**, Fort Wayne, IN (2004). Technical expert for an ISO17025 laboratory assessment.
- **Anuvu Corporation**, Sacramento, CA (2002 – 2005). Fuel cell development for automotive applications.
- **National Technology Transfer Center**, Wheeling, WV (2003 – 2005). Evaluated patents for potential commercial applications.
- **Richard Nash, Attorney**, Dryden, MI (2003). Technical expert with respect to a product liability case involving a farm tractor accident.
- **Magna Mirror Systems**, Lowell, MI (2003). Resolved quality control problem in automotive mirror production.
- **Wilkie Brothers Conveyors, Inc.**, Marysville, MI (2003). Technical expert to evaluate Ford Motor Company specifications for conveyors bearings.
- **Battelle/U.S. Army Tank and Automotive Command (TACOM)**, Warren, MI (1997–2001). Investigated heat transfer techniques for cooling electronic equipment in ground combat vehicles.
- **Black and Veatch**, Ann Arbor, MI (2000). Developed and taught a several training course including: Cooling Towers, Heat Exchangers, and Mathcad.

- **Monarch Design Company**, Farmington Hills, MI (1984 – 1999). Developed finite element programs that are used to design paint distribution systems for automobile plants. These programs are capable of modeling the behavior of viscoelastic waterborne paints.
- **Altair Engineering**, Troy, MI (1994). Developed training material for Altair's *HyperMesh* program, a pre- and post-processor for Finite Element Analysis. Assisted in the development of a training course in Finite Element Analysis using NASTRAN, and FEA optimization using GENESIS.
- **Acme Mills Co.**, Detroit, MI (1994). Developed a computer model to simulate the behavior of Dymetrol fabric relative to the filming of a television commercial.
- **Ford Motor Company**, Dearborn, MI (1985–1986). Developed and taught a course in *Manufacturing Processes* for design engineers.
- **Schering-Plough**, Miami, FL (1985). Resolved a manufacturing problem relative to the thermal processing of transdermal patches.
- **Ford Motor Company**, Dearborn, MI (1984–1985). Developed and taught a course in *Design for Assembly* for Ford's PN38 Advanced Truck group.
- **Eaton Corporation**, Southfield, MI (1983). Developed and taught a course in Fluid Mechanics for practicing engineers.
- **General Motors Corporation** – Pontiac Division, Pontiac, MI (1982–1983). Developed and taught a course in technical mathematics for designers.
- **Engineer Trainee, Saab-Scania**, Sodertjale, Sweden (1980). Summer intern at an automotive assembly plant.
- **Product Engineer, Firestone - Hamill Manufacturing Division**, Washington, MI (1978 & 1979). Designed fixtures for reaction injection molding operation as part of a quality control function.
- **Production Worker, Hamilton Manufacturing Company**, Warren, MI (1977). Worked on die casting and chrome plating machines.

PUBLICATIONS

Journal & Peer Reviewed Publications

- Dewan, A., Ramadan, B.H., and **Hoff, C.**, "A Numerical Study on Combustion and Emissions in A Dual Fuel Directly Injected Engine Using Biogas and Diesel". ASME-ICEF2014-5541, ASME Internal Combustion Engine Division 2014 Fall Technical Conference, Columbus, IN, 2014.
- Wu, Y.Y, Duan, C., Hong, K.X., Tsai, H.C., **Hoff, C.J.**, "Design, Modeling and Development of a Serial Hybrid Motorcycle with HCCI Engine", *Advances in Automobile Engineering Journal*, 2013.
- Aurandt, J., Borchers, A.S., Lynch-Caris, T.L., El-Sayed, J., and **Hoff, C.J.**, "Bringing Environmental Sustainability to Undergraduate Engineering Education: Experiences in an Inter-Disciplinary Course," *Journal of STEM Education*, Volume 13, Issue 2, April 2012.
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MI, 2011. Also published in: *SAE Int. J. of Passeng. Cars – Mech. Syst. June 2011* 4:836-847.

- **Hoff, C.J.**, and Davis, G.W., “The Effect of Using Ethanol-Blended Gasoline on the Performance and Durability of Fuel Delivery Systems in Classic Automobiles,” SAE Paper 2010-01-2135, SAE Powertrain, Fuels, and Lubrication Conference, San Diego, CA, October 2010.
- Thompson, M.G, **Hoff, C.J.**, and Gover J.E., “A Model to Estimate the Effect of DC Bus Voltage on HEV Powertrain Efficiency,” IEEE Vehicle Power and Propulsion Conference, Lille, France, September 2010.
- Gover, J.E., Thompson, M.G., **Hoff, C.J.**, “Design of a Hybrid Electric Vehicle Education Program Based on Corporate Needs,” IEEE Vehicle Power and Propulsion Conference, Lille, France, September 2010.
- Rising, D., Kane, J., Vernon, N., Adkins, J., **Hoff, C.J.**, Brelin-Fornari, J., “Analysis of a Frontal Impact of a Formula SAE Vehicle,” SAE Paper 2006-01-3627, SAE Motorsports Engineering Conference, Dearborn, MI, October 2006.
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- Block, C., Carrick, N., Maurer, J., Davis, G., **Hoff, C.J.**, “The Development of a Clean Snowmobile for the 2004 SAE Clean Snowmobile Challenge,” SAE Paper 04SETC-83, SAE Small Engine Technology Conference, Gratz, Austria, September 2004.
- **Hoff, C.J.** and Yang, W.J., “Distributed Flow Leakage in Viscoelastic Tubes: An Experimental Study,” Journal of Mechanics and Medicine in Biology, Vol. 4, Number 2, June 2004
- Ku, J., Ottenstein, L., Kaya, T., Rogers, P., and **Hoff, C.J.**, “Testing of A Loop Heat Pipe Subjected to Variable Accelerations, Part 1: Start-up,” 30th SAE International Conference on Environmental Systems, SAE 2000-01-2488, Toulouse, France.
- Ku, J., Ottenstein, L., Kaya, T., Rogers, P., and **Hoff, C.J.**, “Testing of A Loop Heat Pipe Subjected to Variable Accelerations, Part 2: Temperature Stability,” 30th SAE International Conference on Environmental Systems, SAE 2000-01-2489, 2000, Toulouse, France.
- Rogers, P., Ku, J., and **Hoff, C.J.**, “Suitability of Loop Heat Pipes for Thermal Management of Ground Vehicles,” IMechE Paper No. C543-41, 4th SAE Vehicle Thermal Management Conference, London, May 1999.
- Davis, G.W., and **Hoff, C.J.**, “The Development of an Electro-Hydraulically Controlled, Five-Speed Transmission for a Hybrid Electric Vehicle,” SAE Transactions – Journal of Passenger Cars, 1998.
- Davis, G.W., and **Hoff, C.J.**, “The Development of an Electro-Hydraulically Controlled, Five-Speed Transmission for a Hybrid Electric Vehicle,” SAE-980830, 1998.
- **Hoff, C.J.** and Yang, W.J., “A Review of Pulse Propagation in Viscoelastic Arteries with Distributed Flow Leakage,” Bio-Medical Materials and Engineering, 4:419-437; 1994.

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- Steketee, R., Osborne, T., Michelini, J., **Hoff, C.**, Atwater, P., Grabowski, T., Brown, R., Brancik, B., Mase, B., Chu, B., "Design and Development of a Parallel Hybrid Electric Vehicle for the 1998 FutureCar Challenge," SAE Special Publication 1452, 1999.
- Swan, J., Spravsow, J., Davis, G., Brancik, G., Beattie, E., Dombrowski, J., Settle, B., Day, R., Kornosky, P., Okubo, F., Silas, R., Johnson, R., **Hoff, C.J.**, "Design and Development of Hyades, a Parallel Hybrid Electric Vehicle for the 1997 FutureCar Challenge," SAE Special Publication 1359, 1998.

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- Hoff, K.L., **Hoff, C.J.**, and Davis, G.W., "A Peer-Tutor's Perspective on Peer-Tutoring in Thermodynamics," ASEE Annual Conference, San Antonio, TX, June 2012.
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- Davis, M.G., **Hoff, C.J.**, and Riffe, W.J., "Incorporating Entrepreneurship into Mechanical Engineering Automotive Courses: Two Cased Studies," ASEE Paper AC 2011-2443, Society for Engineering Education Annual Conference, Vancouver, BC, June 2011.
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- **Hoff, C.J.** and Davis, G.W., "Promoting Professional Development in Undergraduate Engineering Using Laboratory Team Projects: A Case Study," ASEE Annual Conference, Pittsburgh, PA, June 2008.
- Lemke, B. and **Hoff, C.J.**, "Fuel Cell Education at the College Level," Fuel Cell Magazine Conference and Expo, Long Beach, CA, May 2008.
- Davis, G.W., Hoff, C.J., "Using the SAE Collegiate Design Series to Provide Research Opportunities for Undergraduates," ASEE Annual Conference, Honolulu, HI, June 2007.
- Lovria, N., **Hoff, C.J.**, "Utilizing a Fuel Cell to Extend the Range of a Global Electric Motorcar," Fuel Cell Seminar, Honolulu, HI, November 2006.

- **Hoff, C.J.** and Davis, G.W., “Using the SAE Collegiate Design Series to Provide Hands-on Team Project Experience for Undergraduates,” ASEE Annual Conference, Chicago, IL, June 2006.
- Lynch-Caris, T.M., Harding, T., Borchers, A., Redekop, B., El-Sayed, J., **Hoff, C.J.**, “Creating A Multi-Disciplinary Course With Industrial Input,” American Society of Engineering Education, Conference Proceedings, Chicago, IL, June 2006.
- **Hoff, C.J.** and Davis, G.W., “The Integration of Hands-on Team Projects into an Engineering Course to Help Students Make the Transition from Student to Professional Engineer,” ASEE Annual Conference, Portland, OR, 2005-2130, June 2005.
- Borchers, A., Harding, T., Lynch-Caris, Redekop, B., **Hoff, C.J.**, El-Sayed, J., and Doyle, D., “Undergraduate Course in Environmental Design and Manufacturing,” SME Innovations in Manufacturing Engineering Education Conference, San Luis Obispo, CA, June 2005.
- Van Tiem, R., **Hoff, C.J.**, Berry, K.J., “Modeling of a Fuel Cell Hybrid Vehicle,” ASME Annual Fuel Cell Conference, Ypsilanti, MI, May 2005.
- White, C.V., Dippery, R.E., and **Hoff, C.J.**, “Using Failure Analysis as a Capstone Design Tool,” Integrating Practice into Engineering Education Conference, University of Michigan – Dearborn, October 2004.
- **Hoff, C.J.**, Slagle, T., Lo, A., Zang, P., “Early Introduction of CAE Tools Enhances Success in Student Design Competitions,” ASEE/IEEE Frontiers in Education Conference, Savannah, GA, October 2004.
- Anzieck, J., Berry, K.J., **Hoff, C.J.**, et al., “Fuel Cell Hybrid Vehicle Development at Kettering University,” Electrical Manufacturing and Coil Winding Association: Electrical Manufacturing Expo 2004 Conference, September 2004.
- Waldron, W.K., Echempati, R., **Hoff, C.J.**, and Zang, P., “Learning Module for using Dynaform to Study the Effects of Die-Entry and Punch-Nose Radii on Drawing Cups,” 8th International LS-DYNA Users Conference, May 2004.
- **Hoff, C.J.**, Dippery, R.E., Knapp, J., “Stress Evaluation of a Bicycle Crank Arm Connection Using BEM,” 15th International Conference on Boundary Element Technology, Detroit, MI, 2003.
- Dippery, R.E., **Hoff, C.J.**, White, C.V., “Failure Analysis of a Structural Weld Using BEM,” 15th International Conference Boundary Element Technology, Detroit, MI, 2003 (Invited Paper).
- White, C.V., Dippery, R.E., and **Hoff, C.J.**, “Failure Analysis as a Design Tool for Non-Material Engineers,” ASM Materials Solutions 2003, Pittsburgh, PA, October 2003.
- **Hoff, C.J.** and Rogers, P.D., “Correlation of a Sinda/Fluint Model for a Switchbox Loop Heat Pipe,” ASME Paper No. NHTC2000-12160, National Heat Transfer Conference, Pittsburgh, PA, July 2000.
- Davis, G.W., **Hoff, C.J.**, “Evaluation of an Electro-Hydraulically Controlled, Manual Transmission for a Hybrid Electric Vehicle,” 33rd Intersociety Energy Conversion Engineering Conference, 1999.
- Davis, G.W., **Hoff, C.J.**, “Evaluation of an Electro-Hydraulically Controlled, Manual Transmission for a Hybrid Electric Vehicle,” Global Powertrain Congress, Detroit, MI, 1998.

- **Hoff, C.J.**, Brancik, N., Michelini, J., Grabowski, A., Madar, G., "Design and Development of Lawrence Technological University's Parallel Hybrid Electric Vehicle for the 1998 FutureCar Challenge," 17th Congress of the World Energy Council, Houston, TX, 1998.
- **Hoff, C.J.** and Yang, W.J., "Distributed Flow Leakage in Viscoelastic Tubes: An Experimental Study," 10th International Conference on Mechanics in Medicine and Biology, Honolulu, HI, 1998.
- Anneberg, L., **Hoff, C.J.**, Yaprak, E., "Use of AutoCad in an Electrical Engineering Curriculum," ASEE Annual Conference and Exposition, Milwaukee, WI, 1997.
- Hideg, L., **Hoff, C.J.**, Crist, J., Mioduszewski, D., Sverdluk, W., "Summer Science Institute," Proceeding: Engineering and Technology Education for the Future, ASEE North Central Section Spring Conference, 1996.
- **Hoff, C.J.** and Yang, W.J., "An In-Vitro Study of Distributed Flow Leakage on Pulse Propagation in the Aorta," Second World Congress of Biomechanics, Amsterdam, the Netherlands, 1994.
- **Hoff, C.J.** and Yang, W.J., "A Transmission Line Model For Pressure and Flow Waves in Viscoelastic Arteries with Distributed Leakage," Second World Congress of Biomechanics, Amsterdam, the Netherlands, 1994.
- **Hoff, C.J.**, Yang, W.J., "A Transmission Line Model for Pressure and Flow Waves in Viscoelastic Arteries with Distributed Flow Leakage," in Topics on Biomathematics, World Scientific, 1992.

Other Technical Publications

- Davis, G.W., **Hoff, C.J.**, Borton, Z., and Ratcliff, M.A., "Legacy Vehicle Fuel System Testing with Intermediate Ethanol Blends," Technical Report, NREL/TP-5400-53606, March 2012.
- Stein, J.A. and **Hoff, C.J.**, "Safe at the Pump?" Hagerty's, Volume 4, Issue 3, Fall 2009.
- **Hoff, C.J.**, "Final Report: Hydrogen Hybrid Internal Combustion Engine (H2ICE) Data Acquisition Equipment," US Army TARDEC, DESPII Contractual Engineering Task (CET), Contract No. FA8222-05-D-0001-0029, June 2009.
- Stein, J.A., and **Hoff, C.J.**, "Ethanol: Demonic or Devine. Is E10 an enemy of your collector car fuel system?" Hagerty's, Volume 4, Issue 1, Spring 2009.
- Lynch-Caris, T.M., Harding, T., Borchers, A., Redekop, B., El-Sayed, J., **Hoff, C.J.**, "Final Report: Development of a Course on Environmentally Benign Design and Manufacturing," National Science Foundation, DUE #0511322, December 2008.
- **Hoff, C.J.**, and Kane, J., "Final Report: Conversion and Testing of a Fuel-cell Powered Harlan Tow Tractor," US Army TARDEC, Department of Defense Report, June 2008.
- **Hoff, C.J.**, "Final Report: Testing and Modeling of the Baseline Harlan HTH Tow Tractor," US Army TARDEC, Department of Defense Report, March 2008.
- Lynch-Caris, T., and **Hoff, C.J.**, "Final Report: Innovative Emulsion Recycling Technology for the Metal Working Process," Michigan Pollution Prevention Research Grant Program, October 2007.
- **Hoff, C.J.** and Davis, G.W., "Introduction to Automotive Powertrains," Self-published 2003.

- **Hoff, C.J.**, "Final Report: Evaluation of Capillary Pump Loops for Electronics Thermal Management in Combat Vehicles," Battelle Scientific Services Program, Contract No. DAAHO4-96-C-0086 TCN 98-012, February 2000.
- Frasch, L.G. and **Hoff, C.J.**, "Evaluation of the State-of-the-Art in Vehicle HVAC Systems for Application of Combat Vehicles," U.S. Army TACOM, February 2000.
- **Hoff, C.J.**, Rogers, P., "Two-Phase Heat Transfer Devices for Electronics Cooling," U.S. Army TARDEC Advanced Technology Assessment Report, 1999.
- **Hoff, C.J.**, "Thermal Control Techniques for Electronics Equipment," Internal Report: U.S. Army Tank and Automotive Command, Warren, MI, 1997.
- **Hoff, C.J.**, "Thermal Modeling Software for Electronics," Internal Report: U.S. Army Tank and Automotive Command, Warren, MI, 1997.
- **Hoff, C.J.**, "Engineering Computer Applications Laboratory User Manual," Lawrence Technological University, 1996.
- **Hoff, C.J.**, "The Effects of Distributed Leakage on Pulse Propagation in Viscoelastic Arteries," Doctoral Presentation, University of Michigan, Ann Arbor, MI 1992.
- **Hoff, C.J.**, "An Analytical and Numerical Study of the Thermodilution Method of Measuring Cardiac Output," Master Thesis, Michigan State University, East Lansing, MI 1981

PRESENTATIONS

Invited Talks

- **American Petroleum Institute: Mid-Level Ethanol Blends Research Coordination Group Meeting**, "The Effect of Ethanol-blended Gasoline on the Fuel Delivery Systems in Classic Automobiles," October 2010.
- **SAE India**, TOPEC: Powertrain Selection for Acceleration and Fuel Economy, Chennai, India, October, 2005.

Conference Presentations

- Hoff, K.L., **Hoff, C.J.**, and Davis, G.W., "A Peer-Tutor's Perspective on Peer-Tutoring in Thermodynamics," ASEE Annual Conference, San Antonio, TX, June 2012.
- Davis, G.W., and **Hoff, C.J.**, "Incorporating Entrepreneurship into Mechanical Engineering Automotive Courses: Two Case Studies," ASEE Annual Conference, Vancouver, BC, June 2011.
- **Hoff, C. J.** and Davis, G. W., "Using Professional Engineering Standards as a Resource for Improving Undergraduate Education," 8th ASEE Global Colloquium on Engineering Education, Budapest, Hungary, October 2009.
- **Hoff, C. J.** and Davis, G. W., "Promoting Professional Development in Undergraduate Engineering Using Laboratory Team Projects: A Case Study," 7th ASEE Global Colloquium on Engineering Education, Cape Town, South Africa, October 2008.
- **Hoff, C. J.** and Davis, G. W., "Promoting Professional Development in Undergraduate Engineering Using Laboratory Team Projects: A Case Study," ASEE Annual Conference, Pittsburgh, PA, June 2008.

- Lemke, B. and **Hoff, C. J.**, “Fuel Cell Education at the College Level,” Fuel Cell Magazine Conference and Expo, Long Beach, CA, May 2008.
- Lovria, N., **Hoff, C. J.**, “Utilizing a Fuel Cell to Extend the Range of a Global Electric Motorcar,” Fuel Cell Seminar, Honolulu, HI, November 2006.
- **Hoff, C. J.** and Davis, G.W., “Using the SAE Collegiate Design Series to Provide Hands-on Team Project Experience for Undergraduates,” ASEE Annual Conference, Chicago, IL, June 2006.
- **Hoff, C. J.** and Davis, G.W., “The Integration of Hands-on Team Projects into an Engineering Course to Help Students Make the Transition from Student to Professional Engineer,” ASEE Annual Conference, Portland, OR, 2005-2130, June 2005.
- Van Tiem, R., **Hoff, C.J.**, Berry, K.J., “Modeling of a Fuel Cell Hybrid Vehicle, ASME Annual Fuel Cell Conference, Ypsilanti, MI, May 2005.
- **Hoff, C.J.**, “Using CAE Tools for University SAE Vehicle Competitions,” PLM World Annual Users Conference, Dallas, TX, May 2005.
- **Hoff, C.J.**, “MECH545 Hybrid Vehicle Propulsion,” NextEnergy Alternative Energy Curriculum Implementation Workshop, November 2004.
- White, C.V., Dippery, R.E., and **Hoff, C.J.**, “Using Failure Analysis as a Capstone Design Tool,” Integrating Practice into Engineering Education Conference, University of Michigan–Dearborn, October 2004.
- **Hoff, C.J.**, Slagle, T., Lo, A., Zang, P., “Early Introduction of CAE Tools Enhances Success in Student Design Competitions,” ASEE/IEEE Frontiers in Education Conference, Savannah, GA, October 2004.
- Block, C., Carrick, N., Maurer, J., Davis, G., **Hoff, C.J.**, “The Development of a Clean Snowmobile for the 2004 SAE Clean Snowmobile Challenge,” SAE Paper 04SETC-83, SAE Small Engine Technology Conference, Gratz, Austria, September 2004.
- Anzieck, J., Berry, K.J., **Hoff, C.J.**, et al., “Fuel Cell Hybrid Vehicle Development at Kettering University,” Electrical Manufacturing and Coil Winding Association: Electrical Manufacturing Expo 2004 Conference, September 2004.
- Waldron, W.K., Echempati, R., **Hoff, C.J.**, and Zang, P., “Learning Module for using Dynaform to Study the Effects of Die-Entry and Punch-Nose Radii on Drawing Cups,” 8th International LS-DYNA Users Conference, May 2004.
- **Hoff, C.J.**, Dippery, R.E., Knapp, J., “Stress Evaluation of a Bicycle Crank Arm Connection Using BEM,” 15th International Conference on Boundary Element Technology, Detroit, MI, 2003.
- **Hoff, C.J.** and Rogers, P.D., “Correlation of a Sinda/Fluint Model for a Switchbox Loop Heat Pipe,” ASME Paper No. NHTC2000-12160, National Heat Transfer Conference, Pittsburgh, PA, July 2000.
- Rogers, P.D., Ku, J., **Hoff, C.J.**, and Nelson, D., “Evaluation of Loop Heat Pipe Technology for Vehicle Thermal Management,” U.S. Army TACOM, FY99 In-house Laboratory Innovation Research, Review, January, 2000.
- Rogers, P., Ku, J., **Hoff, C.J.**, and Nelson, D., “Loop Heat Pipe Technology,” U.S. Department of Energy Workshop on Thermal Management for Heavy Vehicles (Class 7-8 Trucks), October 1999.

- Rogers, P. and **Hoff, C.J.**, "Electronics Thermal Management in Ground Combat Vehicles," NASA Two Phase Technology '99 Workshop, Greenbelt, MD, May 1999.
- Davis, G.W., **Hoff, C.J.**, "Evaluation of an Electro-Hydraulically Controlled, Manual Transmission for a Hybrid Electric Vehicle," Global Powertrain Congress, Detroit, MI, October 1998.
- Davis, G.W., Hoff, C.J., "The Design of an Electro-Hydraulically Controlled, Manual Transmission for a Hybrid Electric Vehicle," 33rd Intersociety Energy Conversion Engineering Conference, Colorado Springs, CO, August 1998.
- Davis, G.W., **Hoff, C.J.**, "Evaluation of an Electro-Hydraulically Controlled, Manual Transmission for a Hybrid Electric Vehicle," 1998 SAE International Congress and Exposition, February, 1998.
- **Hoff, C.J.** and Yang, W.J., "Distributed Flow Leakage in Viscoelastic Tubes: An Experimental Study," 10th International Conference on Mechanics in Medicine and Biology, Honolulu, HI, 1998.
- **Hoff, C.J.**, Davis, G., Anneberg, L., "Technology Transfer from Industry to Academia through Student Competition Projects," ASEE Annual Conference and Exposition, Milwaukee, WI, 1997.
- **Hoff, C.J.** and Yang, W.J., "An In-Vitro Study of Distributed Flow Leakage on Pulse Propagation in the Aorta," Second World Congress of Biomechanics, Amsterdam, the Netherlands, 1994.

Workshops

- Creating a Multi-Disciplinary Course in Environmentally Conscious Design and Manufacturing Workshop, ASEE Annual Conference, Pittsburgh, PA, (June 2008).

Other Technical Presentations

- Hoff, C.J., and Davis, G.W., "Kettering University/Anuvu Corporation – Potential Strategic Partnership, at Anuvu Corporation, Sacramento, CA (2003).
- Hoff, C.J., "Solar Powered Cars," Grand Blanc Middle School, (2000).
- TV Interviews/Newspaper/Newsletters: Regularly interviewed as a technical expert on automotive and energy technology.

Campus Presentations

- "CAE Tool Use by Kettering Formula SAE Team," Invited Presentation to Kettering University Mechanical Engineering Industrial Advisory Board, (November 2004).
- "CAE Tools in Automotive Engineering," Presentation to High School and Community College Counselors for KU Admissions Department, (October 2004).
- "Hybrid Electric Vehicles," Invited Speaker, Kettering University Tau Beta Pi Initiation Banquet, (May 2000).
- "Distributed Flow Leak in Viscoelastic Tubes: An Experimental Study," Presented to the Faculty of the Mechanical Engineering Department, (February 1999).

FUNDING

External Grants

- **U.S. Department of Energy**, Co-PI: "Legacy Vehicle Fuel System Testing with Intermediate Ethanol Fuel Blends." Testing fuel system compatibility to E17 with mid-1990 vintage vehicles, with Dr. Gregory Davis (ME) (\$125,000, 2010-2011).
- **U.S. Department of Energy**, Co-PI: "Development of a Green Mobility Laboratory." Designed and built three electric vehicle simulation stations consisting of a 15 kW electric motor, a DC power supply, Infineon inverter, Yokagawa power analyzer and eddy current dynamometer, with Dr. Jim Gover (EE) and Dr. Mark Thompson (EE) (\$500,000, 2010-2011).
- **PAICE, LLC**, Bonita Springs, FL, Co-PI: "Analytical and Simulation Study of Advantages of High Voltage (≥ 600 V) versus Low Voltage (≤ 300 V) Hybrid System Operation," with Dr. Mark Thompson (EE) and Dr. Jim Gover (EE) (\$40,000, 2010).
- **Society of Automotive Engineers Formula SAE Rules Committee** –Conducted a series of impact tests to ensure the safety of student-built Formula SAE vehicle. To date the work has resulted in 6 rule changes to improve safety. (unfunded, 2006 – 2009)
- **Hagerty Insurance Company**, Traverse City, MI, Co-PI: "Effect of Low-Blend Ethanol and the Fuel Systems of Classic Cars." Tested fuel system compatibility to E10 in pre-1970 vehicles, with Dr. Gregory Davis (\$50,000, 2008-2009).
- **Michigan Department of Environmental Quality/Crystal Filtration**, Co-PI: "Innovative Emulsion Recycling Technology for the Metal Working Process." Evaluated process for removing metal shavings from lubricant in stamping plant, with Dr. Terri Lynch-Caris (IME) (\$50,000, 2007).
- **National Science Foundation**, Washington, DC, Co: PI: "Development of a Course on Environmentally Benign Design and Manufacturing," DUE #0511322, with Dr. Terri Lynch-Caris (IME), Dr. Andy Borchers (BUS), Dr. Jenifer Aurandt (CHEM), Dr. Ben Redekop (LS), and Dr. Jackie El-Sayed (ME) (\$300,000, 2006-2008).
- **NextEnergy Corporation**, Detroit, MI. PI: Development of a chassis dynamometer to support a Hybrid Electric Vehicle Course (\$88,000, 2005).
- **Partners for the Advancement of Collaborative Engineering Education (PACE)**, Warren, MI. PI: Development of a Fluent tutorial for designing induction systems for Formula SAE vehicles (\$10,000, 2005).
- **NextEnergy Corporation**, Detroit, MI Co-PI: "Development of a fuel cell curriculum," with Dr. K. Joel Berry (ME), Dr. Etim Ubong (ME) (\$100,000, 2004).
- **U.S. Army Tank and Automotive Command (TACOM)**, Warren, MI Co-PI: Worked with a team from Kettering University to develop a fuel-cell hybrid system for a GEM electric vehicle, with Prof. Brenda Lemke. (\$150,000, 2004)
- **Anuvu Corporation**, Sacramento, PA. PI: Development of fuel cells for automotive applications. (\$10,000, 2003)
- **Magna Mirror Systems**, Grand Rapids, MI. Conducted analysis of quality control issues with respect to MMS's side-view mirror business (\$50,000, October 2001 – June 2002).

- **General Motors EV1 Research Donation Program**, Warren, MI. Donation of a Saturn EV1 (\$40,000 – 2001).
- **U.S. Army Tank and Automotive Command (TACOM)**, Warren, MI. Co-PI: FY2000 In-house Laboratory Innovation Research (ILIR) Grant, “Evaluation of Loop Heat Pipe Technology for Vehicle Thermal Management,” with Paul Rodgers (\$146,100, 2000).
- **U.S. Army Tank and Automotive Command (TACOM)**, Warren, MI. Co-PI: FY1999 In-house Laboratory Innovation Research (ILIR) Grant, “Evaluation of Loop Heat Pipe Technology for Electronics Thermal Management,” with Paul Rodgers (\$216,100, 1998).
- **U.S. Army Tank and Automotive Command (TACOM)**, Warren, MI. Co-PI: FY1998 In-house Laboratory Innovation Research (ILIR) Grant, “Theoretical Evaluation of Capillary Pumped Loops for Electronics Thermal Management,” with Paul Rodgers (\$110,000, 1998).
- **Society of Manufacturing Engineers – Education Foundation**, Dearborn, MI. PI, “Establishing a Design and Manufacturing Integration Center at Lawrence Technological University,” (\$1,000,000 – 1998).
- **U.S. Department of Energy - FutureCar Challenge**, PI: Lead a student team that developed a hybrid electric version of a Ford Taurus, (\$10,000, 1998).
- **U.S. Department of Energy - FutureCar Challenge**, PI: Lead a student team that developed a hybrid electric version of a Ford Taurus, (\$10,000, 1997).

Other External Cash Grants

Year	Project	Grantor/Donor	Amt/Value
2014	SAE Motorsports	GM Foundation	\$30,000
2014	SAE Motorsports	Denso Foundation	\$20,000
2014	SAE Motorsports	Chrysler Foundation	\$6,000
2014	SAE Motorsports	Ford Foundation	\$50,000
2013	SAE Motorsports	GM Foundation	\$30,000
2013	SAE Motorsports	Denso Foundation	\$20,000
2013	SAE Motorsports	GM Foundation	\$30,000
2012	SAE Motorsports	Denso Foundation	\$20,000
2012	AVL Fire Software	AVL	\$50,000
2012	SAE Motorsports	Meritor	\$6,000
2011	SAE Motorsports	GM Foundation	\$30,000
2011	SAE Motorsports	Denso Foundation	\$20,000
2011	AVL Cruise Software	AVL	\$50,000
2010	SAE Motorsports	GM Foundation	\$30,000
2010	SAE Motorsports	Denso Foundation	\$20,000
2009	SAE Motorsports	GM Foundation	\$30,000
2009	SAE Motorsports	Denso Foundation	\$20,000
2008	SAE Formula Car	Denso Foundation	\$20,000
2005	Fluent Tutorial	PACE	\$10,000
2005	SAE Formula Car	American Axle & Manufacturing	\$5,000

Year	Project	Grantor/Donor	Amt/Value
2014	SAE Motorsports	GM Foundation	\$30,000
2014	SAE Motorsports	Denso Foundation	\$20,000
2014	SAE Motorsports	Chrysler Foundation	\$6,000
2014	SAE Motorsports	Ford Foundation	\$50,000
2013	SAE Motorsports	GM Foundation	\$30,000
2013	SAE Motorsports	Denso Foundation	\$20,000
2013	SAE Motorsports	GM Foundation	\$30,000
2012	SAE Motorsports	Denso Foundation	\$20,000
2012	AVL Fire Software	AVL	\$50,000
2012	SAE Motorsports	Meritor	\$6,000
2011	SAE Motorsports	GM Foundation	\$30,000
2011	SAE Motorsports	Denso Foundation	\$20,000
2011	AVL Cruise Software	AVL	\$50,000
2010	SAE Motorsports	GM Foundation	\$30,000
2010	SAE Motorsports	Denso Foundation	\$20,000
2009	SAE Motorsports	GM Foundation	\$30,000
2009	SAE Motorsports	Denso Foundation	\$20,000
2005	SAE Formula Car	National Automotive Test Center	\$1,500
2004	SAE Formula Car	American Axle & Manufacturing	\$15,000
2004	SAE Formula Car	National Automotive Test Center	\$1,000
2003	SAE Formula Car	American Axle & Manufacturing	\$12,000
2002	SAE Formula Car	American Axle & Manufacturing	\$10,000
2001	SAE Formula Car	American Axle & Manufacturing	\$5,000

External Gifts in Kind

Year	Item	Grantor/Donor	Amt/Value
2014	Tooling	Kennametal	\$10,000
2013	Tooling	Kennametal	\$10,000
2012	Tooling	Kennametal	\$10,000
2012	Transmission cutaways	Borg Warner	\$2,000
2008	PSAT Software	Argonne National Lab	\$10,000
2005	Transmission #1	Ford	\$1000
2005	Transmission #2	Ford	\$1000
2005	SAE Formula Car	Various	\$15,000
2004	ADVISOR Software	AVL	\$12,000
2004	CVT Transmission	Jasco	\$2000
2004	SAE Formula Car	Various	\$15,000
2003	Transmissions (3)	BorgWarner	\$1500
2003	Fuel Cell	Anuvu	\$10,000
2004	SAE Formula Car	Various	\$15,000
2003	SAE Formula Car	Various	\$15,000

Year	Item	Grantor/Donor	Amt/Value
2002	Transmission Cut-away	Federal Mogul	\$10,000
2002	GT Power Software	Gamma Technologies	\$10,000
2002	SAE Formula Car	Various	\$23,200
2002	SAE Formula Car–Cash	American Axle & Mfg	\$10,000
2001	Cruise Software	AVL	\$10,000
2001	SAE Formula Car	Various	\$18,000
1998	Coordinate Measuring Machine and metrology equip.	Mitutoyo	\$48,000
1998	Programmable Controllers	Siemmen Electric	\$15,000
1997	Ford Taurus	Ford Motor Company	\$22,000
1997	VW Jettas (3) for FutureCar	Volkswagen of America	\$54,000
1997	Personal Computers (20)	Ford Motor Company	\$10,000
1996	Horiba Chasis Dynamometer (1)	General Motors Corp.	\$200,000
1996	Autocad Mechanical Desktop (2)	Autocad	\$6,000
1996	SGI Workstations (5)	Chrysler	\$10,000
1995	DaDisp Software	DaDisp	\$10,000
1995	Aries Software	SME Foundation	\$75,000
1994	MasterCam Software	SME Foundation	\$10,000
1993	Apollo Workstations (8)	Easi Engineering	\$10,000

Internal Grants

- **LTU Internal Grant – FutureCar Challenge**, PI: Led student team that developed a hybrid electric version of a Ford Taurus. (\$50,000, 1998)
- **LTU Internal Grant – FutureCar Challenge**, PI: Led student team that developed a hybrid electric version of a Ford Taurus. (\$10,000, 1997)

Proposals – Unfunded

- **U.S. Department of Energy, EcoCAR 2 Competition**, Co-PI with Dr. Mark Thompson. (165,000, 2011)
- **Nation Science Foundation, DUE–CCLI–Adaptation and Implementation Program**, Co-PI, “Development of a Course in Environmentally Conscious Design and Manufacturing for Undergraduates–Part 2,” (\$500,000, 2009).
- **National Science Foundation, EEC–Partnerships for Innovation Program**, Co-PI, “Partnership for Hybrid Energy Systems Innovations, Research and Commercialization,” (\$600,000, 2005).
- **Department of Education - FIPSE Program**, Co-PI, “Use of FM Sound-Field Systems for Improved Knowledge Transfer and as an Intervention Toward ADA Compliance,” (\$534,183 – 2005).
- **Department of Defense**, Co-PI, “Hybrid Propulsion Systems for Undersea Weapons Technical Proposal,” N054-024-0219 (2005).

- **Partners for the Advancement of Collaborative Engineering Education (PACE)**, Warren, MI. PI, "Development of a MSC.ADAMS for FSAE Teams," (\$10,000, 2005).
- **National Science Foundation – EEC Engineering Education**, PI, "Fear Factors: Overcoming Obstacles to the Integration of Product Design and Realization Tools into the Mechanical Engineering Curriculum, (\$100,000 – 2004).
- **Partners for the Advancement of Collaborative Engineering Education (PACE)**, Warren, MI. PI, "Computers for FSAE Teams," (\$20,000, 2004).
- **Partners for the Advancement of Collaborative Engineering Education (PACE)**, Warren, MI. PI, "Development of CAE Toolkits," (\$15,000, 2004).
- **National Science Foundation – EIA – ITR Medium (Group) Grant**, Co-PI, "ITR Collaborative Proposal: A Distributed Vehicle Open System Architecture," (\$1,428,170 – 2003).
- **Kettering University Research Initiation/Improvement Grant Program**, PI, "Development of a Fog Detection System," (\$6960 – 2001).
- **Kettering University Research Initiation/Improvement Grant Program**, PI, "A Mobile Climate Control/Engine Cooling Laboratory," (\$14,861 – 2000).
- **National Science Foundation – DUE – ILI-IP**, PI, "Automotive Sensor and Measurement Laboratory," (\$88,400 – 1997).

PROFESSIONAL SOCIETY MEMBERSHIP

- American Society of Engineering Educators (ASEE)
- American Society of Mechanical Engineers (ASME)
- Society of Automotive Engineers (SAE)

PROFESSIONAL SERVICE

Review Committees

- External Reviewer, Graduate Program in Automotive Systems Engineering, University of Michigan Dearborn (2012).
- External Reviewer, Graduate Program in Manufacturing Systems Engineering, University of Michigan Dearborn (2012).

Society Committees

- Chair, SAE International – Scholarship Committee (2002 - 2008)
- Member, SAE International – Scholarship Committee (2000 – present)
- Member, SAE International – Engineering Education Board (2002 – present)
- Member, SAE International – FSAE Rules Committee (2004 – present)
- Member, SAE International – Faculty Advisors Committee (2000 – present)
- Member, SAE International – FSAE Education Committee (2004 – present)
- Member, SAE International – Powertrain Certificate Advisory Panel (2003)
- Member, SAE International/Kettering University Partnership (2003 – present)
- Member, NextEnergy Alternative Energy Education Board (2004 – present)
- Director of Industrial Representatives, SAE Detroit Section (1997-1999)

Conference Organization

- Organizer and Chair, SAE International Congress Engineering Education Session (2006-2010)
- Organizer and Co-Chair (w/Barb Mizdail, Penn State), SAE International Congress Engineering Education Session (2005)
- Organizer, ASME Power, Transmission and Gearing Technical Meeting, Chicago, IL (2003)
- Session Chair, 15th International Conference Boundary Element Technology, Detroit, MI, (2003)
- Organizer, and Proceedings Editor, 11th International Conference on Mechanics in Medicine and Biology. Kettering University was a sponsoring organization. (Maui, 2000)
- Organizer and Session Chair, 10th International Conference on Mechanics in Medicine and Biology. University of Michigan was a sponsoring organization. (Honolulu, 1998)

Publications Reviewed

- Executive Editor, Advances in Automotive Engineering Journal (2012 – present)
- Member, Editorial Advisory Board for Journal of Mechanics in Medicine and Biology (2002 – present)
- SAE – Regularly review conference papers (2000 – present)
- ASEE Frontiers in Education (2004) – Reviewed several papers.
- United Kingdom – Natural Environment Research Council: Research Grant Assessment, “From Technology to Market: Accelerating the Introduction of Fuel Cells Through Increasing Returns. (2004)
- American Society of Mechanical Engineers - International Gas Turbine Institute – Reviewed: “Trends in Engine Bearing Design and Bearing Material Development under Consideration of Environmental Protection,” (2003).
- ASME Power, Transmission and Gearing Technical Committee (2003) reviewed 10 papers.
- Introduction to Fluid Mechanics, 6th Edition, R. Fox and A. McDonald, John Wiley & Sons, New York, (1998).
- U.S. Army TACOM, “Advanced Conversion Technology Review Panel Report,” (1997).
- ASME-IGTI Turbo Asia Conference, “A Practical Method for Predicting Windmilling Characteristics of Simple Turbo Jet Engine,” (1996).

Other Professional Service

- Design Judge, SAE MiniBaja 100 Competition (Tuscon, 2005)
- National Defense Science and Engineering Graduate Fellowship Program (Research Triangle Park, NC, 1999).

UNIVERSITY SERVICE

Kettering University – Committees

- Provost Search Committee (2013-14)
- Member, Entrepreneurship Across the Curriculum Committee (2009 – Current)

- Member, Kettering Industrial Ecology Team (2004 – Current)
- Member, University Promotion Tenure and Ethics Committee (2008 – Current)
- Member, University Promotion and Tenure Committee (2007 – 2009)
- Chair, ME Department Promotion and Tenure Committee (2008 – 2009)
- Vice-Chair, ME Department Promotion and Tenure Committee (2007 – 2008)
- Chair, Recruitment, Admission and Retention (RADAR) Committee (1999 – 2004)
- Chair, Academic Review Committee (1999 – 2004)
- Member, Faculty Senate (2005 – 2008)
- Member, University Strategic Planning Committee – Teaching & Learning (2002)
- Member, University Honorary Degree Committee (2003 – present)
- Member, University President’s Medal Committee (2003 – present)

Kettering University – Other

- Advisor, Kettering University’s Formula SAE Team
- Co-Advisor, Kettering University’s SAE Student Section (w/Dr. Greg Davis)
- Presentations to alumni at Detroit Athletic Club during SAE Congress (Annually)
- Presentations of SAE Motorsports vehicles for Board of Trustees picnic (Annually)
- Organized SAE Motorsports vehicle presentations for Discover Kettering (Annually)
- Organized SAE Motorsports vehicle presentations for SAE Foundation Banquet (Annually)
- Organized SAE Motorsports vehicle presentations for SAE Congress (Annually)
- Parent Night for Admissions
- Presentations to community college counselors
- Presentations to M.E. Industrial Advisory Board

Lawrence Technological University

- Chair, Engineering Faculty Council (1993 – 1995)
- Chair, Promotion and Tenure Committee (1991 – 1992)
- Vice Chair, Engineering Faculty Council (1992 – 1993)
- Member, Computer Lab Directors Committee (1991–1999)
- Member, Master Automotive Engineering Admissions Committee (1995 – 1999)
- Member, Teaching Learning Technology Roundtable (1997 – 1999)
- Member, Capital Campaign Committee (1997 – 1999)
- Member, Dean Search Committee (1994 – 1996)
- Member, Promotion and Tenure Committee (1989 – 1991)

DEPARTMENTAL SERVICE

Kettering University - Committees

- Provost’s Council (2012 – present)
- Chair, Mechanical Engineering Automotive Group (2005 – 2012)
- Representative to Faculty Senate (2005 – present)
- Member, Mechanical Engineering Assessment Team (1999 – present)
- Member, Mechanical Engineering Transfer Credit Team (2001 – present)

- Member, Mechanical Engineering Energy Systems Group (1999 – present)
- Member, Fuel Cell Educational & Research groups (2004 – present)
- Chair, Mechanical Engineering Department Promotion and Tenure Committee (2008-2009)
- Vice-Chair, Mechanical Engineering Department Promotion and Tenure Committee (2007-2008)
- Member, Mechanical Engineering Graduate Committee (2001 – 2004)
- Member, Mechanical Engineering Curriculum Reform Committee (1999-2001)
- Member, Mechanical Engineering Curriculum Committee (2001-2004)
- Member, Mechanical Engineering Strategic Planning Committee (2002)

Lawrence Technological University

- Chair, Mechanical Engineering (1995-1999)
- Advisor, Pi Tau Sigma Honor Society (1982 – 1999)
- Advisor, Formula SAE Team (1983 – 1986)
- M.E. Representative, Engineering Faculty Council (1990 – 1992)
- Member, Master Automotive Engineering Admissions Committee (1995 – 1999)
- Member, Teaching Learning Technology Roundtable (1997 – 1999)

COMMUNITY SERVICE

- **Precinct Observer, LWV of the Flint Area**, Flint, Michigan. Volunteered to serve as a precinct observer to act as a presence to help ensure fair access to voting; also gathered data to be used in election reform. (2012, 2014)
- **Future City Mentor, Grand Blanc Middle School**. Advised 7th-8th graders on the engineering aspects of their Future City Project. Placed 2nd in Michigan region in 2002, 3rd in 2003, and 3rd in 2004. (2001 - 2004)
- **District Technology Steering Committee, Livonia Public Schools**. Advised the district on how to carry out a \$60 million bond improvement program to implement computer usage in the K-12 curriculum (1993 - 1999)
- Frequent speaker to School groups on “Mechanical Engineering as a Profession.” (1995 – 1999)
- **DAPCEP**, Outreach program for inner-city teenagers. Taught a program on “Computers in Engineering.” (1991 - 1995)
- **Girl Scouts of America**, Michigan Metro Council & Fair Winds Council program assistant and camp first-aider. (1988 - 2004)
- **Olympics of the Mind Mentor, Clarkston Public Schools**, Acted as advisor for 5/6th grade students. (1984 -1986)

HONORS AND AWARDS

- Carroll Smith Mentor's Cup, Sports Car Club of American (2015)
- Outstanding Educational Scholar, Kettering University Center for Education, Teaching and Learning (2007).
- SAE Forest R. McFarland Award – For outstanding contributions in the planning, development, and dissemination of technical information.
- Nominee, Kettering University Tau Beta Pi Teacher of the Year (2004)
- SAE Ralph R. Teetor Award (2002) – In recognition of significant contribution to teaching, research and student development in automotive engineering
- Tau Beta Pi (1991) - National Engineering Honor Fraternity, Gamma of Michigan Chapter
- Teacher of the Year (1984) - LTU Chapter of Michigan Society of Professional Engineers
- Pi Tau Sigma (1979) - National Mechanical Engineering Honor Fraternity, Tau Epsilon Chapter
- Michigan State University (1976-1979) - Community College Transfer Scholarship

COURSES TAUGHT

Kettering University

- Introduction to Engineering (ENG100)
- Statics (MECH210)
- Mechanics of Materials (MECH212)
- Design of Machine Elements (MECH312)
- Thermodynamics (MECH 320)
- Fluid Mechanics (MECH 322)
- Heat Transfer (MECH 420)
- Energy Systems Laboratory (MECH422)
- Automotive Capstone Design Project (MECH 448)
- Introduction to Automotive Powertrains (MECH544)
- Hybrid Electric Vehicle Propulsion (MECH545)
- Independent Study (MECH599)
- Automotive HVAC & Engine Cooling (MECH6xx)
- Environmentally Benign Design and Manufacturing (IME540)

Lawrence Technological University

- Introduction to Electrical Circuits
- Engineering Cost Analysis
- Engineering Design Graphics
- Manufacturing Processes
- Engineering Computer Applications Lab
- Computer Aided Engineering
- Statics

- Dynamics
- Mechanics of Materials
- Mechanics of Materials Lab
- Design of Machine Elements
- Kinematics of Machines
- Thermodynamics I
- Thermodynamics II
- Fluid Mechanics
- Heat Transfer
- Thermal Science Lab
- Engineering Solar Systems
- Internal Combustion Engines
- Senior Design Project
- Independent Study

Michigan State University

- Drafting I & II
- Fluid Mechanics Laboratory
- System Dynamics

OTHER ASSIGNED DUTIES

Co-Advisor (w/Greg Davis) SAE Student Section,

- Provided supervision and leadership for the activities of the student members
- Helped to develop the 6500 sq. ft. Student Design Center (a.k.a. the Garage)
- Supported university recruiting activities by organizing tours of the lab

Advisor, Kettering University Formula SAE Team

- Provided supervision and technical advice to a team of students designing and building a small open-wheel race car.
- Supervised students while traveling to competitions (Including two trips to compete in England)
- Assisted with funding raising

Course Coordination (Current)

- MECH544 Automotive Powertrains (w/Greg Davis)
- MECH545 Hybrid Electric Vehicle Propulsion

Graduate Student – Master Thesis Advising

- Zackery Borton, “Legacy Vehicle Fuel System Testing with Intermediate Ethanol Fuel Blends.” (2011-pending)
- Jason Fahland, “Evaluating Impact Attenuator Performance for a Formula SAE Vehicle” (2010)
- Jason Kane, “Development of a Fuel Cell Tow Tractor” (2009)

- Nick Lovria, "Data Acquisition and Modeling of a Fuel-Cell Equipped GEM Vehicle" (2009)
- Seth Lerner, "Characterization of an ANUVU Fuel Cell Stack" (2008)
- Rob Lillicrap, "Development of a Fuel Cell Test Bench" (2005)

Graduate Student – Master Thesis Committee Member

- Allan Taylor, "Development of a Green Mobility Laboratory," (2011).
- Abdrahamane Traore, "Power Electronics & Controls for a Fuel Cell Hybrid Electric Vehicle," (2010).
- Philip Lundberg, "A Computational Study of Flow Maldistribution and Pressure Drop in Catalytic Converters," (2007).
- Amit Khamkar, "A Numerical study of In-cylinder Mixture Preparation, Combustion and Emissions Using Multiple Injection Points in Diesel Engine," (2007).
- Sumit Kaul, "Effect of Biodiesel Blended Fuels on the Emissions and Performance of an Unmodified Medium Duty Diesel Engine" (2007).
- Arvind Jujare "A Numerical Study of an Automotive Catalytic Converter Internal Flow," (2005).
- Prashant Ahire, "CFD Simulations for the Development of Problem Based Learning Modules in Engineering Thermodynamics," (2005).
- Claude Pilger, "Small Engine Development" (2005).
- Ed Heil, "The Design and Development of a Hydrogen Reformation System," (2003).
- Deepak Sathyanarayana, "External Knee Geometry Surface Variation as a Function of Subject Anthropometry and Flexion Angle for Human and Surrogate Subjects," (2003).
- Yubo Zhang, "Minimum Supplementation to Achieve Acceptable Cold Start Performance in Ethanol Fueled Vehicles," (2002).
- Jason Cartwright, "Design and Development of a Windshield Fog Test Chamber," (2001).
- Sanjay Singh, "Hydrogen Supplemented E85 for Cold Start Improvement," (2000).

PROFESSIONAL DEVELOPMENT

Training

- Mustang Dynamometer operation (2005)
- ISO1705 Laboratory Assessment (2004)
- "A Familiarization of Drivetrain Components," SAE Seminar, Troy, MI (2003)
- BlackBoard User's Training (2002) and continuous self-instruction
- ABET 2000 Workshop at Rose-Hulman University, Terre Haute, IN (1998)

Conferences Attended

- SAE International Congress & Exposition (Annually)
- ASEE Annual Conference, Portland, OR (2005)
- **Invited Speaker**, PLM World Conference, Dallas, TX (2005)
- SAE Small Engine Technology Conference, Gratz, Austria (2004)
- Frontiers in Education, Savannah, GA (2004)

- Electrical Manufacturing and Coil Winding Association: Electrical Manufacturing Expo 2004 Conference, Indianapolis, IN (2004)
- MSC Users Conference, Dearborn, MI (2003)
- 15th International Conference on Boundary Element Technology, Dearborn, MI (2003)
- ASME Power, Transmission and Gearing Technical Meeting, Chicago, IL (2003)
- **Invited Participant**, ABET Colloquy on Laboratory Experiences, San Diego, CA (2002)
- 11th International Conference on Mechanics in Medicine and Biology, Maui, HI (2000)
- ASME National Heat Transfer Conference, Pittsburgh, PA (2000)
- FutureCar Congress, Ypsilanti, MI (1999)
- U.S. Department of Energy Workshop on Thermal Management for Heavy Vehicles (Class 7-8 Trucks), Washington, DC (1999)
- NASA Two Phase Technology '99 Workshop, Greenbelt, MD (1999)
- 10th International Conference on Mechanics in Medicine and Biology, Honolulu, HI (1998)
- Space Technology and Applications International Forum, Institute for Space and Nuclear Power Studies, Albuquerque, NM (1998)
- Engineering Society of Detroit HEV Ride and Drive, Ypsilanti, MI (1998)
- U.S. Representative to World Energy Congress, Houston, TX (1998)
- Global Powertrain Congress, Detroit, MI (1998)
- 9th International Conference on Mechanics in Medicine and Biology and Second World Congress of Biomechanics, Amsterdam, Netherlands (1998)
- **Invited Participant**, Ford Global Dean's Conference, Detroit, MI (1996)
- ASEE Annual Conference, Milwaukee, WI (1997)
- ASEE Annual Conference, Washington, DC (1996)

Computer Software

- Adams – Training (1996)
- Algor – Training (1995)
- Ansys – Training (1995) and continuous self-instruction
- BEASY – Self-instruction (2003)
- CANalyzer – Self-instruction (2004)
- Fortran – Continuous self-instruction
- HyperMesh – Training (1994)
- Labview – Self-instruction and training (2004)
- Mathcad – Continuous self-instruction
- Matlab/SIMULINK – Continuous self-instruction
- Nastran – Training (1994)
- Powertrain Simulation and Analysis Toolkit (PSAT) – Continuous self-instruction