

# Malcolm H. Ray, P.E., Ph.D.



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## CURRICULUM VITA

### EXPERTISE

Impact mechanics, nonlinear dynamic finite element analysis, nonlinear dynamics, full-scale crash testing, side-impact crash testing and structural design. Risk and cost effectiveness analysis of roadside and highway safety alternatives. Roadside and highway safety, design and analysis of impact resistant structures and crashworthiness of transportation vehicles.

### EDUCATION

- PhD Civil Engineering, Vanderbilt University, Nashville, Tennessee (1992).
- MS Civil Engineering, Carnegie-Mellon University, Pittsburgh, Pennsylvania (1984).
- BS in Civil Engineering from the University of Vermont, Burlington, Vermont (1983).

### HONORS AND HONOR SOCIETIES

- AFB20 Best Paper Award, Using Risk Analysis to Minimize Adverse Consequences in Non-Standard Designs by Malcolm H. Ray and Christine E. Carrigan (2015).
- Kenneth A. Stonex Roadside Safety Award – presented by the Roadside Safety Design Committee of the Transportation Research Board as a life-time achievement award in the area of roadside safety (2012).
- Kalenian Award, Honorable Mention -- The Collaborative for Entrepreneurship and Innovation, Worcester Polytechnic Institute (2008).
- Outstanding Paper Award – Transportation Research Board, Roadside Safety Features Committee (A2A04), Transportation Research Board (2000).
- Outstanding Paper Award -- Transportation Research Board, Roadside Safety Features Committee (A2A04), Transportation Research Board (1997).
- ASCE Favorite Professor Award, The University of Iowa, Department of Civil and Environmental Engineering (1997).
- Special Recognition Award, Federal Highway Administration, Design Concepts Research Division (1995).
- Fred Burgraf Award -- Outstanding research performed by a young researcher, Transportation Research Board (1986).

- D. P. Fay Award -- Outstanding contributions to the Civil Engineering Department, University of Vermont (1983).
- Chi Epsilon, Civil Engineering Honor Society.
- Tau Beta Pi, Engineering Honor Society.

#### **PROFESSIONAL REGISTRATION**

- Alabama (36175-E, active)
- Arizona (63196, active)
- Iowa (13724, expired)
- Illinois (062-054292, active)
- Maine (9212, active)
- Mississippi (20476 LTD, expired)
- New Hampshire (15187, active)
- North Carolina (041549, active)
- South Carolina (33855, active)
- Tennessee (00022296, expired)
- Texas (124399, active)

#### **SERVICE**

- Lake Anasagunticook Dam Commission (2005 – present).
- Transportation Research Board -- Roadside Safety Features, Committee AFB20 (Member 2010 – 2019 and 1997-2003).
- Transportation Research Board -- Roadside Safety Features – Computational Mechanics Subcommittee AFB20(1) (Chair, 2010- present, Member, 1998-present).
- Transportation Research Board -- Roadside Safety Features -- International Activities, Subcommittee AFB20(2) (Member).
- American Society of Civil Engineers (Member since 1983).
- American Society of Civil Engineers -- Committee on Expert Systems (Past Member).
- American Society of Civil Engineers -- Committee on Metrication (Past Member).
- AASHTO-ARTBA-AGC Joint Subcommittee on New Materials, Task Force 13 (Current Chair of Subcommittee 10, Past Executive Committee Member and Research Advisor).

## **EXPERIENCE**

- 2014 – Present** Selectman, Town of Canton: Elected selectman for the Town of Canton, Maine. Assist the Select Board and town departments in the governance and management of all town affairs.
- 2010-Present** Managing Partner, RoadSafe LLC, Canton, Maine: Perform research and consulting services in the area of transportation safety, crash modeling, risk assessment, roadside hardware design, analysis and testing.
- 2010-Present** Affiliate Professor, Professor of Civil and Environmental Engineering at the Worcester Polytechnic Institute, Worcester, MA.
- 2005-2006:** Visiting Professor of Aerospace Engineering, Politecnico di Milano, Milano, Italy: Spent the 2005-2006 academic year on sabbatical at the Laboratorio sulla Sicurezza dei Trasporti (LAST) performing research and teaching in the area of impact finite element analysis and passive vehicle safety.
- 1999 to 2010:** Ralph H. White Family Distinguished Professor, Professor of Civil and Environmental Engineering and Professor of Mechanical Engineering at the Worcester Polytechnic Institute, Worcester, MA: Taught classes in the area of transportation, transportation safety, crashworthiness and finite element analysis. Performed research in the areas of impact, roadside safety, and finite element analysis and risk assessment. Director of the Interdisciplinary Program on Impact Engineering, associated with the Highway Infrastructure Program. Hired in 1999 as an Associate Professor and promoted to Professor in 2005.
- 1995 to 1998:** Assistant Professor of Civil Engineering at the University of Iowa: Taught classes in the areas of structural mechanics and structural design. Performed research in the areas of impact, roadside safety, and finite element analysis and risk assessment. Affiliated with the Center for Computer Aided Design (CCAD).
- 1992 to 1995:** On-site support contractor for the Design Concepts Research Division of the Federal Highway Administration at the Turner-Fairbank Highway Research Center in McLean, Virginia. Performed research in the area of roadside safety and especially the use of nonlinear dynamic finite element programs like LSDYNA for roadside hardware design applications. Also worked closely with the FHWA's Federal Outdoor Impact Laboratory (FOIL) in performing crash tests and validating finite element results.
- 1987 to 1992:** Research Instructor at Vanderbilt University. Taught a variety of undergraduate classes including Statics, Mechanics of Materials and Surveying. Performed contract research sponsored by the Federal Highway Administration and other organizations. Involved with the Vanderbilt Engineering Center for Transportation and Operations Research, VECTOR.

**1984 to 1987:** Worked in the Highway Safety Section at Southwest Research Institute in San Antonio, Texas. Assisted in the design and full-scale crash testing of a wide variety of guardrails, guardrail terminals, crash cushions, luminaire supports and other roadside safety hardware.

**1975 to 1979:** Served in the U. S. Coast Guard at a variety of search and rescue and aids to navigation stations.

## **PUBLICATIONS**

Dr. Ray has been very active in publishing the results of his scholarship work in a variety of forums over the past 30 years. He has 154 publications including: two manuals that are nationally recognized design manuals, one State-of-the Practice Monograph for the National Academy of Sciences and four major research reports for the National Academy of Sciences; over 60 papers in peer-reviewed journals, over 50 papers in conference proceedings, four broadcast-quality technical videotape presentations, over 20 technical reports published by research sponsors and four articles in trade magazines and professional society publications.

### **Books and Monographs**

1. M. H. Ray and C. E. Carrigan, "Recommended Guidelines for the Selection of Test Levels 2 through 5 Bridge Railings," National Cooperative Highway Research Program Report (In Press), National Academy of Sciences, Washington, D.C., 2014.
2. M. H. Ray, M. Mongardini, C. A. Plaxico and M. Anghileri, "Recommended Procedures for Verification and Validation of Computer Simulations used for Roadside Safety Applications," National Cooperative Highway Research Program Report No. W179, National Academy of Sciences, Washington, D.C., 2012.
3. M. H. Ray, C. A. Plaxico, J. A. Weir, F. Council, Recommended Guidelines for Curb and Curb-Barrier Combinations, National Cooperative Highway Research Program Report No. 537, ISBN 0-309-08920-8, National Academy of Sciences, Washington, D.C., 2005.
4. M. H. Ray, J. A. Weir, J. A. Hopp, In-Service Performance of Traffic Barriers, National Cooperative Highway Research Program Report No. 490, ISBN 0-309-08762-7, National Academy of Sciences, Washington, D.C., 2003.
5. M. H. Ray for AASHTO-ARTBA-AGC Task Force 13, A Guide to Small Sign Support Hardware, American Association of State Highway and Transportation Officials, Washington, D.C., 1998.
6. M. H. Ray and R. G. McGinnis, Guardrail and Median Barrier Crashworthiness, Synthesis No. 244, Transportation Research Board, National Academy of Sciences, Washington, D.C., 1997.
7. M. H. Ray for AASHTO-ARTBA-AGC Task Force 13, A Guide to Standardized Highway Barrier Hardware, American Association of State Highway and Transportation Officials, Washington, D.C., 1995.

### **Journal Articles**

8. C.E. Carrigan and M.H. Ray, "Consideration of Placement Criteria for Utility Poles to Minimize Crash Risk," First International Roadside Safety Research Circular, Transportation Research Board, Washington, D.C., (in review).

9. M.H. Ray, C.E. Carrigan, and C.A. Plaxico, "Heavy Vehicle Encroachment Trajectories," First International Roadside Safety Research Circular, Transportation Research Board, Washington, D.C., (in review).
10. C.E. Carrigan and M.H. Ray, "Assessment of the MASH Heavy Vehicles for Field Relevancy," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., (expected 2017).
11. C.E. Carrigan, M.H. Ray, and A.M. Ray "Evaluating the Performance of Roadside Hardware," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., (expected 2017).
12. C.E. Carrigan and M.H. Ray "A New Approach to Run-off-Road Crash Prediction," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., (expected 2017).
13. C.E. Carrigan and M.H. Ray, "Practitioner's Guide to the Analysis of In-Service Performance Evaluation Data," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., 2016 (accepted, expected 2016).
14. C.E. Carrigan, T.O. Johnson, and M.H. Ray, "Tree Planting and Clearing Guidance with Consideration of Minimized Crash Risk," Transportation Research Board Record 2588, Transportation Research Board, Washington, D.C., 2016.
15. M.H. Ray and C.E. Carrigan, "Use of Risk Analysis to Minimize Adverse Consequences in Nonstandard Designs," Transportation Research Record No. 2521, pg. 109-114, Transportation Research Board, Washington, D.C., 2015.
16. C.E. Carrigan and M.H. Ray, "Proposed Horizontal Curve and Vertical Grade Encroachment Adjustment Factors," Transportation Research Record No. 2521, pg. 94-100, Transportation Research Board, Washington, D.C., 2015.
17. C. E. Carrigan, M. H. Ray and T. O. Johnson, "Understanding Heavy Vehicle Encroachment Frequency," Transportation Research Record 2437, Transportation Research Board, Washington, D.C., 2014.
18. M. H. Ray, C. E. Carrigan, and C.A. Plaxico, "Selection Table Development for Bridge Railing," Transportation Research Record 2437, Transportation Research Board, Washington, D.C., 2014.
19. M. H. Ray, C. E. Carrigan, and C.A. Plaxico, "Method for Modeling Crash Severity with Observable Crash Data," Transportation Research Record 2437, Transportation Research Board, Washington, D.C., 2014.
20. C. E. Carrigan, M. H. Ray and C. A. Plaxico, "Influence of Geometric Design on Roadside Encroachments," 4<sup>th</sup> Urban Street Symposium, Chicago, IL., 2012.
21. C. E. Carrigan, M. H. Ray, and C. A. Plaxico, "Modeling Urban and Suburban Run Off Road Crashes: A Comparison of the RSAP and the Highway Safety Manual," 4<sup>th</sup> Urban Street Symposium, Chicago, IL., 2012.
22. M. Mongiardini, M. H. Ray and C. A. Plaxico, "Development of a Program for the Quantitative Comparison of a Pair of Curves," Int. Journal of Computer Applications in Technology, Vol. 46, No. 2, Interscience Publishers, 2013.
23. D. R. Heath, C. Silvestri, M. H. Ray "A Numerical Investigation of Knee-Thigh-Hip Injuries in Frontal Vehicle Collisions," Transportation Research Record, Transportation Research Board, Washington, D.C., 2012.

24. C. Silvestri, M. H. Ray, "Finite Element Parametric Evaluation of Out-of-Position Failure Modes of the Knee-Thigh-Hip Complex in Frontal Car Crashes", *International Journal of Human Factors Modeling and Simulation*, InterScience Publishers, Vol. 1, No. 3, 2010.
25. C. Silvestri, D. Heath, T. Ruparel, M. H. Ray, "Validation of a Biofidelic LS-DYNA Model and comparison versus a traditional ATD Finite Element Model for Assessing Knee-Thigh-Hip Injuries", *International Journal of Vehicle Safety*, Vol. 5, No. 1, Interscience Publisher, 2010.
26. C. Silvestri, M. H. Ray, "Development of a Finite Element Model of the Knee-Thigh-Hip of a 50th Percentile Male including Ligaments and Muscles", *International Journal of Crashworthiness*, Vol. 14, No. 2, pp: 215-229, 2009.
27. M. Mongiardini, M. H. Ray and M. Anghileri, "Acceptance criteria for validation metrics in roadside safety based on repeated full-scale crash tests," *Int. J. Reliability and Safety*, Vol. 4, No. 1, pp. 69–88, 2010.
28. C. E. Conron, C. Silvestri, C., Gagne, A., Ray, M.H. "Using Public Information and Graphics Software in Graduate Highway Safety Research at Worcester Polytechnic Institute", *Engineering Design Graphics Journal*, 2009.
29. M. H. Ray, C. Silvestri, C. Conron, "Experience With Cable Median Barriers in United States: Design Standards, Policies and Performance," *Journal of Transportation*, Vol. 153 No. 10, American Society of Civil Engineering, , Washington, D.C., October 2009.
30. M. H. Ray, M. Mongiardini and A. Atahan, "Design and Analysis of the Annisquam River Bridge Railing," *International Journal of Crashworthiness*, Vol. 14, No. 2, April 2009.
31. L. R. Peck, K. L. Billiar, and M. H. Ray, "Dynamic Failure Properties of the Porcine Medial Collateral Ligament-Bone Complex: Predicting Injury in Automotive Collisions," *The Open Biomedical Engineering Journal*, Vol. 4, Pg. 71-78,2010.
32. C. Silvestri and M. H. Ray, "Development of a finite element model of the knee-thigh-hip of a 50<sup>th</sup> percentile male including ligaments and muscles," *International Journal of Crashworthiness*, Vol. 14, No. 2, April 2009.
33. "M. H. Ray, E. Oldani and C. A. Plaxico, "Design and Analysis of an Aluminum F-Shape Bridge Railing," In *International Journal of Crashworthiness*, Vol. 9 No. 4 pp. 349-363, London, U.K. 2004.
34. C. A. Plaxico, F. Mozzarelli and M. H. Ray, "Tests and Simulation of a W-Beam Rail-to-Post Connection," In *International Journal of Crashworthiness*, Vol. 8 No. 6, London, U.K. 2003.
35. M. H. Ray and J. A. Weir, "In-Service Performance Evaluation of the Bullnose Median Barriers in Iowa, In *Journal of Transportation Engineering*, American Society of Civil Engineers, Vol. 129, Issue 1, January-February, 2003.
36. P. Tiso, C. A. Plaxico and M. H. Ray, "An Improved Truck Model for Roadside Safety Simulations: Part II -- Suspension Modeling," *Transportation Research Record No. 1797*, Transportation Research Board, Washington, D.C., 2002.
37. P. Tiso, C. A. Plaxico and M. H. Ray, "An Improved Truck Model for Roadside Safety Simulations: Part II -- Suspension Modeling," *Transportation Research Record No. 1797*, Transportation Research Board, Washington, D.C., 2002
38. M. H. Ray and J. A. Weir, "Unreported Collisions with Post-and-Beam Guardrails in Connecticut, Iowa and North Carolina," *Transportation Research Record No. 1743*, Transportation Research Board, Washington, D.C., 2001.

39. M. H. Ray, C. A. Plaxico and K. E. Engstrand, "Performance of W-Beam Splices," ,Transportation Research Record No. 1743, Transportation Research Board, Washington, D.C., 2001.
40. M. H. Ray, C. A. Plaxico, K. E. Engstrand and R. G. McGinnis "Improvements to the Weak-Post W-Beam Guardrail," Transportation Research Record No. 1743,Transportation Research Board, Washington, D.C., 2001.
41. C. A. Plaxico and M. H. Ray, "Comparison of the Impact Performance of the G4(1W) and G4(2W) Guardrail Systems Under NCHRP Report 350 Test 3-11 Conditions," In *Roadside Safety Features and Hydraulic, Hydrology and Water Quality Issues*, Transportation Research Record No. 1720, Transportation Research Board, Washington, D.C., 2000.
42. M. H. Ray and K. Hiranmayee, "Evaluating Human Risk in Side Impact Collisions with Roadside Objects," In *Roadside Safety Features and Hydraulic, Hydrology and Water Quality Issues*, Transportation Research Record No. 1720, Transportation Research Board, Washington, D.C., 2000.
43. M. H. Ray and J. A. Hopp, "Performance of Breakaway Cable and Modified Eccentric Loader Terminals in Iowa and North Carolina," In *Roadside Safety Features and Hydraulic, Hydrology and Water Quality Issues*, Transportation Research Record No. 1720, Transportation Research Board, Washington, D.C., 2000.
44. M. H. Ray, "Safety Effectiveness of Upgrading Guardrail Terminals to Report 350 Standards," In *Roadside Safety Features and Hydraulic, Hydrology and Water Quality Issues*, Transportation Research Record No. 1720, Transportation Research Board, Washington, D.C., 2000.
45. M. H. Ray, K. Hiranmayee and S. Kirkpatrick, "Performance validation of two side impact dummies," In *International Journal of Crashworthiness*, Vol. 4 No. 3, Woodhead Publishing Limited, London, UK, 1999.
46. G. S. Patzner, C. A. Plaxico and M. H. Ray, "Effect of Post and Soil Strength on the Performance of the Modified Eccentric Loader Breakaway Cable Terminal," In *Roadside Safety and Other General Design Issues*, Transportation Research Record No. 1690, Transportation Research Board, Washington, D.C., 1999.
47. M. S. Fitzpatrick, K. L. Hancock and M. H. Ray, "Videolog Assessment of the Vehicle Collision Frequency with Concrete Median Barriers on an Urban Highway in Connecticut," In *Roadside Safety and Other General Design Issues*, Transportation Research Record No. 1690, Transportation Research Board, Washington, D.C., 1999.
48. M. H. Ray, "Impact conditions in side impact collisions with fixed roadside objects," In *Accident Analysis and Prevention*, Vol. 31, No. 1, Pergamon Press, 1999.
49. M. H. Ray, "Safety and Cost-Effectiveness of Clearzones in Rockcuts," In *Journal of Safety Research* Vol. 29, No. 4, American Society of Civil Engineers, Washington, D.C., 1998.
50. M. H. Ray, M. W. Hargrave, J. F. Carney III and K. Hiranmayee, "Side Impact Test and Evaluation Criteria for Roadside Safety Hardware," In *General Design and Roadside Safety Features*, Transportation Research Record No. 1647, Transportation Research Board, Washington, D.C., 1999.
51. C. A. Plaxico, G. S. Patzner and M. H. Ray, "Finite-Element Modeling of Guardrail Timber Posts and Soil-Post Interaction," In *General Design and Roadside Safety*

- Features*, Transportation Research Record No. 1647, Transportation Research Board, Washington, D.C., 1998.
52. M. H. Ray, "The Use of Finite Element Analysis in Roadside Hardware Design," *International Journal of Crashworthiness*, Vol 2, No 4, Woodhead Publishing, London, UK, 1997.
  53. M. H. Ray and G. S. Patzner, "A Finite Element Model of the Modified Eccentric Loader Breakaway Cable Terminal," In Transportation Research Record 1599, Transportation Research Board, Washington, D.C., 1997.
  54. M. H. Ray, "Repeatability of Full-Scale Crash Tests and a Criteria for Validating Finite Element Simulations," In Transportation Research Record No. 1528, Transportation Research Board, Washington, D.C., 1996.
  55. E. Wright and M. H. Ray, "Characterizing Guardrail Steels for LS-DYNA3D Simulations," In Transportation Research Record No. 1528, Transportation Research Board, Washington, D.C., 1996.
  56. M. H. Ray, "The Safety Advisor: A Framework for Performing Roadside Safety Assessments," In Transportation Research Record 1468, Transportation Research Board, Washington, D.C., 1994.
  57. M. H. Ray and J. F. Carney III, "Test and Evaluation Criteria for Side Impact Crash Tests", *ASCE Journal of Transportation*, Vol. 120 No. 4, July/August 1993.
  58. M. H. Ray and J. F. Carney III, "Severity Measures in Side Impact Collisions with Narrow Roadside Structures", *ASCE Journal of Transportation*, Vol. 120 No. 2, 1994.
  59. G.D. Hahn, J. F. Carney III and M. H. Ray, "On the Numerical Evaluation of the Unforced Response of a Duffing Oscillator (Note)", *Journal of Applied Mechanics*, Transactions of the ASME., Vol. 59, March 1992.
  60. G.D. Hahn, J. F. Carney III and M. H. Ray, "Suitability of Numerical Methods for Unforced Duffing Oscillators", *International Journal of Mechanical Engineering Education*, Vol. 20 No. 3, 1991.
  61. M. H. Ray, L.A. Troxel and J. F. Carney III, "Characteristics of Side Impact Accidents involving Fixed Roadside Objects", *ASCE Journal of Transportation*, Vol. 117, No. 3, May 1991.
  62. L. A. Troxel, M. H. Ray and J. F. Carney III, "Side Impact Collisions with Roadside Objects" *Roadside Safety Features*, Transportation Research Record No. 1302, Transportation Research Board, 1991.
  63. J. F. Carney III and M. H. Ray, "Full-Scale Crash Testing of Roadside Safety Appurtenances in the United States", *Journal of Forensic Engineering*, Vol. 2, No. 3, pp. 327-342, 1990.
  64. M. H. Ray and J. F. Carney III, "An Improved Method for Determining Vehicle and Occupant Kinematics in Full-scale Crash Tests," *Design and Testing of Roadside Safety Devices*, Transportation Research Record No. 1233, Transportation Research Board, Washington, D.C., 1989.
  65. D. S. Logie, J. F. Carney III and M. H. Ray, "A Computer Based Methodology for the Generalized Design of the Connecticut Impact Attenuation System," *Design and Testing of Roadside Safety Devices*, Transportation Research Record No. 1233, Transportation Research Board, Washington, D.C., 1989.



66. M. H. Ray, "The Design of Independent Anchor Blocks for Vehicular-Impact Loadings," Roadside Safety Features, Transportation Research Record No. 1133, Transportation Research Board, Washington, DC, 1987.
67. M. H. Ray, J. D. Michie, W.W. Hunter and J. Stutts, "An Analysis of Occupant Injury in Second Collisions," Roadside Safety Features, Transportation Research Record No. 1133, Transportation Research Board, Washington, DC, 1987.
68. M. E. Bronstad, M. H. Ray, J.B. Mayer, Jr., and C. F. McDevitt, "Guardrail Bridge-Rail Transition Evaluations," Roadside Safety Features, Transportation Research Record No. 1133, Transportation Research Board, Washington, DC, 1987.
69. M. E. Bronstad, M. H. Ray, J. B. Mayer Jr., and C. F. McDevitt, "W-Beam Approach Treatment at Bridge Rail Ends Near Intersecting Roadways," Roadside Safety Features, Transportation Research Record No. 1133, Transportation Research Board, Washington, DC, 1987.
70. M. H. Ray, M. E. Bronstad and J. G. Viner, "Importance of Vehicle Structure and Geometry on the Performance of Roadside Safety Features," Vehicle/Highway Infrastructure: Safety Compatibility, Society of Automotive Engineers, Detroit, MI, February 1987.
71. M. H. Ray and J. D. Michie, "Events that Produce Occupant Injury in Longitudinal Barrier Collisions," Roadside Safety, Transportation Research Record No. 1065, Transportation Research Board, Washington, DC, 1986.

### **Conference Proceedings**

72. C.E. Carrigan and M.H. Ray, "Assessing the Field Performance of W-beam Terminals in Washington and Ohio," Road Safety & Simulation International Conference Proceedings, Delft University of Technology and the Dutch Institute for Road Safety Research, The Hague, Netherlands, (in review) 2017.
73. M.H. Ray and C.E. Carrigan, "Meta-Analysis of the Risk of Fatal and Incapacitating Injury in Tangent W-Beam Guardrail Terminal Collisions," Road Safety & Simulation International Conference Proceedings, Delft University of Technology and the Dutch Institute for Road Safety Research, The Hague, Netherlands, (expected 2017).
74. M.H. Ray and C.E. Carrigan, "A Review of Bus Run-off-Road Crashes," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., 2015.
75. C.E. Carrigan, M.H. Ray, T.O. Johnson, and A.M. Ray, "Run-off-road Crash Prediction Models for Each Edge of Undivided and Divided Roadways," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., 2015.
76. C.E. Carrigan and M.H. Ray, "Proposed Heavy Vehicle Encroachment Adjustment Factor," Transportation Research Record No. 2521, pg. 101-108, Transportation Research Board, Washington, D.C., 2015.
77. M.H. Ray, C. E. Carrigan, and C. A. Plaxico, "Estimating Crash Costs in the Updated Roadside Safety Analysis Program," Transportation Research Board Annual Meeting Compendium of Papers, Washington, D.C., 2012.

78. M. H. Ray and C. E. Carrigan, "Methodology for Systematically Comparing Longitudinal Barrier Performance," Transportation Research Board Annual Meeting Compendium of Papers, Transportation Research Board, Washington, D.C., 2014.
79. M. Mongiardini, M. H. Ray, R. Grzebieta and M. Bambach, "Verification and Validation of Models Used in Computer Simulations of Roadside Barrier Crashes," Proceedings of the 2013 Australasian Road Safety Research, Policing and Education Conference, Brisbane, Australia, 28-30 August, 2013.
80. C. E. Carrigan and M. H. Ray, "Incorporating Measurable Outcomes into the Highway Design Process: A Case Study to Demonstrate Highway Safety Improvements," In Urban Transport XVII, Proceedings of the Urban Transport and Environment in the 21<sup>st</sup> Century Conference, Pisa, Italy, WIT Press, 2011.
81. C. E. Carrigan and M. H. Ray, "A Proposed Performance-Based Highway Design Process: Incorporating Safety Considerations," In Urban Transport XVII, Proceedings of the Urban Transport and Environment in the 21<sup>st</sup> Century Conference, Pisa, Italy, WIT Press, 2011.
82. C. Silvestri, S. Mendes and M. H. Ray, "Characterization of Human Lower Limb Tissue Model for Occupant Injury Prediction in Frontal Car Impacts," Paper No. IMECE2010-40498, American Society of Mechanical Engineers, International Mechanical Engineering Conference and Exhibition, Vancouver, BC, Canada, November 2010.
83. C. Silvestri, D. Heath, M. H. Ray, "An LS-DYNA Model for the Investigation of the Human Knee Joint Response to Axial Tibial Loadings", 11<sup>th</sup> International Users LS-DYNA Conference, Dearborn, Michigan, USA, 2010.
84. S. Mendes, C. Silvestri, M. H. Ray, "Investigation of LS-DYNA Modeling for Active Muscle Tissue", 11<sup>th</sup> International Users LS-DYNA Conference, Dearborn, Michigan, USA, 2010.
85. C. Silvestri, T. Ruparel, M. H. Ray, "An Augmented Finite Element Model of Femur for Simulations Involving Frontal Impacts", 36<sup>th</sup> Annual Northeast Bioengineering Conference, New York, 2010.
86. D. Heath, C. Silvestri, T. Ruparel, M. H. Ray, "A Biofidelic Finite Element Model for Knee-Thigh-Hip Injury Prediction in Frontal Car Crashes", 18<sup>th</sup> Annual Symposium On Computational Methods in Orthopaedic Biomechanics, Tulane University, New Orleans, Louisiana, 2010.
87. C. Silvestri, M. H. Ray, "An LS-DYNA Finite Element Parametric Study for Relation of Out-of-Position Failure Modes of the Lower Extremity to Abbreviated Injury Scale Level 2+ and 3+", ASME International Mechanical Engineering Congress and Exposition, Lake Buena Vista, FL, 2009.
88. C. Silvestri, R. L. Peck., K. L. Billiar, M. H. Ray, "Validation of a New Finite Element Model for Human Knee Ligaments for Use in High Speed Automotive Collisions", 2009 Summer Bioengineering Conference, Lake Tahoe, CA, 2009.
89. C. Silvestri, M. H. Ray, "Finite Element Investigation of Out-of-Position Failure Modes for the Knee-Thigh-Hip of a 50<sup>th</sup> Percentile Male During a Frontal Car Crash", 2009 Summer Bioengineering Conference, Lake Tahoe, CA, 2009.
90. M. Mongiardini, C. Silvestri, M. H. Ray, "Quantitative Validation of a Finite Element Model of a Knee-Thigh-Hip Complex of a 50<sup>th</sup> Percentile Male", 2009 Summer Bioengineering Conference, Lake Tahoe, CA, 2009.

91. C. Silvestri, M. Mongiardini, M. H. Ray, "Improvements and Validation to an LS-DYNA Model of the Knee-Thigh-Hip of a 50<sup>th</sup> Percentile Male Including Muscles and Ligaments", LS-DYNA Conference, Salzburg, Austria, 2009.
92. C. Silvestri, M. H. Ray, "An LS-DYNA Finite Element Parametric Study for Relation of Out-of-Position Failure Modes of the Lower Extremity to Abbreviated Injury Scale Level 2+ and 3+", Proceedings of ASME International Mechanical Engineering Congress and Exposition, Lake Buena Vista, FL, 2009.
93. Conron, C.E., Silvestri, C., Gagne, A., Ray, M.H., Using Public Information and Graphics Software in Graduate Highway Safety Research at Worcester Polytechnic Institute, American Society for Engineering Education, Engineering Design Graphics Division, 63rd Annual Midyear Meeting Conference Proceedings, January 2009.
94. C.E. Conron and M.H. Ray, "Incorporating Crash Costs into Highway Cost Analysis," American Association of State Highway and Transportation Officials, National Value Engineering Conference Proceedings, September 2009.
95. M. Mongiardini, C. Silvestri, M. H. Ray, "Quantitative Validation of a Finite Element Model of a Knee-Thigh-Hip Complex of a 50th Percentile Male", 2009 Summer Bioengineering Conference, Lake Tahoe, CA, 2009.
96. C. Silvestri, R. L. Peck, L. K. Billiar and M. H. Ray, "Validation of a New Finite Element Model for Human Knee Ligaments for Use in High Speed Automotive Collisions", 2009 Summer Bioengineering Conference, Lake Tahoe, CA, 2009 .
97. C. Silvestri and M. H. Ray, "Finite Element Investigation of Out-of-Position Failure Modes for the Knee-Thigh-Hip of a 50th Percentile Male During a Frontal Car Crash", 2009 Summer Bioengineering Conference, Lake Tahoe, CA, 2009.
98. C. E. Conron, C. Silvestri and M. H. Ray, "A Policy Recommendation for the Reduction of Tree Crashes", Transportation Research Forum 50th Annual Forum Conference Proceedings, Portland, Oregon, March 2009.
99. C. E. Conron, C. Silvestri, A. Gagne and M. H. Ray, "Using Public Information and Graphics Software in Graduate Highway Safety Research at Worcester Polytechnic Institute", American Society for Engineering Education 63rd Annual Midyear Meeting, California, USA, January 2009.
100. M. H. Ray, M. Mongiardini and C. A. Plaxico, "Validation of Finite Element Models for Approving the Use of Roadside Safety Hardware", 10th US National Congress on Computational Mechanics, Columbus, OH, July 16 – 19, 2009.
101. M. H. Ray and A. Atahan, "Using Finite Element Analysis to Design Roadside Hardware", Proceedings of the 10th International Conference on Applications of Advanced Technologies in Transportation, Athens, Greece, 2008.
102. M. H Ray, M. Anghileri, M. Mongiardini, "Comparison of validation metrics using repeated full-scale automobile crash tests," *Proceedings of IACM - ECCOMAS 2008*, 5<sup>th</sup> European Congress on Computational Methods in Applied Sciences and Engineering, Venice, Italy, June 2008.
103. M. H. Ray, C. Silvestri, C.E. Conron and R.B Albin, "Assessment of fatality risk in collisions with cable median barriers in the State of Washington," *Proceedings of Risk Analysis 2008*, Wessex Institute, Cephalonia, Greece, May 2008.
104. M. H. Ray and A. Atahan, "Using Finite Element Analysis To Design Roadside Hardware", *Proceedings of the 10th International Conference on Applications of Advanced Technologies in Transportation*, Athens, Greece, 2008.

105. Karl Barth, Richard McGinnis and Malcolm Ray, "Development of an Improved Roadside Barrier System Phase I," Research Results Digest No. 273, National Cooperative Highway Research Program, Transportation Research Board, Washington, D.C., 2003.
106. F. Orengo, C.A. Plaxico and M. H. Ray, "Modeling Tire Blow-out in Roadside Hardware Simulations Using LS-DYNA," *Proceedings of the Annual Meeting*, American Society of Mechanical Engineers, Reston, VA, 2003.
107. M. H. Ray *et al*, "In-Service Performance of Traffic Barriers," Research Results Digest No. 273, National Cooperative Highway Research Program, Transportation Research Board, Washington, D.C., 2003.
108. M. H. Ray, "Preliminary Recommendations for Performing Side Impact Crash Tests of Roadside Safety Features," In *Issues for Improving Roadside Safety*, Transportation Research Circular, Transportation Research Board, Washington, D.C., 1999.
109. M. H. Ray, "The Importance of In-Service Performance Evaluation of Roadside Safety Features," In *Issues for Improving Roadside Safety*, Transportation Research Circular, Transportation Research Board, Washington, D.C., 1999.
110. C. A. Plaxico, G. S. Patzner and M. H. Ray, "Finite Element Modeling of a Guardrail Post Mounted in Soil," In *Proceedings of the 12th Engineering Mechanics Conference*, Society of Civil Engineers, Reston, VA, 1998.
111. M. H. Ray, K. Hiranmayee and S. Kirkpatrick, "Performance validation of two side impact dummies," In *International Crashworthiness Conference*, Proceedings of IJCRASH'98, Woodhead Publishing Limited, London, UK, 1998.
112. J. Wekezer, R. Wuttrich, M. Ramaley and M. H. Ray, "Design Flaws and Structural Retrofit Analysis of Existing BCT Terminals," In *International Crashworthiness Conference*, Proceedings of IJCRASH'98, Woodhead Publishing Limited, London, UK, 1998.
113. M. H. Ray and G. S. Patzner, "A Finite Element Model of the Modified Eccentric Loader Breakaway Cable Terminal," In Conference Proceedings FHWA Vehicle Crash Analysis, Federal Highway Administration, FHWA-RD-96-212, Washington, D.C., 1997.
114. M. H. Ray, "Finite Element Analysis of the Modified Eccentric Loader Breakaway Cable Guardrail Terminal," In Proceedings of the 32nd Annual Society of Engineering Science, New Orleans, LA, 1995.
115. M. H. Ray, "Finite Element Analysis as a Tool in Roadside Safety Hardware Design," In *Issues for Improving Roadside Safety*, Transportation Research Circular 453, Transportation Research Board, Washington, D.C., 1996.
116. M. H. Ray, J. F. Carney III, and K. S. Opiela, "Summary of Roadside Safety Issues," In *Issues for Improving Roadside Safety*, Transportation Research Circular 453, Transportation Research Board, Washington, D.C., 1996.
117. M. H. Ray, "The Safety Advisor: An Interactive Object-Oriented Program for Assessing the Safeness of Roadway and Roadside Designs," In Proceedings of First Congress on Computing in Civil Engineering, American Society of Civil Engineers, New York, 1994.
118. M. H. Ray, "Quantifying Safety and Managing the Roadside Environment", In *Issues Surrounding Highway and Roadside Safety Management*, Transportation Research Circular No. 416, Transportation Research Board, Washington, D.C., 1993.
119. M. H. Ray, "Safety Management and the Assessment of Highway Designs," Proceedings of the Strategic Highway Research Program and Traffic Safety on Two Continents, Vagoch Trafik-Institutet, Linkoping, Sweden, September 1991.

120. J. F. Carney III and M. H. Ray, "Side Impact Crash Testing of Highway Safety Hardware," Proceedings of the Strategic Highway Research Program and Traffic Safety on Two Continents, Vag-och Trafik-Institutet, Linköping, Sweden, September 1991.
121. M. H. Ray and D.S. Logie, "An Object-Oriented Approach to Warranting Roadside Safety Hardware", Proceedings of the ASCE 6th Conference on Computing in Civil Engineering, September 1989.
122. J. F. Carney and M. H. Ray, "Safety Performance Evaluation of 21st Century Appurtenances", American Society of Civil Engineers, Engineering 21st Century Highways, San Francisco, CA, April 1989.
123. M. H. Ray and J. F. Carney, "Use of Accelerometer Data to Estimate the Kinematics of Automobile Occupants during Collisions", Proceedings of the Structures Under Shock and Impact Conference, Cambridge, MA, July 1989.
124. M. H. Ray, "An Object-Oriented Approach to Warranting Roadside Safety Hardware," In Proceedings of the Sixth Congress on Computing in Civil Engineering: Computers in Engineering Practice, American Society of Civil Engineers, New York, 1989.
125. M. H. Ray and J. F. Carney, "The Use of Vehicle Acceleration Data to Estimate the Kinematics of Automobile Occupants during Collisions", Proceedings of the First International Conference on Structures under Shock and Impact, Cambridge, MA, July 1989.
126. J. F. Carney, J.R. Veillette, and M. H. Ray, "Energy Dissipation Properties of Laterally Crushed Tubes and Tubular Clusters", Proceedings of the Seventh Conference on Vehicle Structural Mechanics, p.169, Society of Automotive Engineers, Detroit, MI, April, 1988.
127. M. H. Ray, J. D. Michie and M.W. Hargrave, "Occupant Risk in Longitudinal Barrier Collisions," Effectiveness of Highway Safety Improvements, Highway Division of the American Society of Civil Engineers, New York, NY, March 1986.
128. J. D. Michie, M. H. Ray and W.W. Hunter, "Hazardous Events After Re-directional Collisions," Effectiveness of Highway Safety Improvements, Highway Division of the American Society of Civil Engineers, New York, NY, March 1986.
129. M. H. Ray, "The Design of Reinforced Concrete Members Using an Expert System," Applications of Artificial Intelligence to Engineering Problems, Proceedings of the 1st International Conference, A Computational Mechanics Publication, Southampton, U.K., April 1986.

#### **Articles in Trade Magazines**

130. M. H. Ray, J. F. Carney III, and K. S. Opiela, "Emerging Roadside Safety Issues," in TR NEWS No. 177, National Research Council, Transportation Research Board, March-April, 1995.
131. M. H. Ray, "Metrication of Standard Guardrail Designs," In Public Roads, Vol. 59, No. 1, Federal Highway Administration, Washington, D.C., Summer 1995.
132. M. H. Ray, "Using Finite Element Analysis in Designing Roadside Hardware," In Public Roads, Vol. 57, No. 4, Federal Highway Administration, Washington, D.C., 1994.

#### **Films and Videotapes**

133. M. H. Ray, Aesthetic Bridge Rails and Guardrails, produced for the Federal Highway Administration, 1992.

134. M. H. Ray, Concrete Bridge Railings, produced for the Federal Highway Administration, 1992.
135. M. H. Ray, The Modified Thrie Beam Guardrail, produced for the Federal Highway Administration, 1992.
136. M. H. Ray, Cable Guardrails, produced for the Federal Highway Administration, 1992.

## Technical Reports

137. M. H. Ray, C. A. Plaxico and C.E. Carrigan, "Roadside Safety Analysis Program (RSAP) User's Manual," Roadsafe LLC, rsap.roadsafellc.com, October 25, 2012.
138. M. H. Ray, C. A. Plaxico and C.E. Carrigan, "Roadside Safety Analysis Program (RSAP) Engineer's Manual," Roadsafe LLC, rsap.roadsafellc.com, October 25, 2012.
139. M. H. Ray, C. A. Plaxico and C.E. Carrigan, "Roadside Safety Analysis Program (RSAP) Programmer's Manual," Roadsafe LLC, rsap.roadsafellc.com, October 25, 2012.
140. M. H. Ray and M. Mongiardini, "LS-DYNA Crash Simulations of the Annisquam River Bridge for Report 350 Test level three Conditions," Report for the Massachusetts Highway Department, August 30, 2007.
141. Douglas B. MacDonald and John R. Batiste, "Cable Median Barrier Reassessment and Recommendations," (Chapter 1 and Appendix B authored by M. H. Ray), Washington State Department of Transportation, Olympia, Washington, 29 June 2007.
142. M. H. Ray, C. A. Plaxico and E. Oldani, "Performance of the Alberta Weak-Post W-Beam Guardrail," Report for the Alberta Department of Transportation, Alberta, Canada, 10 April 2005.
143. K. Barth, M. Ray, R. McGinnis, "Development of an Improved Roadside Barrier System -- Phase I," Research Results Digest No. 273, National Cooperative Highway Research Program, Washington, D.C., February 2003.
144. K. E. Engstrand, M. H. Ray, C. A. Plaxico and R. G. McGinnis, "Improvements to the Weak-Post W-Beam Guardrail," Final Report, Pennsylvania Department of Transportation, Harrisburg, PA, 2001.
145. D. Shauer, F. Tokarz, G. Kay, A. Lee, R. Logan, E. Coffie and M. H. Ray, Preliminary Vehicle Impact Simulation Technology Advancement (Pre-VISTA), Report No. FHWA-RD-96-059, Federal Highway Administration, Washington, D.C., February 1997.
146. A. E. Wright and M. H. Ray, Characterizing Roadside Hardware Materials for LS-DYNA3D Simulations, Report No. FHWA-RD-96-108, Federal Highway Administration, Washington, D.C., February 1997.
147. M. H. Ray, Quantifying the Safeness of Highway Designs, Ph.D. Dissertation, Vanderbilt University, May 1993.
148. M. H. Ray and J. F. Carney III, Side Impact Crash Testing of Roadside Structures, Federal Highway Administration, FHWA-RD-92-079, Washington, D.C., 1992.
149. M. H. Ray and J. F. Carney III, Side Impact Test and Evaluation Procedures for Roadside Structure Crash Tests, Federal Highway Administration, FHWA-RD-92-062, Washington, D.C., May 1993.
150. M. H. Ray and J. E. Bryden, Summary Report on Selected Guardrails, Federal Highway Administration, FHWA-SA-92-049, Washington, D.C., 1992.

151. M. H. Ray, Summary Report on Selected Bridge Railings, Federal Highway Administration, FHWA-SA-92-050, Washington, D.C., 1992.
152. M. H. Ray and J. E. Bryden, Summary Report on Selected Aesthetic Bridge Rails and Guardrails, Federal Highway Administration, FHWA-SA-92-051, Washington, D.C., 1992.
153. L. A. Troxel, M. H. Ray, and J. F. Carney III, Accident Data Analysis of Side-Impact, Fixed-Object Collisions, Federal Highway Administration, FHWA-RD-91-122, Washington, D.C., 1992.
154. J. B. Mayer and M. H. Ray, Full-Scale Vehicle Crash Tests of the V-LOC Mailbox Support System, Foresight Products Inc., Northglenn, CO, 1987.
155. M. H. Ray and M. A. Scofield, CRASH3 User's Manual, National Highway Traffic Safety Administration, Washington, DC, 1986.
156. M. E. Bronstad, L. R. Calcote, M. H. Ray and J. B. Mayer, Guardrail-Bridge Rail Transition Designs, Federal Highway Administration, Washington DC, June 1986.
157. M. H. Ray and J. B. Mayer, Full-Scale Crash Tests of the EZE-ERECT Sign Support, Vol. 1-2, Franklin Steel Co., Franklin, PA, 1986.
158. M. H. Ray and J. D. Michie, Evaluation of Design Analysis Procedures and Acceptance Criteria for Roadside Hardware, Volumes 1-6, Final Report, Federal Highway Administration, Washington, DC, 1985.
159. M. H. Ray, Geophysical Sensors for Use in Construction Robotics, Masters Thesis, Carnegie Institute of Technology, Carnegie-Mellon University, Pittsburgh, PA, 1984.

### **Patents**

1. Malcolm H. Ray and Chuck A. Plaxico, "Variable force energy dissipater and decelerator," Patent 20,040,011,615, January 22, 2004
2. John F. Carney III, Malcolm H. Ray, "Reusable High Molecular Weight/ High Density Polyethylene Guardrail," 6,637,971 B1, October 28, 2003.

### **Sponsored Research Projects**

Dr. Ray has nearly 30 years of experience in attracting and performing sponsored research work. During his career he has served as the principal investigator on nearly 60 projects worth over \$10 million. He has worked for the most prestigious sponsors in the field of roadside and highway safety including the Federal Highway Administration, the National Highway Traffic Safety Administration, the National Cooperative Highway Research Program as well as many State Departments of Transportation, commercial organizations and the National Science Foundation.

1. "Recommended Guidelines for the Selection and Placement of Test Levels 2 through 5 Median Barriers," National Cooperative Highway Research Program (NCHRP) Project 22-31, National Academy of Sciences, \$300,000.
2. "Development of a Strategic Plan for the AASHTO SCOD Technical Committee on Roadside Safety (TCRS)," National Cooperative Highway Research Program (NCHRP) Project 20-7(360), National Academy of Sciences, \$75,000.
3. "TF13 On-Line Barrier Hardware Guide," AASHTO-ARTBA-AGC Task Force 13, \$50,000.
4. "Roadway Departure Technology Transfer – Finite Element Analysis," Subcontract from KLS Engineering, LLC, \$40,700.

5. "Development of a Bridge Railings for Steel Decked Through-Truss Bridges," Structural Bridges, Quebec, QC, \$50,000.
6. "Guidelines for Shielding Bridge Piers," National Cooperative Highway Research Program (NCHRP) Project 12-90, National Academy of Sciences, \$450,000.
7. "Criteria for Restoration of Longitudinal Barriers – Phase II," National Cooperative Highway Research Program (NCHRP) Project 22-28, National Academy of Sciences, \$300,000.
8. "Consideration of Roadside Features in the Highway Safety Manual," National Cooperative Highway Research Program (NCHRP) Project 17-54, National Academy of Sciences, \$800,000.
9. "Recommended Guidelines for the Selection of Test Level 2 through 5 Bridge Railings," National Cooperative Highway Research Program (NCHRP) Project 22-12(03), National Academy of Sciences, \$250,000.
10. "Update of the Roadside Safety Analysis Program (RSAP)," National Cooperative Highway Research Program (NCHRP) Project 22-27, National Academy of Sciences, \$600,000.
11. "Development of Verification and Validation Procedures for Computer Simulation use in Roadside Safety Applications," National Cooperative Highway Research Program (NCHRP) Project 22-24, National Academy of Sciences, \$300,000.
12. "Development of an On-Line Guide to Luminaire Supports," Wyoming Department of Transportation Pooled Fund Study, 2007.
13. "Center for Collision Trauma Protection," 3<sup>rd</sup> year funding, National Highway Traffic and Safety Administration (NHTSA), U.S. Department of Transportation, \$350,000.
14. "LS-DYNA Crash Simulation of the Annisquam River Bridge for Report 350 Test Level Three Conditions," Massachusetts Highway Department, \$30,000.
15. "Evaluation of a New Guardrail Post Concept," Interstate Steel Company, \$2,000.
16. Development of an On-Line Guide to Small Sign Support Hardware, National Cooperative Highway Research Program, Project 20-7(214), 2006.
17. Development of an On-Line Guide to Bridge Railing Hardware, National Cooperative Highway Research Program, Project 20-7(196), 2006.
18. "Blunt Trauma Chest Simulator Project," Battelle Memorial Laboratories, \$15,000.
19. "Center for Collision Trauma Protection," 2<sup>nd</sup> year funding, National Highway Traffic and Safety Administration (NHTSA), U.S. Department of Transportation, \$1,670,000.
20. Development of an On-Line Guide to Roadside Hardware, National Cooperative Highway Research Program, Project 20-7(192), 2005.
21. Consultant, "Update of the Alberta Roadside Design Guide", National Capitol Engineering, Toronto, Canada, 2005.
22. Consultant, "Update of the Ontario Roadside Design Guide", National Capitol Engineering, Toronto, Canada, 2005.
23. "Structural Adequacy of a Stepped Constant Slope Median Barrier Using the AASHTO Bridge Specification LRFD Method," Leighton Contractors (Asia) Ltd., Manila North Tollways Project, Pulilan Interchange, Brgy Tibag, Pulilan, Bulacan, Philippines, 2005.
24. "Center for Collision Trauma Protection," 1<sup>st</sup> year funding, National Highway Traffic and Safety Administration (NHTSA), U.S. Department of Transportation, \$347,000.
25. "Finite Element Analysis of an F-Shape Truss-Core Aluminum Barrier," Valentine Industries, OH, 2004.



26. "Evaluation and Testing of Alberta's Weak-Post W-beam Guardrail System," Providence of Alberta, Canada, \$40,467.
27. "ATSSA Guardrail Installation Level II Training Course," American Traffic Safety Services Association, \$4,000.
28. "ATSSA Guardrail Installation Level II Training Course," American Traffic Safety Services Association, \$29,075.
29. "Design and Analysis of an Aluminum Bridge Parapet and Median Barrier," Valentine Inc., \$9,000.
30. "Simulation and Analysis of Guardrail System Impacted by a 3/4 ton Pickup Truck", Battelle Memorial Labs, \$9,900.
31. "Simulation and Analysis of Guardrail System Impacted by a 3/4 ton Pickup Truck", Battelle Memorial Labs, \$5,000.
32. "Impact Testing of Reinforced Concrete Beams," APTEK, Inc., \$24,419.
33. "Simulation and Analysis of Guardrail System Impacted by a 3/4 ton Pickup Truck", Battelle Memorial Labs, \$5,000.
34. "Simulation and Analysis of Guardrail System Impacted by a 3/4 ton Pickup Truck", Battelle Memorial Labs, \$23,000.
35. "Side Impact: Finalizing the Test Procedures and Preliminary Countermeasures," Subcontract from the University of Iowa for the Federal Highway Administration, \$60,000.
36. "ATSSA Guardrail Installation Training Course," American Traffic Safety Services Association, \$17,867.
37. "Center of Excellence in DYNA3D Analysis," Federal Highway Administration, \$49,850.
38. "Development of an Improved Roadside Barrier System," Subcontract from the University of West Virginia for the National Cooperative Highway Research Program, Project 22-16, \$60,792.
39. "Acquisition of Structural Mechanics Tester," National Science Foundation, Major Research Instrumentation Program NSF 99-168, \$143,093.
40. "Design Alternatives for the Weak-Post W-beam Guardrail System," Subcontract from Bucknell University for the Pennsylvania Department of Transportation, \$8,023.
41. "Center of Excellence in DYNA3D Analysis," Federal Highway Administration, \$50,000.
42. "Recommended Guidelines for Curbs and Curb-Barrier Combinations," National Cooperative Highway Research Program Project 22-17, \$300,000.
43. "Design Alternatives for the Weak-Post W-beam Guardrail System," Subcontract from Bucknell University for the Pennsylvania Department of Transportation, \$35,906.
44. "In-Service Evaluation of Traffic Barriers," National Cooperative Highway Research Program Project 22-13(2), \$280,000.
45. "In-Service Evaluation of Traffic Barriers in Iowa," Iowa Department of Transportation, Project 19.2, \$94,255
46. "Side Impact: Finalizing the Procedures," Federal Highway Administration, \$168,291.
47. "Acquisition of a High Performance Computing Environment," National Science Foundation, \$503,000.
48. "In-Service Evaluation of Traffic Barriers in Iowa," Iowa Department of Transportation Project 19.2, Iowa Department of Transportation, Washington, D.C., \$100,000.
49. "In-Service Evaluation of Traffic Barriers," National Cooperative Highway Research Program Project 22-13, National Academy of Sciences, Washington, D.C., \$500,000.

50. "Development of Finite Element Models for Roadside Safety Applications," Federal Highway Administration, Washington, D.C., \$106,000.
51. "Side Impact Test and Evaluation Procedures," Federal Highway Administration, Washington, D.C., \$430,000.
52. "Simulation of Roadside Safety Structures," Federal Highway Administration, Washington, D.C., \$158,000.
53. "Roadside Safety Issues Conference," National Cooperative Highway Research Program, National Academy of Sciences, Washington, D.C., \$20,000.
54. "Guardrail and Median Barrier Crashworthiness: A Synthesis of Highway Practice," National Cooperative Highway Research Program, National Academy of Sciences, Washington, D.C., \$25,000.
55. "Roadside Safety Issues Conference, National Cooperative Highway Research Program, National Academy of Sciences, Washington, D.C., \$20,000.
56. "Research Associate, Nonlinear Finite Element Simulation Studies with DYNA3d, Momentum Engineering. Assigned to FHWA's Design Concepts Research Division, \$26,000.
57. "Conceptual Requirements for an Interactive Highway Design Model," Momentum Engineering for Federal Highway Administration, \$35,200.
58. "Updated Materials for a Traffic Barrier Hardware Guide," Project 22-10, Momentum Engineering for National Cooperative Highway Research Program, \$350,000.
59. "Technical Sharing Materials on Selected Bridge Rails and Guardrails, Momentum Engineering for Federal Highway Administration, \$138,000.
60. "Side Impact Crash Testing, Vanderbilt University, Federal Highway Administration, \$350,000.
61. "An Expert System for Warranting Roadside Safety Hardware, Vanderbilt University, University Transportation Research Center Program, U.S. Department of Transportation, \$40,000.
62. "Revision of the CRASH3 User's Manual, Southwest Research Institute, National Highway Traffic and Safety Administration, \$19,000.
63. "Vehicle Crash Tests of EZE-ERECT Small Sign Support, Southwest Research Institute, Franklin Steel, Inc.

### **Litigation Consulting**

Dr. Ray has provided litigation support, reports and testimony in nearly 100 litigation cases. To-date he has been hired by the defense in about 70 (i.e., 70%) cases and by the plaintiff in about 30 (i.e., 30%).

1. Holmes v. Ford Motor Co. (CA), retained by Joseph Carcione, Jr. of Redwood, CA on 22 January 1992 on behalf of the plaintiff. Status: Settled.
2. Gkitzias v. FL DOT (FL) retained 21 November 2000 by Micheal Audie on behalf of the plaintiff, Status: Settled.
3. Van Vegten v. Abari Construction (IL), retained by Mary Hartigan of Stein, Ray and Harris, Chicago in 2000 on behalf of the defendant. Status: Settled.
4. Murphy v. Lussier (ME), retained by Paul Dumas of Mexico, ME in 2000 on behalf of the plaintiff. Status: not filed.

5. Turner v. State of Tennessee (TN), retained by Rebecca Lyford of the Tennessee Department of Transportation Legal Division on 30 May 2001 on behalf of the defendant, deposed 17 August 2001, provided expert report 25 July 2001. Status: Settled.
6. Kellison v. Worden (MA), retained on 5 September 2001 by Kenneth Brown of Sullivan and Greg of Nashua, NH, on behalf of the plaintiff, Status: Settled.
7. Tully v. State of Iowa (IA), retained 24 October 2001 by Richard Mull of Iowa Department of Transportation Legal Division on behalf of the defendant. Status: Case dropped by plaintiff.
8. Trinity Industries v. Kothman Enterprises (TX Fed.), Civil Action No. 1-98CV1623, retained 5 August 2002 by Casey Griffin of Carstens, Yee and Cahoun on behalf of the plaintiff. Provided expert report 21 November 2002, Status: Settled.
9. North v. Salem County (NJ), retained 14 January 2003 by Ernest Alvino of Hoffman, DiMuzio and Hoffman on behalf of the plaintiff. Provided expert report March 2006, Status: pending. Status: Settled.
10. Chamberlain v. State of California (CA), retained 14 January 2003 by Steven Dadaian of CALTRANS Legal Division on behalf of the defendant, Deposed 04-18-03, Status: Settled.
11. Combs v. State of Ohio (OH), retained 14 February 2003 by Robert Traci of Traci and Marx, of Cleveland, OH on behalf of the plaintiff. Provided expert report 14 April 2005. Status: Settled.
12. Newhart v. Trinity Industries (FL), retained 26 February 2003 by Clyde Murphree of Jacksonville, FL on behalf of the defendant, Provided affidavit on 6 May 2003. Status: Settled.
13. Kothman Enterprises, Inc. v. Trinity Industries (TX Fed.), Civil Action No. H-01-2668, retained 20 March 2003 by Mr. Steven Ross of Gardere Wynne and Sewell L.L.P., on behalf of the defendant, Trinity Industries. Provided expert testimony and report, Status: Settled.
14. Ochoa v. Williams Brothers Construction, Inc. (TX), Cause No. 079-02-H, retained 20 June 2003 by Paula Wyatt of the Wyatt Law Firm, Corpus Christi, TX on behalf of the plaintiff. Reviewed materials and provided opinions, Status: Settled.
15. Hamilton v. Clermont County (OH), retained 29 September 2003 by Mr. Steven Halper of Katzman, Logan, Halper and Bennet of Cincinnati, OH on behalf of the plaintiff. Status: Complete.
16. Shaw v. Arizona DOT (AZ), Civil Action No. RSK02-05842, retained 22 December 2003 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 12 May 2005, rebuttal report and testimony at trial. Status: Jury verdict for defendant.
17. DeVries v. Arizona DOT (AZ), Civil Action No. RSK03-01852, retained 22 December 2003 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided affidavit, expert report on 17 August 2005, rebuttal report 15 February 2006, deposition and trial testimony. Status: Jury verdict for defendant.
18. Jeanisee v. Arizona DOT (AZ), Civil Action No. RSK G2003-04249, retained 30 December 2003 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Status: Settled.

19. Sharpe v. Arizona DOT (AZ), Civil Action No. RSK03-02459, retained 5 January 2004 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 23 August 2005. Status: Settled.
20. Lehnerz v. Arizona DOT (AZ), Civil Action No. RSK G2004-20047, retained 12 February 2004 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Status: Settled.
21. Genduso v. Arizona DOT (AZ), Civil Action No. RSK G2004-20008, retained 6 February 2004 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Status: Settled.
22. Napolitano v. Mass Turnpike Authority (MA), Retained 26 May 2004 by Edward McIntyre on behalf of the plaintiff. Status: Case withdrawn by Plaintiff.
23. Lechuga v. State of California et al (CA) , Retained 13 May 2004 by Mr. Barry Rodolff, Campion Rodolff LLP on behalf of one of the defendants. Also retained by Wilson, Kenna and Borys on behalf of a co-defendant. Status: Defendants dropped from action.
24. Ceciliano v. City of New York (NY), Retained 30 September 2004 by Andrew Pillersdorf of Gary Pillersdorf and Associates P.C. on behalf of the plaintiff. Prepared expert report. Status: Settled.
25. Torok v. State of California (CA), Civil Action SCC No. VCVVS 033801, retained 15 November 2004 by Steven Dadaian of CALTRANS Legal Division on behalf of the defendant, Status: Presumed settled.
26. Cruz v. State of California (CA), Los Angeles County BC321308, retained 5 September 2005 by Steven Dadaian of CALTRANS Legal Division on behalf of the defendant, Status: Presumed settled.
27. Johnson v. Arizona DOT (AZ), retained 10 October 2005 by Mr. Kevin Bonner, Office of the Attorney General of Arizona, on behalf of the defendant. Status: Settled.
28. Cook and Miller v. Florida Turnpike Authority (FL), retained 15 December 2005 by Susan Levy of Levy and Pruett on behalf of the plaintiff, Status: Presumed settled.
29. Brandt v. Trinity Industries (MO), retained May 2006 by Martin Buckley of Buckley and Buckley LLC on behalf of the defendant. Provide affidavit 25 June 2007, deposed 25 August 2007. Trial testimony September 13, 2007, Status: Jury verdict for defendant.
30. Ross v. PCC Construction , retained by Mr. Eric Johnson of Gregory Wright Law Offices, S.C., on behalf of the defendant. Provided affidavit February 2007 and deposed 10 April 2007. Status: Settled.
31. Alvarado v. Interstate Steel (TX), retained 14 June 2006 by Shalimar Wallis of the Watts Law Firm on behalf of the plaintiff. Provided expert report 6 October 2006. Deposed 13 July 2007. Status: Settled.
32. Bayze v. Arizona DOT (AZ), Pima County Superior Court, No. C20062272, retained October 2006 by Mr. Bryan Schmid, Office of the Attorney General of Arizona, on behalf of the defendant. Prepared Expert Report May 16, 2007, Deposed July 11, 2007, Testified at trial 6 August 2008. Status: Jury verdict for defendant.
33. Biggers v. ODOT (OH), retained by Mr. David Deutsch on behalf of the plaintiff. Provided affidavit 3 August 2009, expert report on 11 December 2009 and a deposition on 29 October 2010. Status: Settled.
34. Brown v. Verizon (MA), Civil Action No. 04-11924 RGS, retained 17 January 2007 by Mr. Joshua Levin of Prince, Lobel, Glovsky and Tye LLP on behalf of the defendant. Provided affidavit 12 march 2007. Status: Settled.

35. Morgan v. Arizona DOT (AZ), Maricopa County Superior Court CV2006-002287, retained 1 February 2007 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 6 April 2007 and rebuttal report. Status: Settled.
36. Melvin v. Arizona DOT (AZ), Maricopa County Superior Court CV2006-002287, retained 1 February 2007 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 19 February 2008, rebuttal report, declaration and affidavit. Status: Settled.
37. Cila v. Massachusetts Turnpike Authority (MA), retained 20 May 2007 by Ms. Annette Gonthier and Associates on behalf of the plaintiff, performed site measurements 30 September 2007, provided affidavit and expert report 3 November 2009. Status: Settled.
38. Reboloso v City of Garland, Texas (TX), retained 24 May 2007 by Richard Harrell of the Edwards Law Firm on behalf of the plaintiff. Status: Settled.
39. Barnard v. Trinity Industries (AL), retained 12 March 2007 by Michael Knight of the McDowell Knight Law Firm on behalf of the defendant. Status: Settled.
40. Dunlap v. Arizona DOT (AZ), Maricopa County Superior Court CV2006-008606, retained 26 April 2007 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided a declaration 26 June 2008, 5 August 2008, expert report 14 November 2008 and rebuttal report 8 May 2009. Status: presumed settled.
41. Torres v. Arizona DOT (AZ), Maricopa County Superior Court CV2006-019365, retained 6 September 2007 by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 12 March 2008. Status: Settled.
42. Blalock v. Usher and TN DOT (TN), Retained 15 August 2008 by Ms. Dawn Jordan, Office of the Attorney General of the State of Tennessee on behalf of the defendant. Provided deposition on 21 October 2008 and Trial testimony 21 January 2009. Status: Jury verdict for Plaintiff, reversed by trial judge for defendant, reversal upheld on appeal by plaintiff in February 2011.
43. Sweeny v. Trinity Industries (NJ), retained 18 August 2008 by Mr. Roger Kaplan on behalf of the defendant. Provided certification 6 August 2009, expert report 30 June 2009 and supplemental report 12 September 2009. Status: summary judgment for defendant.
44. Kuminkoski v. Trinity Industries (PA), Retained 18 August 2008 by Mr. Anthony Giaramita on behalf of the defendant. Provided expert report on 15 August 2008. Status: summary judgment for the defense.
45. Ringen et al v. State of Washington (WS), retained by Mr. John Kirschner, Office of the Attorney General of the State of Washington on behalf of the defendant on July 15, 2008. Status: Settled.
46. Cummin v. DeSouza and Canada Post (ON), Retained December 2008 by Mr. Duncan Embury of Torkin Manes, Toronto, Canada. Provided Expert Report 30 January 2008. Status: Settled
47. Knapp et al v. State of Washington (WS), retained by Mr. John Kirschner, Office of the Attorney General of the State of Washington on behalf of the defendant on July 15, 2008. Status: Settled.
48. Jones v. State of Washington (WS), retained by Mr. John Kirschner, Office of the Attorney General of the State of Washington on behalf of the defendant on July 15, 2008. Status: Settled.

49. Bolton v. ADOT (AZ), retained by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 23 January 2009. Status: dismissed by Plaintiff with prejudice.
50. Sheets/Yanovskaya v. ADOT (AZ), retained by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 29 May 2009, supplement, declaration and trial testimony 4-5 February 2013. Status: Jury verdict for defense.
51. Keller v. ADOT (AZ), retained by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 30 June 2009 and declaration on 28 October 2009. Status: Settled.
52. Shaw v. Trinity Industries (TX), Retained by Attorney Russell Brown on behalf of the defendant. Provided expert report February 13, 2009. Status: Summary judgment for defendant.
53. Benjamin v. City of New York (NY), Retained by Attorney William Galina on February 24, 2009 on behalf of the plaintiff. Status: Presumed settled.
54. Gaitan v. Gibraltar Cable Barrier Systems et al (FL), retained by Mr. Scott Leeds of The Cochran Law Firm on behalf of the plaintiff. Status: Settled.
55. Herd v. Trinity Industries (KY), retained by Mr. Russell Brown in May 2010 on behalf of the defendant. Status: dismissed by the Plaintiffs.
56. Small v. Trinity Industries (WV), retained by Mr. Russell Brown on behalf of the defendant. Status: summary judgment for the defendant.
57. Mata v. Energy Absorption Systems et al (TX), Retained by Attorney Lansford Ireson of Ireson and Weizel PC on behalf of the defendant on February 25, 2009. Status: Summary judgment for defendant.
58. Lehtinen v. Watson Construction (WS), retained by Mr. Kerry Gress of Floyd, Pflueger and Ringer on behalf of the defendant, Status: Summary Judgment for Defendant.
59. Carrier v. Trinity Industries (TN), retained by Mr. Russell Brown on behalf of the defendant on 16 April 2010, Status: In-Progress.
60. Singley v. Trinity Industries (MS), retained by Mr. Russell Brown on behalf of the defendant on 18 May 2010, Status: Summary judgment for defendant.
61. Glazer v. ADOT (AZ), retained by Mr. Steven LaMar, Office of the Attorney General of Arizona, on behalf of the defendant. Provided expert report 29 December 2009, two supplements and trial testimony 7 February 2012, Status: Jury verdict for Plaintiff.
62. Gregory v. City of Independence, MO et al., (MO) Retained by Attorney John Tuner on behalf of Plaintiff on 17 August 2009. Status: Settled.
63. Prichett v. ADOT (AZ), retained 22 April 2011 by Mr. Terry Harrison, Office of the Attorney General of Arizona on behalf of the defendant. Status: In progress.
64. Madden v. Town of Greene, New York, Retained by Attorney Arthur Thorn of Thorn Gershon Tymann and Bonanni LLP August 2011 on behalf of the plaintiff. Status: Settled.
65. Thibodeaux v. Louisiana DOT, (LA) Retained 29 July 2011 by Lirette and Gary LLC on behalf of the plaintiff. Status: Settled.
66. Humphrey v. ADOT, (AZ) Retained September 23, 2011 by Fred Zeder of the Arizona Attorney General's Office on behalf of the defendant, provided expert report 24 September 2012 and testified at trial on 9 December 2015. Status: Jury verdict for Plaintiff.

67. Pike v. Trinity Industries, (FL) Retained 27 January 2012 by Russell Brown on behalf of Trinity Industries. Status: Summary judgment for the defendant.
68. Kishka v. SCDOT, Bagwell Fence and Elderlee, Retained 28 February 2012 by Joseph Rohe of Smith-Moore Leatherwood on behalf of Elderlee. Engaged by Claude Prevost on behalf of Bagwell fence. Status: Settled.
69. Mauer v. Massachusetts Turnpike Authority (MA), retained November 2012 by Ms. Annette Gonthier and Associates on behalf of the plaintiff, performed site measurements 14 November 2012. Status: Settled.
70. Barnet v. State of Tennessee (TN), retained by Rebecca Lyford of the Tennessee Department of Transportation Legal Division on 10 September 2012 on behalf of the defendant, provided expert report 30 November 2012. Status: case dismissed.
71. Duncan v. State of Tennessee (TN), retained by Rebecca Lyford of the Tennessee Department of Transportation Legal Division on 17 August 2012 on behalf of the defendant, provided expert report 29 September 2012. Status: Settled.
72. Morales v. Bay LTD, Trinity Highway Products and Exodyne Technologies, (TX) retained by Russell Brown on behalf of Trinity Highway Products, inspected vehicle and site 20 June 2012 and provided expert report 24 July 2012. Status: Trinity dismissed.
73. Gamarra v. Gibraltar, et al, (FL) retained by Joshua E. Polsky of Kubicki and Draper on behalf of defendant Gibraltar on January 2013. Status: Settled.
74. Coy v. ADOT (AZ), retained 10 October 2013 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Status: Settled.
75. Kingsbury v. ADOT (AZ), retained 29 May 2013 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Status: Settled.
76. Janesh v. ADOT (AZ), retained 17 May 2014 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Status: In progress.
77. Laffoon v. ADOT (AZ), retained October 2013 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Provided expert report 11 December 2014 and deposition testimony 9 April 2015. Status: In progress.
78. Pereira v. ADOT (AZ), retained 12 September 2013 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Expert report 16 April 2014. Status: In progress.
79. Heimann v. Bulter County Motorplex, retained 7 February 2012 by Inserra and Kelly on behalf of the plaintiff. Expert report submitted 23 August 2013. Status: In progress.
80. Williams v. Fletcher Creamer and Son, et al, (NY) retained 18 September 2013 by Mr. David Kuk of Malapero, Prisco, Klauber and Licata LLP on behalf of the defendant. Status: In progress.
81. Teague v Elderlee, et. al., (SC) retained 27 September 2013 by Mr. Joseph Rohe of Smith, Moore and Leatherwood LLP on behalf of the defendant. Status: Elderlee dismissed.
82. Antonicelli v. Trinity Highway Products, retained 28 August 2013 by Russell Brown PC on behalf of the defendant. Status: In progress.
83. Dryer v. Trinity Highway Products, retained 27 August 2013 by Russell Brown PC on behalf of the defendant. Status: In progress.
84. Mulawka v. Trinity Highway Products, retained 27 August 2013 by Russell Brown PC on behalf of the defendant. Status: dismissed by plaintiff.
85. Flores v. Energy Absorption Systems, (NM) retained 30 August 2013 by Russell Brown PC on behalf of the defendant. Status: In progress.

86. Gonzales v. Trinity Highway Products, retained 29 September 2013 by Russell Brown PC on behalf of the defendant. Status: Summary Judgment for Defendant.
87. Swayampakala v. Trinity Highway Products, (CA) retained 30 August 2013 by Russell Brown PC on behalf of the defendant. Status: In progress.
88. Harman on behalf of the United States v. Trinity Highway Products, (US TX Eastern District) Retained 25 February 2013 by Russell Brown PC on behalf of the defendant. Issued expert report May 24, 2014, Supplemental Report on July 8, 2014 and 2<sup>nd</sup> Supplemental Report on October 20, 2014. Supplied depositions on June 17, 2014 and October 10, 2014 and trial testimony on July 17, 2014 and October 17, 2014. Status: Jury verdict for the plaintiff.
89. Reynolds v. ADOT (AZ), retained 17 October 2013 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Status: Settled.
90. Pappakostas v. Trinity Highway Products, (CA) retained 11 April 2014 by Russell Brown PC on behalf of the defendant. Status: In progress.
91. McIntyre v. Nickelston Industries, (NC) retained 10 March 2014 by Benjamin Chesson PC on behalf of the defendant. Provided deposition testimony 19 June 2014. Status: In progress.
92. Teague v SCDOT, (SC), retained March 2014 by Mr. W. McElhaney White of Holcombe Bomar, P.A. on behalf of the defendant. Status: Settled.
93. Elsevir v. Trinity Highway Products, (TN) retained 27 February 2014 by Russell Brown PC on behalf of the defendant. Status: Dismissed by Plaintiff.
94. Benson v. Trinity Highway Products, (TX) retained 3 October 2014 by Russell Brown PC on behalf of the defendant. Status: In progress.
95. Ablen v. Trinity Highway Products, (MO) retained 23 September 2014 by Martin Buckley on behalf of the defendant. Status: In progress.
96. Bichekas v. Massachusetts Turnpike Authority (MA), retained March 2015 by Ms. Annette Gonthier-Kiely on behalf of the plaintiff, Status: Settled.
97. Crooks v SCDOT, (SC), retained March 2015 by Mr. W. McElhaney White of Holcombe Bomar, P.A. on behalf of the defendant. Status: In progress.
98. Williams v. Trinity Highway Products, (AL) retained 8 June 2015 by Russell Brown PC on behalf of the defendant. Status: In progress.
99. White v. ADOT (AZ), retained 8 October 2014 by Mr. Fred Zeder, Office of the Attorney General of Arizona on behalf of the defendant. Status: Dismissed by Plaintiff.
100. Washington v. Trinity Highway Products, (NC) retained 13 January 2016 by Russell Brown PC on behalf of the defendant. Status: In progress.