NAFE Winter Meeting Technical Program – Saturday, January 23, 2016 – Tampa – Expected presentations:

GENERAL SESSION "A" – morning

Author: Laura Liptai, PhD (NAFE 887 Associate Member)

Title: BioMedical Engineering Evidence-Based Analytical Methods

Abstract: This paper reports examples of how biomedical engineering contributed to the analyses of vehicular, pedestrian versus auto, bicycle versus auto and motorcycle impacts. Examples illustrate where the biomedical engineer offered insights beyond quantification of forces/accelerations and contributed to the analysis of causation and liability. Comparing information from experiments and/or biomedical analysis of the physical evidence, the biomedical engineer can supplement traditional accident reconstruction deductions.

Testing methods are also discussed to illustrate how case-specific experiments can be performed to acquire data not available by traditional sources. Data collection follows federal standards, acquiring data using software at a frequency of 10,000 HZ utilizing a 4^{th}-order Butterworth filter with a cut off frequency of 1650 HZ, as per SAE J211. To determine and replicate impact speeds, an inverted pendulum impact protocol was utilized onto the same type of surfaces impacted in the case. Triaxial piezoelectric ICP accelerometers were instrumented onto an anthropometric crash test dummy head and neck. Multi-axial direct contacts to different surfaces and modes were then studied.

Author bio: Dr. Liptai (BioMedical Engineering, PhD, MS; Mechanical Engineering, BS) specializes in biomedical engineering analysis of human trauma and accident reconstruction. Dr. Liptai has testified in over 100 trials in the United States as well as military assignments on the North American continent, Europe, and South America. Dr. Liptai serves on five boards (AAFS, IBFES, LEADR, UCDBME and SFES as President) and had the privilege of reviewing the engineering chapter in the Reference Manual on Scientific Evidence, 2^{nd} Edition for the Judicial Research Center in WDC.

Author: John Leffler, PE (NAFE 709 Senior Member)

Title: Forensic Considerations Regarding Traction and Tribometry of Bathing Surfaces

Abstract: In the mid 1970s, the federal Consumer Product Safety Commission funded a study of injury patterns on bathing surfaces. The study found the majority of injuries were due to slips and falls, and tribometry research was conducted (with the cooperation of bathing surface manufacturers) to come up with a test specification and minimum traction threshold. The standard that resulted in 1979, ASTM F462, was a positive step forward — but, over time, the shortcomings of this long-obsolete standard have become increasingly evident. Nevertheless, F462 remains the sole codified standard for bathing surface traction in the United States. This paper will discuss the limitations of F462, the use (and misuse) of the standard in claims resolution and litigation, the efforts to modernize F462, and some considerations for investigating bathing surface incidents.

Author bio: John Leffler is a mechanical engineer with Forcon International in Atlanta. He earned his bachelor's degree from Georgia Tech, where he also currently lectures (part-time) in Industrial Design. He designed consumer products for Motorola, Herman Miller, Sears, and other companies for 10 years before beginning forensic work. Prior to college he was a race car mechanic, machinist, and fabricator for 8 years (including on an Indy 500-winning team). Mr. Leffler's main areas of expertise are vehicle, machinery, and product design, as well as pedestrian safety. He was lead author of two ASTM standards, and remains active in standards development. He is the Technical Review Committee Chair for NAFE as well as the 2016 President of the Academy.

Author: Maurice Cueva-Eguiguren, PE (NAFE 776 Senior Member)

Title: Forensic Engineering Analysis of a Sequence of Power Infrastructure Failures atop an Office Building

Abstract: A series of equipment failures occurred in a high rise office building in Puerto Rico. The top 18^{th} floor was occupied by the infrastructure systems, including heating, air conditioning, electrical and plumbing systems and two 1,500kVA emergency generators, which provided power for the entire building when the utility power was not available. The first failure occurred on the

3,000kVA, 13.8kV/480-277VAC step down power transformer on a Sunday night — the day after annual maintenance of the electrical equipment took place. Failure of this transformer resulted in the operation of the two emergency generators, last maintained a month earlier. The second failure occurred in one of the two control panels associated with the day tanks for the emergency generators due to power disturbances (harmonics) in the electrical distribution system in the building. This resulted in an overflow of oil in one of the day tanks (615 gallon) and the spill of approximately 1,000 gallons of fuel oil on the 18th floor and lower floors, including the cellar.

Author bio: Maurice Cueva-Eguiguren, president of Acticon Engineering, P.C. has more than 38 years of electrical engineering experience, including managing and overseeing multi-discipline engineering and design services for projects related to the electric utilities, industrial, commercial, residential and government markets. Utility projects include fossil and nuclear fueled power plants and substations up to 765kV. Also provides forensic engineering services for various investigations related to electrical engineering systems and equipment.

Author: Paul Kamen, PE (NAFE 731 Member) and Chris Barry, PE

Title: Forensic Engineering of Personal Watercraft Off-Throttle Steering Accidents

Abstract: Personal watercraft (PWC), or "jet skis" as they are commonly called, account for a disproportionately large number of serious boating accidents. A major contributing factor is off-throttle steering. PWCs are propelled by a water jet and steered by directing the jet nozzle. When power is cut, as in a panic stop, all steering response is lost almost immediately. This has been compared to driving a car that disconnects the steering when the gas pedal is released, and there are no brakes. Methods of establishing off-throttle steering as a risk factor, possible design work-arounds, regulatory history, and full-scale testing programs are discussed in this presentation.

Author bio: Paul Kamen is an independent naval architect specializing in small craft accident reconstruction, surface-piercing propulsion, planing hull performance and urban ferry system design. He holds a B.S. in naval architecture and marine engineering from Webb Institute of Naval Architecture (1973) and an M. Eng. in Naval Architecture from the University of California at Berkeley (1979). Paul has been a senior naval architect for Morris Guralnick Associates in San Francisco, where he developed preliminary designs for large-scale Ocean Thermal Energy Conversion (OTEC) power plants. He has been Applications Naval Architect at Arneson Marine (then in Corte Madera) and currently consults from his office in Berkeley, CA.

Author bio: Chris Barry is a graduate of the University of California, Berkeley in Mechanical Engineering specializing in Naval Architecture and Marine Engineering. He is currently a senior naval architect with the U. S. Coast Guard Surface Forces Logistics Center, naval architecture section, providing engineering support for design, acquisition, new construction, maintenance, and upgrades for the Coast Guard's fleet of boats and small cutters, including response boats, surf rescue boats, cutter embarked boats, smaller aids to navigation craft, and patrol boats. Prior to the Coast Guard, he was chief engineer at small shipyards in San Diego and Seattle, design firms in San Francisco and Seattle, a defense contractor in San Jose, and offshore oil firms in San Francisco and London.

Author: John Certuse, PE (NAFE 708 Fellow)

Title: Forensic Engineering Investigation of PVC Piping Failures in Multistory Condominium Building

Abstract: Polyvinyl chloride (PVC) piping systems in larger commercial buildings are subjected to greater stresses due to normal building movement, when segment length, diameter, and schedule are increased (in comparison to smaller residential installations). The likelihood for increased stresses in larger system installations must be recognized and accommodated for in the initial piping system design. Performance aspects, such as thermal expansion and building settling, must be considered as well as piping configurations and hanger support placement. This paper addresses the investigation methodology used to identify the causes and responsible party of chronic building construction defects that resulted in water and mold damage to a recently renovated multistory multi-use condominium building.

Author bio: John Certuse is a licensed professional engineer and director of engineering at ISE Engineering in Attleboro, MA. ISE Engineering performs forensic engineering examinations for the insurance industry with a large concentration based upon heating system failures.

VEHICLES TRACK - afternoon

Author: Richard Ziernicki, PhD, PE (NAFE 308 Fellow) and William Pierce (NAFE 846 Correspondent)

Title: Advanced Forensic Engineering Analysis of a School Bus/Tractor Trailer Crash

Abstract: This paper presents a state of the art technique to reconstruct a motor vehicle accident involving a fully loaded semi and school bus with 17 young students. The accident reconstruction included a high definition laser scanning, surveillance video analysis, PC Crash simulation, and finally photo match animation. Furthermore, analysis of the occupant kinematics (velocities) and dynamics (acceleration and forces) is performed and discussed. The reconstruction was then compared to a report and analysis performed by the National Transportation Safety Board (NTSB), which was also involved in the accident reconstruction. Multiple graphics are used to demonstrate the accident reconstruction and occupant kinematics and dynamics.

Author bio: Richard Ziernicki, chairman and CEO of Knott Laboratory, has evaluated several thousand industrial and vehicular accidents. He has presented papers and lectured at technical conferences in the United States, Europe, and South America. He is the author of more than 60 publications, primarily in the fields of mechanical engineering and vehicle accident reconstruction. His accident reconstruction expertise has been featured more than 30 times on local and national television including the Discovery Channel, Dateline NBC, Dr. Oz Show, MSNBC, FOX News Channel, and National Geographic Channel on the Princess Diana accident, the Air France Flight 447 accident, and more. Dr. Ziernicki was a member of several past SAE Standards Committees. He is past president and current board member for the National Academy of Forensic Engineers and also serves on many committees for the organization. Dr. Ziernicki has testified in court a few hundred cases and has been deposed more than 500 times. He has testified on behalf of clients such as U.S. Department of Justice, U.S. Department of Defense, State of Colorado Attorney General's Office, District Attorneys, and Public Defenders.

Author bio: William Pierce is a forensic engineer employed by Knott Laboratory, LLC, a forensic engineering and animation company founded in 1982. Pierce has a bachelor's of science degree in mechanical engineering from Purdue University (West Lafayette, IN) and is a licensed professional engineer. He gained interest in forensic engineering while interning with Rimkus Consulting Group, Inc. over two summers during college. After graduating in 2009, Pierce began working full-time for Rimkus Consulting Group, Inc., where he gained experience developing and testing tribometers and investigating motor vehicle accidents and product failures. In 2012, he began working at Knott Laboratory, LLC where he has investigated a variety of motor vehicle accidents involving pedestrians, motorcycles, cars, and heavy commercial vehicles. Pierce has also investigated numerous product liability claims involving consumer products, heavy commercial vehicles, and material handling equipment. In addition, he has published technical papers with the National Academy of Forensic Engineers and American Society of Mechanical Engineers.

Author: Bill Lee, PhD, PE (NAFE 655 Senior Member)

Title: Injury Biomechanics – An Engineering Discipline?

Abstract: Engineers with expertise in biomechanics are often retained by attorneys to provide analysis and render opinions in the area of injury biomechanics. Typically, an individual is making an injury claim as the result of a specific event, such as a vehicular collision, slip and fall, falling object, etc. Forensic engineering experts are retained to provide opinions in areas such as what types of forces might have been experienced by the claimant, what types of injury mechanisms might have been established (or not), etc. During the litigation process, it is not uncommon for opposing counsel to present an argument that "injury biomechanics" is a subject of medicine; therefore, only an M.D. can offer any such opinions. Stated alternately, a PhD in an appropriate area of engineering is not qualified to do so since "biomechanics" is not a subject of any engineering discipline. It should be noted that there are indeed opinions such as: was the claimant injured; was the diagnosis appropriate; was the treatment appropriate, issues related to impairment, etc. However, the argument that engineers cannot offer injury biomechanics opinions because "biomechanics" is a medical subject (not an engineering one) is invalid. Evidence to support this claim will be presented from the following sources: 1) an analysis of engineering academic programs in this country where biomechanics and related subjects are taught; 2) an analysis of

medical academic programs; 3) an analysis of established research groups/centers/institutes/etc. in the area of injury biomechanics; 4) an analysis of the literature in injury biomechanics (coauthor status, affiliations, etc.) and subject areas addressed (including methodology); and 5) other relevant information. The results of this investigation will clearly show that biomechanics and the focus area of injury biomechanics are clearly grounded in engineering.

Author bio: Bill Lee is a professor in the Department of Chemical & Biomedical Engineering at the University of South Florida since 1985 and also has research affiliations at the VA Hospital and Florida Orthopaedics Institute. He has been providing forensic engineering analysis with a focus on biomechanics for the last 22+ years. Bill has published widely in the areas of biomechanics and related subjects in forensic engineering.

Author: Daniel Melcher, PE (NAFE 711 Senior Member) and Rachel Keller, PE (NAFE 873 Member)

Title: Forensic Engineering Technology Solutions for Highway Work Zone Temporary Traffic Control Investigations

Abstract: Incidents or collisions involving pedestrians, bicyclists, motorcycles, automobiles, or tractor-trailers frequently occur in areas affected by highway construction projects. When such events arise, the ensuing claims or litigation process usually concerns whether or not the temporary traffic control (TTC) system in place at the time was compliant with the applicable standard of care. Due to the short-term and constantly changing nature of construction projects and work zones, the hardest challenge for the forensic engineer is often to determine what exactly was in place at the time and location of the incident. This paper will introduce and expound on the application of modern technology solutions to address these questions. Data sources to be discussed include numerous sources of time-stamped photographs, potential video capture of the work zone, aerial photography methods, and 3D scanning technology. Methods for extraction of useful information from the raw data will be addressed, along with examples and case studies demonstrating the engineering application of this data to the underlying legal questions.

Author bio: Daniel Melcher is a Professional Engineer in the field of Transportation Safety Engineering and has practiced in Forensic Engineering for 15 years. He is currently the Director of Engineering for Focus Forensics LLC.

Author bio: Rachel E. Keller is a Professional Engineer in Mechanical Engineering and has practiced in Forensic Engineering for 15 years. Her primary practice involves accident reconstruction. She is currently a Managing Engineer for Focus Forensics LLC.

Author: Martin Gordon, PE (NAFE 699 Senior Member)

Title: Highway Accident Rates for Deaf and Hard of Hearing Drivers – Forensic Engineering Application

Abstract: According to the World Health Organization, there are more than 360 million people worldwide with hearing loss. The National Highway Traffic Safety Administration has reported that close to 30% of the United States population 65 years or older has significant hearing loss. The objective of this study was to determine if deaf and hard of hearing drivers are more likely to be involved in motor vehicle accidents than hearing drivers. Data was extracted from the National Automotive Sampling System (NASS) and motor vehicle accident records from the Rochester Institute of Technology (RIT) and National Technical Institute for the Deaf (NTID) campuses. The results of the NASS data analysis indicate that deaf and hard of hearing drivers are one and a half to nine times as likely to be seriously injured or killed in a motor vehicle accident. Motor vehicle accident records from RIT and NTID suggest that deaf and hard of hearing drivers are approximately three times as likely to be involved in a motor vehicle accident as hearing individuals. Forensic engineers may be able to use this data to assist in establishing cause in cases where drivers with hearing loss or physical limitations are involved.

Author bio: Martin Gordon is Professor and Program Director for Undergraduate Studies in the Manufacturing and Mechanical Engineering Technology department at the Rochester Institute of Technology. He has been teaching at RIT since 1995. Martin specializes in Traffic Accident Reconstruction, Product Liability and Machinery Accidents. He is a NAFE Senior Member and serves on the Board of Directors. He is past Chairman of the Western New York Section of SAE and is the Faculty Advisor for the RIT Baja SAE team. Martin is a past recipient of RIT's Provost's Excellence in Teaching Award. Research interests involve accident reconstruction, highway safety and human factors.

Author: Donn Peterson, PE (NAFE 239 Fellow)

Title: Forensic Engineering Analyses of Trailer Sway-Induced Vehicle Crashes

Abstract: The author was retained to evaluate parameters and variables involved in causation of trailer sway that led to a fatal crash in a freeway re-construction zone. An understanding of the unstable operation of the SUV and camper trailer combination was desired in order to assess the driver's contributory negligence compared to negligence of other parties. The author developed a mathematical model that incorporates more parameters and is an expansion of the basic mathematical model discussed by Hans B. Pacejka in the 2006 SAE publication "Tire and Vehicle Dynamics." Relevant fourth order linear differential equations, solutions, and stability criteria are presented and discussed.

GENERAL SESSION "B" - afternoon

Author: Jerry Tindal, PE (NAFE 642 Member)

Title: Forensic Engineering Analysis of a Shopping Mall Explosion

Abstract: When a catastrophic explosion occurs, widespread attention is rapidly captured by the mainstream news outlets and subsequently the public. Substantial investigative resources from both public and private sectors are quickly poured into determining the cause of the event so that appropriate actions can be implemented to avoid future occurrences. On May 7, 2009, a catastrophic explosion occurred at a shopping mall located just outside of Washington, D.C. in Forestville, MD. As a result of the explosion, several persons, including multiple firefighters, were injured, and a large portion of the mall was destroyed. This paper examines the cause of the explosion.

Author bio: Jerry Tindal is a licensed professional engineer in 20 states. He holds both a Bachelor of Science and Master of Science in Mechanical Engineering from the University of South Carolina. Jerry is a Certified Fire and Explosion Investigator by the National Association of Fire Investigators and was also a Certified State Fire Marshal while employed with the South Carolina State Fire Marshal's Office. He currently serves as a governor-appointed board member on the South Carolina Liquefied Petroleum Gas Board.

Author: Daniel Arthur, PE (NAFE 908 Member)

Title: Gas Well Integrity and Associated Gas Migration Investigations in the Marcellus Shale

Abstract: The Marcellus Shale is one of the largest natural gas fields in the world and has been the site of a massive natural gas development effort, involving hundreds of oil & gas companies. With the onslaught of the shale revolution, developers moved into states like Pennsylvania and began drilling and completing gas wells by the hundreds. This development occurred so rapidly, attention to issues such as wellbore methane intrusion was not initially given the priority it demanded in all cases. This led to instances of alleged gas migration and impacts to groundwater supplies in several areas of the region. Although there has been an onslaught of evaluations geared toward the study of groundwater contamination, the author has researched gas wells themselves. Based on thousands of wellbore integrity studies in the Marcellus and other worldwide shale regions, this paper will summarize the forensic processes, analysis methods, and approaches used in assessing wellbore integrity as part of a gas migration investigation. The paper will also present details that pertain to remedial alternatives and approaches to wells requiring attention.

Author bio: Dan Arthur is a registered professional petroleum engineer specializing in fossil energy, planning/engineering analysis and environmental issues. He has 30 years of diverse experience that includes work in industry, government and consulting. Dan Arthur is a founding member of ALL Consulting and has served as the company's President since its inception in 1999. Prior to founding ALL Consulting, Arthur served as a Vice President of a large international consulting engineering firm managing the firm's upstream energy business. Arthur's experience also includes serving as an enforcement officer and National Expert for the U.S. Environmental Protection Agency (EPA); a drilling and operations engineer with an independent oil producer; and supporting both cementing and completion operations for a large international services company.

Author: Mark Webster, PE (NAFE 868 Member)

Title: Forensic Engineering Analysis of the Instability of a Wheeled Cart Used to Move a Large Sculpture

Abstract: A large sculpture overturned and injured a worker while it was being transferred on a wheeled dolly from a delivery truck onto a dock lift. Determining the motion at the time of this accident required calculation of the mass properties of an irregular object. Although this is most easily completed by approximating the distribution of mass of the object by discretizing it into a number of smaller masses, a more accurate method is to scan the object through the use of lasers or photogrammetry, creating a "point cloud" of data representing the surface. This raw data is then processed and converted to a solid model. Conventional mechanical CAD and multi-body physics software is then used to determine the mass properties and ultimately to calculate and illustrate the dynamic motion.

Author bio: Mark Webster has a BSME from Milwaukee School of Engineering, MSME and MBA from Marquette University. He has more than 30 years of experience in the custom-engineered material handling industry, including conveyors, material lifts, and industrial controls. Training and experience in dynamic analysis and multi-body physics software. Has been practicing Forensic Engineering since 2009. Member of the ASME B20.1 Safety Standard for Conveyors and Related Equipment. Vice Chair of the ASME Board on Safety Codes and Standards.

Author: Mark Kittel, PE (NAFE 757 Member), Allen Molitoris, PE (NAFE 464 Correspondent), Olof Jacobson, MS, PE (NAFE 496 Fellow), Stephen Batzer, PhD, PE (NAFE 677 Member), Jesse Grantham, PhD, PE (NAFE 597 Senior Member), Guy Barbera, PE (NAFE 732 Member)

Title: Forensic Engineering Analysis of Failed UTV Roll Cages

Abstract: Two cases were analyzed that involved rollover accidents of the same model side-by-side utility terrain vehicle (UTV). In each case, the UTV ran over a bump on a dirt road and rolled over. The roll cages collapsed, exhibiting similar failure modes, and the drivers were seriously injured. The design and failure modes of the roll cage structure were analyzed. Engineering analysis included vehicle dynamics, laboratory testing, finite element modeling, and fundamental mechanical engineering design concepts. The suitability of the design and the existing standards for roll cages were evaluated in the context of the subject UTV's overall performance capabilities and foreseeable use. Reasonable design improvements were recommended.

Author bio: Mark Kittel is a principal engineer at Veritech Engineering who specializes in accident reconstruction and product failure analysis, with an emphasis on issues involving on-road motorcycles, dirt bikes, ATVs, and UTVs. He is a former professional motorcycle road racer and previously worked as a product development engineer for Honda R&D of America. His experience as a testing and development engineer gives him extensive knowledge and industry experience related to product design and product development as well as experience with numerous manufacturing methods and processes.

Author bio: Allen Molitoris is a Principal Engineer with Jacobson Forensic Engineering, Inc. He is a licensed professional engineer who specializes in vehicle accident reconstruction, mechanical failure analysis and product defect investigations. He conducts forensic investigations of vehicle accidents involving all types of commercial and passenger vehicles, bicycles, motorcycles and pedestrians. Molitoris provides engineering services for both plaintiff and defense cases. Prior to entering the field of forensic engineering, he worked as a mechanical systems design engineer for new aircraft development and as a mechanical engineer designing components for a laser-based industrial furnace monitoring system. His background enables him to analyze mechanical failures associated with manufacturing equipment, machine guarding and safety devices, and consumer products.

Author: Jim Petersen, PE (NAFE 631 Senior Member)

Title: FE Analysis of Unvented Gas Appliances in High Altitudes

Abstract: A family moves into a house about 4,000 feet above sea level. They use a refrigerator powered by LP gas. A short time after the refrigerator was installed, they notice and complain about smells and soot. They take their 9-month-old to a hospital in response to his persistent crying. A short time later, they notify the refrigerator manufacturer, who examines and tests the refrigerator. They find the refrigerator's burner venturi blocked, generating high levels of carbon monoxide (CO). Twelve years later,

the parents bring a lawsuit against the installers of the refrigerator. The appliance is not available, and the house has been remodeled. A forensic engineering study is assigned to determine the effect high altitude has on this particular appliance design.

Author bio: James Petersen graduated in 1975 with BS degrees in mathematics and mechanical engineering. He was employed by a valve manufacturer for 20 years. Introduced to forensic engineering in 1988, he started Petersen Engineering in 1995. He specializes in products liability matters involving propane and natural gas.

Also – on Sunday afternoon (January 24)

Author: Harold Josephs, PhD, PE (NAFE 295 Fellow)

Title: Bulldozer Visibility Impairments and Landfill Operations Defects Result in a Serious Injury: A Case Study

Abstract: This case study reviews the hazards involved with the work procedures and work environment combined with large mobile equipment associated with a landfill operation. An active landfill is a very busy work environment. There typically is a constant stream of municipal solid waste (MSW) trucks of various sizes and dimensions approaching and dropping their waste load onto the landfill active work area, which is referred to as the landfill face or tipping area. In addition to the MSW delivery truck traffic, the active face in this case study was being traversed back and forth by two large industrial vehicles: one a bulldozer (or tracked vehicle) and the other a wheeled compactor vehicle. The injured party, who was just transferred to the job of "waste spotter," or just spotter, had the responsibility of directing the incoming stream of MSW trucks as to where to dump their loads while also directing (and avoiding) the tracked loader bulldozer and the wheeled compactor vehicle as they operated on the landfill active face. Additionally, due to the dumped MSW, the active landfill face topography is constantly changing, and the pedestrian spotter therefore must constantly be moving on the active face to avoid being struck by the vehicular traffic. The bulldozer manufacturer acknowledged that the bulldozer travels in reverse approximately fifty percent of its operating time on the landfill space. Hence, any static visibility impairments were further compounded when the bulldozer traveled in reverse over changing topography. Other issues that negatively affected the landfill face hazardous environment were a lack of any safety procedures for the landfill face and a lack of hazard training and instructions provided to the waste spotter working the landfill face. Another issue involving this case study was the existence of a vertically gas vent pipe located in the tipping area that had to be avoided by the tipping area truck traffic.

Author bio: Harold Josephs is a Professor Emeritus at Lawrence Technological University. Dr. Josephs is the author of numerous technical papers and is the co-author of two engineering texts. He has nine patents and he has presented numerous seminars to industry focusing on quality, safety, fastening and joining.