



GARY J. NOVAK, Ph.D., P.E.
SENIOR CONSULTANT

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Dr. Novak is a mechanical engineer in ESi's Mechanics Practice with over 40 years of experience in the application of engineering mechanics, mechanical analysis and design, research, and failure analysis to a range of project areas. His project work and fields of expertise include: failure analysis, machine design, stress analysis, fatigue analysis, vibration analysis and control, mechanical dynamics, bolted joint design and analysis, sealing systems, design and analysis of composite, polymer, and rubber components, design and analysis of powertrain components and systems, turbomachinery, internal combustion engines and transmissions, analysis of pump and drain piping systems, and analysis to support patent and trade secret matters. His extensive project experience spans a variety of products used in multiple industries such as power generation, pipelines, oil & gas, transportation, marine, automotive, aviation, rail, mining, forestry, heavy equipment, industrial machinery, heating ventilation and air conditioning (HVAC), medical devices, and consumer products. In his 19 years with ESi, Dr. Novak has provided opinions and testimony as an engineering and failure analysis expert in litigation matters domestically and in international venues. In addition, he has consulted with industry on engineering mechanics, mechanical analysis and design, research, and failure analysis issues.

Prior to joining ESi, Dr. Novak worked in industry for 20 years. His industrial experience includes engineering analysis, product design, research and development, and technology management. His engineering research, design and development experience includes stress analysis, vibration analysis, design of bolted connections, design analysis of gaskets, pressure vessels, clutches, torque converters, gear and chain drives, engine and transmission systems, mechanical components, and machinery. He has University experience that includes teaching mechanical engineering courses and research in the field of orthopedic biomechanics.

Areas of Specialization

Failure analysis

Design and Analysis of Bolted Joints, Gaskets and Sealing Systems

Design and Analysis of Composite, Polymer, and Rubber Components

Design and Analysis of Powertrain Components and Systems

Automotive, Aviation, Marine, Rail and Stationary Engines, Transmissions and Drivelines

Analysis of Rotating Machinery including Turbines and Generators

Structural analysis

Vibration Analysis and Design

Structural and Computational Mechanics

Mechanical Design Analysis

Machine and Component Design, Failure and Safety Analysis

Intellectual Property

August 2022

Education

Ph.D., Materials Engineering (Solid and Fluid Mechanics), University of Illinois-Chicago, 1981
M.S., Materials Engineering (Mechanical Analysis and Design), University of Illinois-Chicago, 1977

B.S., Engineering (Mechanical Analysis and Design), University of Illinois-Chicago, 1975

Licensed Professional Engineer (P.E.)

State of Illinois.....License No. 062-041410

Professional Affiliations

American Society of Mechanical Engineers

Member

Journal of Applied Mechanics Paper Reviewer

Past member in the Bolted Joint Technology Council and PVRC

Society of Automotive Engineers

Member

American Society of Metals, ASM International

Member

Journal of Failure Analysis and Prevention Paper Reviewer

Positions Held

Engineering Systems Inc., Aurora, Illinois

Senior Consultant, 2003 – Present

Federal Mogul Sealing Systems, Skokie, Illinois

Fel-Pro Inc., Skokie, Illinois (Acquired by Federal Mogul in 1998)

Chief Technology Officer, 2000-2002

Director of Advanced Technology, 1990-2000

University of Illinois, Chicago, Illinois

Lecturer, Department of Mechanical Engineering, 1989-1992

Rush Medical Center, Chicago, Illinois

Assistant Professor, Department of Orthopedic Surgery, 1989-1990

Novak Engineering, Indian Head Park, Illinois

Principal Engineer, 1989-2003



Borg Warner Automotive, Inc., Des Plaines, Illinois
Senior Research Engineer, 1985-1988
Senior Engineer, 1981-1985

Chicago Bridge and Iron Company, Oakbrook, Illinois
Engineer, 1980-1981

University of Illinois, Chicago, Illinois
Research Assistant, 1976-1980

Awards

Five U.S. patents

National Institute of Health Post-Doctoral Fellowship in Orthopedic Biomechanics - February 1989 to Jan 1990

Continued Education

SAE Course: Turbo Charging Internal Combustion Engines, 2017

ATR Global LLC: OSHA Scaffold Safety Course, 2015

ASM Course: How to Organize and Run a Failure Investigation Online, 2011

ASME Course: Turbine Principles and Applications, 2011

SAE Course: Vehicle Accident Reconstruction Methods Seminar, 2009

Forklift Training and Certification, 2008 & 2015 & 2019

SAE Course: Patent Law for Engineers Seminar, 2007

SAE Course: Injuries, Anatomy, Biomechanics & Federal Regulation Seminar, 2005

SAE Course: Section Officers Leadership Training, 1993

ASME Course: Shock and Vibration Analysis, 1993

Raymond Engineering: The Bolted Joint, 1991

Northwestern University: Technology Based Innovation, 1991

Strategic Decisions Group: Managing Innovation, 1990

University of Wisconsin: Developing Management Skills Unit I, 1988

SAE Course: Fiber Reinforced Composite Materials, 1986

Publications and Presentations

- “Divining the Origin of Metallurgical Witness Marks Using Reverse Engineering Techniques,” D.E. Alexander, R. Franzese, M. Kenner, A. Maratea, **G. Novak**, M. Stevenson, J. Wagner, presented at the ASM International Indianapolis Chapter Spring Conference, Columbus, IN, February 12, 2019
- “Investigative Use of Reverse Engineering Techniques: Application to Metallurgical Laboratory Analysis of an Aircraft Accident,” D.E. Alexander, R. Franzese, M. Kenner, A. Maratea, **G. Novak**, M. Stevenson, J. Wagner, presented at the Materials Science & Technology Conference, Columbus, OH, October 15, 2018
- Investigation of a Compressor Turbine Blade Failure Involving the Fir Tree Attachment Condition,” E. Wright, **G. Novak**, R. Baron, D. Ahearn, D. Alexander, presented at 2018 MS&T Technical Meeting, Columbus, OH, October 15, 2018
- “Shelving Cart Design and Manufacturing Safety Analysis” D.B Brickman, **G.J. Novak**, C.A.Fox, S.A.Karlins, The XXVIIIth Annual Occupational Ergonomics and Safety Conference, Chicago, IL. June 9-10, 2016
- “Failure Analysis of a Corroded Threaded Fitting in an Ammonia Refrigeration System”, S.A. Sanders, M.E.Stevenson, **G.J. Novak**, R.J.Pape, ASM Journal of Failure Analysis. and Prevention, (2014) 14:420-435.
- “Crib Mattress Support Collapse Accident Reconstruction”, D.B.Brickman, **G.J. Novak**, A.C. Mathias, The XXV Annual Occupational Ergonomics and Safety Conference, Atlanta, Georgia, June6-7, 2013.
- “The Role of Fastener and Gasket Selection on Sealing System Performance”, **Gary Novak**, presented at ASM-WEST Symposium on Material and Design Challenges in Aerospace Fasteners in Irvine, CA, November 5, 2012
- “Measurement of Thermal Residual Stress Using the Strain Gauge Method”, C. R. Morin, E. H. Knox, M. T. Kenner, **G.J. Novak**, J. T. Eganhouse, presented at the Session on “Tools and Techniques,” Failure Analysis Symposium, Materials Science & Technology (MS&T) 2007 Conference and Exhibition, ASM International, Detroit, Michigan, September 17, 2007
- “New Stopper Technologies for MLS Gaskets”, K. Cierocki, **G.J. Novak**, SAE paper 2002-01-0665, 2002.
- “3 D Engine Analysis and MLS Cylinder Head Gasket Design”, T. Chen, J. Zwick, B. Tripathy, **G.J. Novak** SAE paper 2002-01-0663, 2002.
- “Surface Finish Measurement Considerations in Industrial Static Sealing”, E.Widder and **G.J. Novak**, presented at 1998 ASME PVP Conference, San Diego, July 1998.

- "The Role of the Stopper in the Mechanics of Combustion Seals", **G.J. Novak**, M. Sadowski, R. Capretta, E. Widder, SAE paper 980575, 1998.
- "Flange Bending Model and Its Application to Bolt Span Specifications", Z.Hu, **G.J. Novak**, T.Chen, SAE paper 980579, 1998.
- "Thread Lubricants", **G.J. Novak** and T. Patel, chptr 3 in "Handbook of Bolts and Bolted Joints", edited by J.Bickford and S.Nassar, Marcel Dekker, 1998.
- "The Effect of Flange Flexibility on the Response of Gasketed Bolted Joints Subjected to External Forces", **G.J. Novak**, Z. Hu, M.Sadowski, E. Widder, SAE paper 970524, 1997.
- "Parametric Model of Elastomeric Bolt Isolators Under Large Deformation", Z. Hu, T.Chen, **G.J. Novak**, SAE paper 970522, 1997.
- "A Method for Determining the Load Deflection Curve of an Elastomeric Gasket", Z. Hu, T.Chen, **G.J. Novak**, SAE paper 960217, 1996.
- "Development of a Computer Aided Gas Sealability Tester", E. Widder, **G.J. Novak**, SAE paper 960213, 1996.
- "A Design/Analysis Method of Gasketed Bolted Joints for Noise/Vibration Control", J.Zwick, Z.Hu, **G. J. Novak**, SAE paper 952087, 1995.
- "A Probabilistic Gasket Design Method", **G.J. Novak**, M. Sadowski, Z. Hu, SAE paper 950765, 1995.
- "Sealing Performance of an Embossed Rubber Coated Metal Gasket", **G.J. Novak**, G. Schwerdtfeger, E. Widder, SAE paper 950328, 1995.
- "Trunk Muscle Geometry and Centroid Location When Twisting", Y.H. Tsuang, **G.J. Novak**, O.D. Schipplein, A.Hafezi, J.H.Trafimow, G.B.J.Andersson, J.Biomechanics, Vol 26, pp 537-546, 1993.
- "Influence of Erector Spinae Muscle Fatigue on the Lumbo-Sacral Moment During Lifting", **G.J. Novak**, O.D. Schipplein, J.H.Trafimow, G.B.J.Andersson, Eur. J. Exp. Musculoskel. Res., Vol 2, pp 39-44, 1993.
- "Gasketed Joint Analysis Including Flange Bending Effects", E.Widder, M.Sadowski, **G. J. Novak**, SAE paper 930120, 1993.
- "Gasketed Joint Analysis Using Computer Aided Engineering Techniques", E.Widder, **G.J. Novak**, SAE paper 920131, 1992.
- "Influence of Fatigue on the Lumbo-Sacral Moment During Lifting", **G.J. Novak**, O.D.Schipplein, J.H.Trafimow, G.B.J.Andersson, presented at Intl. Soc. of the Lumbar Spine Meeting, Boston, 1990.
- "Modification in Lifting Technique after Lumbar Muscle Fatigue", **G.J. Novak**, O.D.Schipplein, J.H.Trafimow, G.B.J.Andersson, submitted to the Transactions of the 37th Annual Meeting of the Orthopaedic Research Society, 1991

"The Effects of Quadriceps Fatigue on the Technique of Lifting", J.H.Trafimow, O.D.Schipplein, **G.J. Novak**, G.B.J.Andersson, submitted to Spine, 1990.

"An Evaluation of Trunk Models for Studies of Lifting Dynamics", **G.J. Novak**, A.B. Schultz, G.B.J.Andersson, T.P. Andriacchi, poster presentation at American Society of Biomechanics Meeting, Burlington, Vermont, 1989.

"A Design Procedure for Thermoplastic Bumpers", P. Sabol, F.J. Ferfecki, **G.J. Novak**, SAE paper 870109, 1987.

"An Analysis of Body Dynamics in Sagittally Symmetric Lifting", **G.J. Novak**, doctoral thesis, University of Illinois, Chicago, Illinois, 1981.

"Maximum Voluntary Strengths of Male Adults in Some Lifting, Pushing, and Pulling Activities", D. Warwick, **G.J. Novak**, A. Schultz, M.Berkson, Ergonomics, Vol 23, No. 1, pp 49-54, 1980.

"The Effect of Body Configuration and External Loads on Forces Internal to the Human Trunk", **G.J. Novak**, master's thesis, University of Illinois, Chicago, Illinois, 1977.

"A Scheme for Analysis of the Mechanics of the Lower Trunk During Manual Materials Handling", A.B. Schultz, W.K. Liu, **G.J. Novak**, Report on International Symposium: Safety in Manual Materials Handling, State Univ. of N.Y. at Buffalo, 1976.

Select ESi Consulting Project Experience

Machinery, Engines, and Rotating Equipment

Investigated the failure of a propellor drive system that took an oil tanker out of service. This was the result of the failure of the main thrust bearing for one of the two propellor drivelines that stemmed from design decisions involving the vessel's structural, powerplant, and shafting systems. Effects of load, displacement, vibration, and misalignment were addressed. Changes in the design of the vessel during its construction were found to have caused structural changes in the drive shaft support bearing system from what was considered by the vibration analysis in the design phase. The amplitude of resultant vibrations during operation caused excessive misalignment of the thrust surfaces of the non-spherical thrust bearing which led to thrust bearing failure.

Investigated the failure of a 43 MW power transmission system on a multi-jet powered sea vessel. Investigation of damage to running surfaces on the bearings and gears involved the review of the engineering design of the gear, journal bearing, lubrication, and shafting systems along with engineering analysis of the loads, displacements, and operating conditions.

Investigated the failure of connecting rod tie rods (bolts) in a 16-cylinder 6,800 kW 4 cycle diesel engine. The stresses acting on the tie rods were analyzed using the theoretically determined connecting rod forces and connection rod-tie rod joint mechanics. Fatigue and fracture mechanics evaluations were performed.

Investigated the failure of a 64 MW steam turbine driven generator system in a grain processing plant. The system tripped due to performance degradation issues in the generator. After the system was shutdown, an attemperator valve was inadvertently left in an open state and water accumulated in a 36-inch low pressure steam line. The steam line was not drained of water prior to system restart. Upon restart, the accumulated water in the system led to a significant and rapid condensing or collapsing of a volume of steam that caused the low-pressure steam line to physically move and fail. The investigation of the steam piping and generator failure included review and analysis of the process operations, generator performance, and repair and repair history.

Investigated the failure of a 9.4 MW steam turbine driven generator system. The turbine was powered using surplus process steam (cogeneration) from a grain processing plant. Vibration levels in the generator exceeded alarm levels after “bridges” in the rotor shifted and separated from the rotor. The investigation of the failure included assessment of bearing vibration historical data, process data history, and inspection of failed retention bolts. A potential cause of the bridge loosening on the rotor was determined to be overheating of the rotor due to a generator cooling problem.

Provided engineering support to a manufacturer of a multi-stage axial compressor used in a commercial ethylene processing facility. Worked with their engineering staff to determine the root cause of an impellor wheel failure. The review and analysis included: impact of the overall system design on the specific impellor wheel operation; finite element analysis of the impellor to determine frequencies and mode shapes; assessment of measured and predicted natural frequencies of the various blade and disk vibration modes against the potential excitations due to upstream and downstream vanes (Campbell and Safe diagrams were used as part of the evaluation); failure models to correlate a field failure to the analysis; and assessment of the field operating conditions to rule out potential operational issues such as surge or overload.

Investigated and provided engineering and project cost analyses to support subrogation activities involving the failure of a 24 foot diameter helical bull gear on a cement ball mill. Issues included the replacement frequency of the drive pinion, alignment of the gears, and the failure of the bull gear after only 50% of its expected life.

Investigated the failure of a shaft, fan, and bearing system in a cement kiln.

Investigated a failure of a 16-cylinder 2100hp natural gas engine (block, rod, and piston) in an electrical power generation system involving issues of repairs, maintenance, and standard practice.

Investigated the cause of a venting failure of a 2500 hp 12-cylinder engine that was part of a hydraulic fracturing trailer along with an off highway possible transmission, torque converter and flex-plate system.

Investigated the failure and design of a component of a 750-ton powder metal compaction press failure.

Investigated the failure of an 8-cylinder 400 rpm 3600 hp Enterprise engine (liner, piston, ring) in a municipal power generation system shortly after overhaul.

Investigated the failure of a 2200 hp 20-cylinder 1200 rpm biogas engine (liner, piston, and ring) in a cogeneration system shortly after overhaul.

Investigated the failure of a truck driveshaft, universal joint, intermediate bearing and support system involving potential maintenance and design issues.

Investigated the failure of a hydraulic elevator cylinder.

Investigate a leak and gasket blowout on a hydraulic pin pull apparatus used for crane assembly.

Analyzed wheel bearing induced spindle nut loosening forces (as a potential cause a wheel off) Investigate rear axle wheel bearing failures related to the roller profile condition.

Investigated electric motor failures involving harmonic analysis of motor vibration histories.

Investigated a recurring failure of a multiple head machining system to determine root cause in a matter involving allegations of defective design, misuse, and improper installation. Issues included air pressure levels, labyrinth seal, and rolling bearing failures.

Investigated an allegation of a defectively design shaded pole electric auger motor. Issues included the motor operating temperature rating and the thermocouple measurements of the motor and surrounding ambient conditions while operating in a high temperature environment.

Analyzed bearing vibration histories and performed trend analyses to help determine causes of failure in several electric generator, motor, pump, and fan investigations. Vibration order and trend analysis is used to identify changes over time of the components associated with the specific frequencies that are measured.

Investigated the failure of a refrigeration system components that caused damage to a commercial refrigeration system. The effect of temperature on the dynamic vibration of an electric motor was analyzed. Vibration measurements were collected under load at temperatures ranging from -30 F to room temperature. The level of vibration at very low temperatures was determined to be a source of fluctuating loads that lead to a fatigue failure.

Provided investigation and damage assessment analysis to evaluate damaged machinery including a pharmaceutical grade vacuum sealing machine and a CAT scan machine that were damaged during installation.

Investigated recurring failures of an axle component of a high rail (4 wheeled vehicle on rail) system including magnetic particle inspection.

Provided design support to a manufacturer of product utilizing high speed plastic gearing including issues involving gear design and material processing.

Investigated the failure of a large auto assembly plant machine that caused operator injury when a welded travel stop failed.

Investigated a collapse of a screw conveyor that involved issues of design and assembly.

Inspected and analyzed forestry and construction equipment involved in fires. Accumulated debris under the hood, fire suppression system operation, and maintenance were some of the issues.

Aviation

Investigated and analyzed the failure of a turbine wheel in multi-stage turbine section of an aircraft engine. The root cause failure analysis considered the impact of the overall system design on the specific turbine wheel operation; experimental and analytical determination of blade and disk response to test stand loads; vibration frequencies and mode shapes; an assessment of measured and predicted natural frequencies of the blade and disk vibration modes against the potential excitations due to upstream and downstream vanes; and low and high cycle fatigue assessment.

Analyzed the compressible gas flow through an orifice as part of an investigation of an aircraft engine control system.

Analyzed assembly torques, bolt loads, and prevailing torque in gasketed bolted joints in aircraft fuel systems and crankcases.

Evaluated the effect of an imbalanced viscous torsional engine vibration damper on the level of engine vibration. Engine vibration measurements were collected on the ground and in the air. Spectral analysis was used to associate measured vibration with the frequencies associated with the crankshaft pendulum dampers, the rotation speed of engine components, component and system natural frequencies (such as engine-motor mount system), and the natural frequency of a specific spring-mass rotating governor of a failed component.

Investigated the role of a fir tree attachment condition on a turbine blade failure.

Analyzed the failure of a fuel cooler that led to the failure of a commercial jet engine. Aircraft vibration, excitation, response, and cooler design were considered.

Investigated design and manufacturing issues for air bearings for the Air Cycle Machines (ACMs) used in aircraft environment control systems.

Analyzed shafting, bearings, and gearbox issues of tail rotor powertrains of several helicopters that were involved in ground crashes.

Investigated the failure of a twin engine combining gear box of a helicopter that crashed.

Investigated the role of a new helicopter skid shoe component in a fatal accident involving a helicopter on an offshore platform. Testing was conducted on an exemplar structure to measure the effect shoe design change.

Fastening, Sealing, and Threaded Connections

Analyzed and tested threaded a compression fitting and investigated its role in a propane explosion and fire.

Analyzed assembly torques, bolt loads, and prevailing torque in gasketed bolted joints in aircraft fuel systems and crank cases in several matter involving engine failures and crashes.

Analyzed the design, manufacture and installation of plumbing, piping, and sprinkler systems. The analysis involved NPT thread design, thread manufacturing methods, assembly of threaded connections, and thread sealants in relation to leakage.

Analyzed the role of a gasketed bolted flange connection in a shopping center natural gas explosion that involved ANSI flanges, natural gas pipeline, gasket replacement, and ASME recommended practices.

Investigated and analyzed railroad tank car hatch and valve leak conditions. The work included measurement and analysis of retained stud tension load by the measurement of nut pull up torques and gasket deformation using gasketed bolted joint analysis methods.

Investigated the failure of a centrifugal casting machine that included a bolted connection that failed and caused fire damage and burns.

Investigated the failure a threaded connection in a handrail separation incident that resulted in a scissoring hand injury. The work included an engineering and analysis of the design of the threaded connection and a reconstruction and analysis of the accident.

Evaluated the role of an anti-seize compound that was used on fasteners of a vehicle that lost a wheel while at speed. The wheel off accident resulted in the death of an occupant of another vehicle. Report and testimony were provided.

Analyzed the failure of a bridge bolt on a generator rotor that loosened and failed with issues including thermally induced loosening. The generator was part of a cogeneration system in a grain processing plant. Issues included analysis of the SCADA (Supervisory Control and Data Acquisition) data to understand the bearing load, air temperature, and power generation histories prior to the failure.

Investigated and analyzed the failure of a bolted connection on a crane that allowed a stowed jib to fall and cause injury. Exemplar testing of the crane was carried to determine stresses in the failed U-bolt under a variety of operating and transportation conditions using strain gage data collection. Goodman and Gerber fatigue criteria were considered in a fatigue evaluation. Report and testimony were provided.

Investigated the role of a motorcycle brake system in a fatal accident. Issues included an allegation of a brake system failure, a brake system related recall, rubber brake system seal design, manufacturers quality, and the seal condition at the time of failure. Report and testimony were provided.

Investigated the role a gasket on a remote control for a mining machine that was involved in a fatal accident. Report and testimony were provided.

Investigated a leak and gasket blowout on a hydraulic pin pull apparatus used for crane assembly.

Investigated an ammonia compressor gasketed flange connection failure that resulted in leakage of a commercial refrigeration system.

Provided fact witness testimony in a class action suit involving Organic Acid Technology (OAT) engine coolant and gasket technology.

Investigated the failure of connecting rod tie rods (bolts) in a 16 cylinder 6,800 kW 4 cycle diesel engine. Strain gage measurement on the tie rods were collected and analyzed with the connected rod loaded in a test fixture with a tension force equal to the calculated maximum inertia force due to engine normal operating conditions. The stresses determined from the strain gage data were used to perform fatigue and fracture mechanics evaluations. Goodman fatigue criteria, threshold, and critical stress intensity factors were considered.

Provided design analysis support for the development of a sealed enclosure to a manufacturer of a LiDAR (Light Detection and Ranging) system for use on road vehicles.

Provided engineering analysis support for the assessment of the nonconforming threads on a connecting rod tie rods (bolts) to a manufacturer of large displacement diesel engines.

Hydraulic and Pneumatics

Investigated the failure of a hydraulic elevator that failed while in use. The issues involved the elevator operating loads and the condition of the inground lift cylinder.

Investigated a trailer cover support system failure (air cylinder, mechanism) that caused a hand injury including issues involving warnings and safety.

Analyzed a building foundation drain tile water system flow into related piping, sumps, pumps, and discharge piping networks.

Analyzed the roof geometry, primary drain, overflow drain, piping configuration, and calculated the rain accumulation on a roof of a large building that collapsed during a 100-year rainfall event.

Analyzed pump discharge piping systems that included single and multiple pumps and determined the system pumping performance in multiple investigations of power loss, floods, and rainfall events.

Investigated and analyzed turbomachinery failures including allegations of design defects in air bearing systems.

Analyzed compressible gas flow through an orifice as part of an investigation of an aircraft engine control system.

Investigated the role of a motorcycle brake system in a fatal accident. Issues included an allegation of a brake system failure, a brake system related recall, rubber brake system seal design, manufacturers quality, and the seal condition at the time of failure. Report and testimony were provided.

Investigated the failure of a high-pressure metal reinforced hydraulic hose that failed and caused a fluid injection injury. The investigation involved issues of design, misuse, and warnings.

Investigated and analyzed the opening of a fill valve on a brine truck on a fracking site that allegedly caused the handle of a butterfly valve on the brine reservoir to move in a manner to cause injury to the operator holding the valve handle. The fill valve, the butterfly valve, and an adjoining hose were used to transfer brine brought in by truck to the brine tank. The forces acting on the butterfly valve were calculated and were also measured on site. The mechanics of the brine fluid flow from the truck to the tank and the resulting forces acting on the butterfly valve were analyzed and measured on site.

Inspected and analyzed the hose and related valves of an agricultural anhydrous ammonia injection system involved in an accident where the farmer exposed and inhaled ammonia.

Intellectual Property

Conducted patent infringement and invalidity analyses to support a technology licensing dispute involving a gasket technology including doctrine of equivalents issues. The case involved patented technology that was licensed from a Japanese company by a US company. A European company was alleged to be infringing and the matter was addressed by a Swiss tribunal.

Provided investigation and analysis related to an alleged theft of a trade secret of a waste separation system.

Conducted patent infringement and invalidity analyses of stapler technologies that included doctrine of equivalents and means plus function issues.

Conducted infringement and invalidity analyses on a hold down clamp patent that included means plus function claim issues.

Reviewed the patent and prepared an animation to clearly demonstrate the function of the disclosed articulating housing construction of a portable printing system.

Carried out an assessment of alleged infringement of a hydraulic based material processing machine involving prior art and patent claim construction

Reviewed patents and provided a pre-suit assessment of infringement of a medical infusion pump system.

Prepared claim construction and analysis for a high-pressure pump seal ring with applications in hydraulic fracking. Performed investigation and analysis related to an alleged theft of a trade secret involving the manufacturing of the seal ring.

Performed investigation and analysis regarding claim construction (Markman hearing) in an ongoing matter involving an allegation of infringement dispensing system.

Safety

Investigated and reconstructed an accident resulting in injury on a dock plate while the operator was pulling a hand truck (pallet jack).

Investigated a dock plate malfunction that played a role in a forklift dock-plate collision and injury.

Investigated a cabinet tip accident over that resulted in a child injury.

Investigated remote control mining apparatus design and use that resulted in crushing deaths.

Investigated a four-post foam press failure (wire rope system /hydraulics) that resulted in worker's death.

Assessed the condition of a section of railroad track that included the measurement and evaluation of the whole-body vibration of a seated operator.

Investigated a crushing accident involving an operator using an on-rail airport freight handling system. The project included inspection, engineering analysis, animation, and reconstruction.

Investigated a truck loading ramp failure that resulted in operator injury in a project that included testing, engineering analysis, and issues of maintenance, periodic inspection, warnings, and design.

Provided engineering analysis in an investigation and reconstruction of crib mattress support collapse accident

Investigated the role of an industrial mixer in an accident involving the operator and included issues in design, modification, maintenance, lockout, and operator use.

Investigated the role of a hinged bar flap in a head injury matter. Issues included the design of the hinge, bar flap, reconstruction of the injury contact, animation, report, and testimony.

Provided analysis, stability testing, and testimony in an investigation in a matter involving a barbecue grill tip-over resulting in a burn and amputation.

Determined the root cause of a vacuum forming press die drop that crushed and burned the operator's hands.

Investigated a rail car loading and unloading portable belt conveyor accident that resulted in operator death in a project that involved machine design, modifications, testing, maintenance, and operation.

Investigated a skid steer forestry mulcher accident that resulted in an observer's death in a project that involved machine design, warnings, and operation.

Additional Mechanical and Failure Analyses

Investigated the failure of welded on foot pegs on an ATV that was used in off road sports.

Investigated and analyzed a failure of an oven door hinge plate involving issues of design, materials, and manufacturing.

Select Consulting Project Experience Prior to ESi

Developed mathematical tools for the analysis and design of a boat shoe outer sole for optimal performance regarding slip resistance and wear.

Used finite element analysis to simulate the deformation and stresses that develop within the outer sole of an athletic shoe during heel strike to support effort to reduce a delamination issue.

Simulated spring surge for a coil spring manufacturer using the finite element method.

Performed stress and deflection analysis using the finite element method for a manufacturer of a new rocker arm concept.

Evaluated new concept metal, rubber, and plastic automotive suspension components using finite element simulation.

Analyzed the stress and deflection using finite element simulation of a spiral zero backlash coupling including bucking analysis.

Developed a frequency response model for the manufacturer of circuit card support systems using the finite element method.

Conducted finite element simulation of thin corrugated plates under contact loading conditions including buckling to support a manufacturer's new gasket concept.

Designed a booster pump system for a quick fill batch tank farm for a manufacturer of liquid products.

Select Industry Experience

Used commercial finite element analysis (FEA) codes to simulate the behavior of many mechanical systems including: deflection versus time response of new concept bumper and energy absorber systems under impact conditions; stress and fatigue performance of a cast torque converter structure; thermally induced clutch pressure plate warping; forced vibration analysis of an under-sea pump due to wave forces and included added mass effects; pressure vessel stress and deflection analysis; automatic transmission component stress and deflection analysis; stress and deflection analysis of orthotropic composite parts; load deflection performance simulation of rubber boat dock fenders; and gasket bolted joint force, stretch, and contact stress analysis.

At Chicago Bridge and Iron, analyzed a reflector plate support column that was part of the Clinch River Breeder Nuclear Reactor project for stress, deflection, fatigue, creep, and compliance with the ASME Pressure Vessel and Piping code including the high temperature code case. The column was designed to support stainless steel plates suspended over a pool of molten sodium. Hand calculations and finite element methods were used to assess natural frequencies, mode shapes, deflection, and stress response of the proposed design. The load cases that were analyzed were the mechanical and thermal loads associated with the various normal operation modes such as start up or expected operating load levels as well as abnormal anticipated loads such as earthquake or missile attack.

At Borg Warner (BW), designed, prototyped, tested, and performed analyses on machines and structures constructed from a range of materials including steel, cast iron, aluminum, rubbers, plastics, and composites. The parts and components that were considered included transmission cases, gears, clutches, automotive bumpers, and shafting. For example, a new concept structural plastic bumper was analyzed using computer oriented structural dynamic modeling. Barrier impact tests were simulated on the computer using the transient dynamic analysis capabilities in a finite element analysis computer model. Multiple designs of varying stiffness and mass distribution were investigated to obtain a preferred force and displacement time response before a first prototype. Costs and time to market were controlled in the development phase because numerous designs were considered and evaluated before the first prototype was constructed and tested. The savings were in expensive tooling, manufacturing and testing costs.

Gained experience in powertrain systems and components at BW including: stress analysis of 16-inch diameter cast aluminum torque converter; performance modeling of 3-element torque converters; prototype of new concept torque converters; simulation of clutch flywheel engagement; troubleshooting clutch engagement induced vehicle shudder; and design analysis and simulation of sprag clutches and band brakes. The analysis of the 16-inch converter included finite element analysis of the static, dynamic, and thermal loads. The loading included the blade pressure loads from fluid dynamic models of the converter system as well as rotational forces induced on the converter structure and the contained fluids. Developed mathematical tools for the analysis and design of mechanical systems including torque converters, one-way (sprag) clutches, and continuously variable transmissions.

At BW a long pump support column that was submerged in the sea was analyzed. The pump column was subjected to loads that included ocean wave forces and the pump and drive support forces. The natural frequencies of the column were sought to understand the in-well pump and motor vibration measurements that were being considered for diagnostic and maintenance purposes. The analysis included the effect of the added mass of a layer of sea water attached to the column. A finite element program was used to determine the frequency and forced response of the system.

At Fel-Pro and Federal Mogul, performed or directed design, analysis, testing, and other development activities for sealing systems in the automotive, heavy duty and industrial business sectors. The sealing systems included gaskets, seals, structures to be joined, bolts and other fastening means. The sealing structures layered constructions of metals, rubbers, and composite facings and molded rubber gaskets and seals. A significant aspect of this work was determining and modeling the behavior of the materials including modulus, strength, thermal expansion, and density. For example, a methodology and tools for the design and analysis of vibration isolating structures that are constructed of thick rubber were developed. Finite element analysis (FEA) was used to characterize the dynamic stiffness and damping of a proposed geometry and material. Dynamic stiffness and loss factor were used to generate frequency response functions for the proposed material and shape. The tool was used to quick develop and bring to market oil pan gaskets that effectively seal as well as reduce the transmission and radiation of engine noise via the large surface area on large diesel engines.

Lead large multi-disciplinary projects involving materials, design, and testing of automotive and off highway powertrain systems using both inhouse and outside resources. At BW designed, prototyped and tested automotive powertrain components using composite materials (long and short fiber reinforced polymers) including a spiral clutch spring, a filament wound shaft, transfer case housings, a torque converter turbine, and a planet carrier.

At Fel-Pro and Federal Mogul, developed, prototyped, and tested new concept gaskets, sensors, and powertrain components including dynamometer testing for automotive, off-high, and motorsport applications. Worked with outside suppliers and customer on the development and evaluation of new concept products including electric vehicle seal and fuel cell product flow field concepts. Developed and managed the sealing R&D project portfolio for the global engineering resources in the US and western Europe.

Industrial Intellectual Property Activities

Awarded 5 US patents

Member of a corporate patent committee regarding trade secret process, patent filing, and maintenance decisions.

Major Industrial Reports

"Reflector Plate Support Column Stress Analysis", section 5.4 of the Clinch River Breeder Reactor Project Closure Head Final Report by Chicago Bridge and Iron Co., July 1981.

"A Design Procedure for the Initial Belt Sheave Layout for a Metal Belt CVT", Borg Warner Corp. Research Center Project 4525 report, September 1983.

"Review of Freewheel Analysis", Borg Warner Corp. Research Center Report, November 1984.

"Stress Analysis of a Cast Aluminum Torque Converter Impellor", Borg Warner Corp. Research Center project 3147-80-81014, November 1984.

"Stress Analysis of a Glass Reinforced Nylon TD25E Turbine", Borg Warner Automotive Inc. Research Center project 4839 report, October 1987.

"Preliminary Report, Analysis of Rubber Suspension Bushing", March 1990.

"Preliminary Report, Optimal Boat Shoe Outsole Construction", September 1994.

Academic Activities

As a member of Marquette University Mechanical Engineering Industrial Advisory Board, reviewed curriculum, provided insight to the university regarding the needs of industry, made presentations to students and faculty describing the work activities and requirements of my employers.

As an Assistant Professor in the department of Orthopedic Surgery at Rush Medical Center, Chicago, performed analytical investigations of body loading and motion during the performance of human lifting activities, EMG levels, optimization models for muscle force determination. Supervised students and academic researchers in the design, construction, and startup of a 4-camera lifting laboratory. Conducted research that supported the development of safe lifting guidelines.

Taught courses in the department of Mechanical Engineering as a lecturer at University of Illinois, Chicago, in dynamics, machine design, vibration analysis, and finite element analysis.