Exponent®
Engineering & Scientific Consulting

Rich Klopp, Ph.D., P.E., F.A.S.M.E.

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Professional Profile

Dr. Klopp specializes in mechanical engineering and the mechanics of materials. He has particular expertise in laboratory-based testing, mechanical design, failure analysis and prevention, and manufacturing.

Dr. Klopp's mechanical engineering background includes extensive experience in machining; machinery; mechanisms; analysis of fasteners, gears, and bearings; power generation; mechanical power transmission; optical systems; metrology; hydraulic systems; and fluid handling components. His mechanics of materials background includes extensive experience in fracture mechanics, high strain rate deformation and failure, impact and shock wave loading, mechanical testing and optical measurement methods.

Dr. Klopp has applied his expertise to machine tools, industrial machinery, laser systems, electric and gas utilities, automobiles, trucks, construction equipment, potable, fire protection, and wastewater system components, plumbing, computer equipment, electronic packaging, consumer products, hand and power tools, medical equipment and medical devices, toys, recreational products, railroad tank cars, chemical storage tanks, underground tunnels, armor/antiarmor, and missile defense. Dr. Klopp has studied the mechanical behavior of metals, ceramics, rock, plastics, advanced composites, liquids, and wood.

Dr. Klopp has provided consulting services on matters of industrial problem solving, product recalls, product defect litigation, intellectual property disputes, commercial disputes, national defense, and insurance issues. His consulting relating to intellectual property has included patent infringement and non-infringement analyses, patent invalidity analyses, patent claim construction support, trade secret matters, and technology licensure.

Dr. Klopp is a skilled machinist qualified to set up and operate machine tools such as lathes, milling machines and other shop equipment. His personal machine shop is equipped with a computer numerical control (CNC) vertical machining center, two manual milling machines, two toolroom lathes, grinders, and a wide variety of supporting tooling and equipment. Dr. Klopp routinely uses computer-aided design (CAD) and computer-aided manufacturing (CAM) software. Dr. Klopp is a mentor for the local high school FIRST Robotics team. In addition to mentoring on mechanical design, Dr. Klopp’s role includes maintaining, tooling, upgrading, and repairing the school’s machine tools and teaching students and other mentors how to use them.

Prior to joining Exponent, Dr. Klopp was a Research Engineer at SRI International and worked as a Research Associate at Brown University. He is a Fellow of the American Society of Mechanical Engineers.

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Academic Credentials & Professional Honors

Ph.D., Engineering, Brown University, 1986

Sc.M., Applied Mathematics, Brown University, 1986

Sc.M., Engineering, Brown University, 1984

B.S., Mechanical Engineering, Lehigh University, 1981

Fellow, American Society of Mechanical Engineers, 2019

SRI International Postdoctoral Fellowship

University Fellowship, Brown University

Ingersoll Rand Award

Alfred Stenning Award

Pi Tau Sigma

Tau Beta Pi

Licenses and Certifications

Professional Engineer Mechanical, California, #31530

Professional Engineer, Michigan, #6201069727

Professional Engineer Mechanical, Nevada, #024867

Professional Engineer Mechanical, Texas, #113452

Professional Engineer Mechanical, Washington, #52816

Prior Experience

Research Engineer, SRI International Poulter Laboratory, 1987-1999

Postdoctoral Fellow, SRI International Poulter Laboratory, 1986-1987

Professional Affiliations

Community Service

Mentor to the FIRST Robotics teams at Woodside High School, Woodside, CA.

Affiliations

American Society of Mechanical Engineers (ASME - Fellow)

ASME B5 Technical Committee 52 - Machine Tool Performance

ASME B5 Technical Committee 64 – Linear Positioning

ASM International — American Society for Metals

Society of Manufacturing Engineers

Peer reviewer for ASM International Journal of Materials Engineering and Performance

Peer reviewer for Proceedings of the iMeche Part E: Journal of Process Mechanical Engineering

Peer reviewer for ASME 2010 International Design Engineering Technical Conferences (IDETC) and Computers and Information in Engineering Conference(CIE)

Peer reviewer for ASME 2013 International Design Engineering Technical Conferences (IDETC) and Computers and Information in Engineering Conference (CIE)

Peer reviewer for ASME 2015 International Design Engineering Technical Conferences (IDETC) and Computers and Information in Engineering Conference (CIE)

Peer reviewer for ASME 2015 International Mechanical Engineering Congress and Exhibition (IMECE)

Peer reviewer for American Gear Manufacturers Association (AGMA) 2024 Fall Technical Meeting

Publications

Spak KS, Klopp RW. Traces of bentonite prevent bonding of electrofusion pipeline joints. Pipeline & Gas Journal, pp. 50-52, December 2017.

Klopp RW. Failure analysis of redundant escalator chain pin retention mechanisms. Proceedings of the ASME 2011 International Mechanical Engineering Congress & Exposition (IMECE2011), Denver, CO, ASME, November 11-17, 2011.

Klopp RW, Dugnani R, Edmonds JS. The role of brush spring kinking in a generator flash-over incident. Proceedings, 43rd North American Power Symposium (NAPS2011), Boston, MA, IEEE, August 4-6, 2011.

Tokheim RE, Cooper T, Lew B, Klopp RW, Groethe MA, Peterson RR, Williamson D, Blanchard JP. Computational modeling of Z plasma-radiation-source debris. Journal of Radiation Research Engineering 2004; 20(1).

Duffner DH, Klopp RW, Wagner-Jauregg A, Sire RA, Webster EM. Component damage from printed circuit board loading. Proceedings, IPC Printed Circuits Expo 2002, Long Beach, CA, IPC, pp. S12-4-1-S12-4-8, March 2002.

Kirkpatrick SW, Klopp RW. Hazard assessment for pressure tank cars involved in accidents. Proceedings, International Crashworthiness Conference (Icrash), London, UK, Chirwa EC and Otte D (eds), pp. 223-235, September 6-8, 2000.

Simons JW, Kirkpatrick SW, Klopp RW, Seaman L. Methods for modeling damage in finite element calculations. IA'99 - Proceedings, International Seminar on Numerical Analysis in Solid and Fluid Dynamics in 1999, pp. 79-86, Osaka University, Japan, November 15-16, 1999.

Giovanola, JH, Klopp, RW, Kirkpatrick, SW. A note on one-point-bend impact fracture experiments with curved specimens. Journal of Testing and Evaluation 1998; 26(1):79-81.

Kobayashi T, Shockey DA, Schmidt CG, Klopp RW. Assessment of fatigue load spectrum from fracture surface topography. International Journal of Fatigue 1997; 19(1):S237-S244.

Klopp RW, Florence AL, Simons JW, Gran JK. Spherical Wave interaction with cylindrical holes in large limestone specimens. J de Physique IV, Colloque C8, supplément au Journal de Physique III, 1994; 4:735-740.

Klopp RW, Crocker JE. A dynamic fiber push-out test applied to metal-matrix composites. J de Physique IV, Colloque C8, supplément au Journal de Physique III 1994; 4:47-51.

Klopp RW, Crocker JE. Dynamic fracture behavior of SCS 6/Ti-15-3 metal-matrix composite. International Journal of Fracture 1993; 61(R77-R83).

Klopp RW, Shockey DA. The strength behavior of granulated silicon carbide at high strain rates and confining pressure. Journal of Applied Physics 1991; 70(12):7318-7326.

Giovanola JH, Klopp RW, Kirkpatrick, SW, McDonald WW. Dynamic fracture of welded joints. J. de Physique, Colloque C3; 1991 1(suppl. III):565-572.

Klopp RW, Shockey DA, Osher JE, Chau HH. Characteristics of hypervelocity impact debris clouds. Internationa Journal of Impact Engineering 1990; 10(1-4):323-335.

Klopp RW, Clifton RJ. Analysis of tilt in the high-strain-rate pressure-shear plate impact experiment. Journal of Applied Physics 1990; 67(11):7171-7173.

Giovanola JH, Kobayashi T, Klopp RW, Gaines T, Arwood R. A note on dynamic displacement measurement using Hall Effect sensors. Journal of Testing and Evaluation1989; 17(3):196-200.

Klopp RW, Clifton RJ, Shawki T. Pressure-shear impact and the dynamic viscoplastic response of metals. Mechanics of Materials 1985; 4(3&4):375-385.

Reports (Exclusive of FaAA Work Product)

Klopp RW, Kirkpatrick SW, Shockey DA. Damage assessment of tank cars involved in accidents: Phase II—modeling and validation. Final Report DOT/FRA/ORD-02/04, Federal Railroad Administration, Office of Research and Development, 2002.

Klopp RW, Shockey DA, Curran DR, Cooper T. A granular flow model for developing smart armor ceramics. Final Report to Army Research Office on Contract DAAH04-94-K-0001, January 1998.

de Resseguier T, Klopp RW, Seaman L, Kanazawa C, Curran DR. Characterization and modeling penetration of ceramic armor. Final Report to Army Research Office on Contract DAAL03-92-K-0004, February 1995.

Giovanola JH, Klopp RW, Shockey DA. Modeling of microstructural effects on fracture processes at high loading rates. SRI International report, SRI International, Menlo Park, CA, 1992.

Klopp RW, Shockey DA. Tests for determining failure criteria of ceramics under ballistic impact. SRI International report, SRI International, Menlo Park, CA, 1992.

Giovanola JH, Klopp RW, Simons JW, Marchand AH. Investigation of the fracture behavior of scaled HY-130 weldments. SRI International report, SRI International, Menlo Park, CA, 1990.

Book Chapters

Kirkpatrick SW, Klopp RW. Risk assessment for damaged pressure tank cars. In: Computer Technology and Applications, PVP-Vol. 458. ASME, New York, NY, 2003.

Giovanola JH, Klopp RW, Crocker JE, Alexander DJ, Corwin WR, Nanstad RK. Using small cracked round bars to measure the fracture toughness of a pressure vessel steel weldment: A feasibility study. In: Small Specimen Test Techniques, ASTM STP 1329. Corwin WR, Rosinski ST, van Walle E (eds), ASTM, Philadelphia, PA, 1998.

Giovanola JH, Homma H, Lichtenberger M, Crocker JE, Klopp RW. Fracture toughness measurements using small cracked round bars. In: Constraint Effects in Fracture: Theory and Applications, ASTM STP 1244. Kirk M, Bakker A (eds), ASTM, Philadelphia, PA, 1994.

Klopp RW, Shockey DA, Seaman L, Curran DR, McGinn JT, de Resseguier T. A spherical cavity expansion experiment for characterizing penetration resistance of armor ceramics. In: Mechanical Testing of Ceramics and Ceramic Composites, AMD-Vol. 197. ASME, New York, NY, 1994.

Curran DR, Seaman L, Klopp RW, de Resseguier T, Kanazawa C. A granulated material model for quasibrittle solids. In: Fracture and Damage in Quasibrittle Structures. Bazant ZP, Bittnar Z, Jirásek M, Mazars J (eds), E.& F.N. Spon, London, 1994.

Clifton RJ, Klopp RW. Pressure-shear impact testing. In: Metals Handbook, Vol. 8, 9th Edition. ASM International, Metals Park, OH, 1985.

Presentations and Published Abstracts

Kerans M, Klopp RW. Bentonite contamination in plastic pipe installed by HDD. 2018 Western Regional Gas Conference, Henderson, NV. August 28-29, 2018.

Klopp RW, Davis BR. The advantages of pressure-testing electrofusion saddle tees prior to tapping the main. American Gas Association Operations Conference & Biennial Exhibition, Orlando, FL. May 2-5, 2017.

Klopp RW, Curran DR, Shockey DA, Cooper T. A comminution model for penetration in ceramics. Proceedings, 14th U.S. Army Symposium on Solid Mechanics, Chou SC, Iyer K (eds), Myrtle Beach, SC, October 16-18, 1996.

Giovanola JH, Klopp RW, Touzé P. Microdamage observations in dynamically fractured Ti-10V-2Fe-3Al microstructures and preliminary modeling attempts. Proceeding, IUTAM Symposium on Micromechanics of Plasticity and Damage of Multiphase Materials, Pineau A, Zaoui A (eds), Sèvres, France, August 29-September 1, 1995, Kluwer Academic Publishers, Dordrecht, 1996.

McGinn JT, Klopp RW, Shockey DA. Deformation and comminution of shock-loaded □-Al2O3 in the Mescall zone of ceramic armor. Proceedings, Materials Research Society 1994 Fall Meeting, Symposium on Grain-Size and Mechanical Properties—Fundamentals and Applications, Grant NJ, Armstrong RW, Otooni MA, Baker TN, Ishizaki K (eds), Materials Research Society, Pittsburgh, PA, 1995.

Kirkpatrick SW, Curran DR, Erlich DC, Klopp RW. Three-dimensional analyses of plate impact experiments with circular and star geometries. In: Shock Waves in Condensed Matter, Proceedings, APS 91 Topical Conference, Williamsburg, VA, S.C. Schmidt, et al. (eds.). Elsevier, New York, NY, 1992.

Giovanola JH, Klopp RW, Simons JW. Effect of shear lips on dynamic crack propagation. In: Dynamic Fracture, Proceedings, OJI International Seminar on Dynamic Fracture, , Toyohashi, Japan, August 1-4, 1989.

Giovanola JH, Klopp RW, Shockey DA, Werner AT. Effect of microstructure and loading rate on the fracture behavior of Titanium-10V-2Fe-3Al. In: Advances in Fracture Research, Proceedings, 7th International Conference on Fracture (ICF7), Houston, TX, March 20-24, 1989.

Invited Lectures

Klopp, RW. Techniques of failure analysis. In: Failure Analysis: The Science of What Went Wrong, ASME Professional Development Seminar/Webinar, Santa Clara, CA, March 23, 2013.

Guest lecturer, Engineering 448 - Electrical Power Systems, San Francisco State University, December 7, 2013.

Klopp, RW. Techniques of failure analysis. In: Failure Analysis: The Science of What Went Wrong, ASME Professional Development Seminar/Webinar, Santa Clara, CA, April 5, 2014.

Project Experience

Intellectual Property

Analyzed semiconductor wafer chemical mechanical polishing patents. Developed opinions relating to enablement and written description.

Characterized thermal strains in ball-grid-array semiconductor packages using Moiré interferometry for an International Trade Commission matter. Prepared interferograms that demonstrated infringement.

Characterized the adhesion between coatings and medicines for an IP dispute involving gel-coated pills.

Analyzed laser surgery fiber optic connector patents for infringement and invalidity. Testified in deposition.

Analyzed claim construction in gemstone laser micro-inscribing equipment patents and then analyzed the patents for infringement and invalidity. Testified in deposition, at a Markman hearing, and at trial.

Demonstrated that a patent on granular pesticide morphology claimed a natural phenomenon.

Analyzed design patent claims to folding pocketknives for functional features. Court adopted sections of expert report in summary judgment ruling of noninfringement.

Performed analysis supporting a successful Daubert motion to exclude reports and testimony relating to testing of handheld power tools for patent infringement. Demonstrated that plaintiff's testing was improper and conclusions based on them lacked sufficient basis.

Analyzed claims for a web-cam support asserted by a Patent Assertion Entity for anticipation and obviousness in light of prior art.

Analyzed linkage motion in fruit-pitting machinery in light of prior art linkages extending back to the time of James Watt and his steam engine.

Analyzed allegations that dimensions and manufacturing methods for sleeve bolts used in aerospace applications were trade secrets. Showed that dimensions easily could be reverse engineered from samples and public standards. Showed that manufacturing methods were commonly known in industry, easily reverse-engineered, and optional methods were known.

Deconstructed a WiFi-connected countertop smart oven and compared the physical parts with CAD files to determine the use of others' proprietary designs deep within the oven.

Demonstrated the detailed, microscopic structure of a high-speed data connector assembly during a trial, using live, unscripted 3D CAD fly-throughs and cross-sectioning.

Analyzed coal pulverizer designs to determine the extent of similarities between competitors' designs and the likelihood that similarities were due to happenstance versus copying.

Analyzed the designs of road mill drivetrains, the response of safety mechanisms, and steering arrangements as part of patent litigation and inter partes review before the Patent Trial and Appeal Board (PTAB).

Analyzed automotive and utility jack mechanisms as part of a patent inter partes review.

Analyzed stacking toolbox technology and patents as part of a proceeding before the International Trade Commission.

Machine Tools

Demonstrated the impact strength of CNC lathe guard windows by launching simulated workpieces at them using Exponent's automotive crash rail.

Surveyed a large lathe and identified numerous design and manufacturing defects.

Examined and tested a high-speed milling machine to diagnose and resolve an intermittent control fault.

Analyzed shop-wide machine tool lubrication system failures in light of the design and construction of such systems and oil contamination.

Analyzed the root cause of vacuum workholding failure and high-speed ejection of a workpiece from a CNC milling machine enclosure.

Assessed a manufacturer's and operator's care and use of a large engine lathe in view of industry standards of care and use. Assessed the design of the lathe's safety features in view of features on peer machines.

Able to set up and operate computer numerical control (CNC) machining centers with Fanuc and Haas controls, including cutting tool selection, work-holding selection, and programming.

Highly skilled manual lathe operator.

Cranes, Elevators, Escalators, and Mining Equipment

Performed a critical safety assessment of the controls for the cableways used to construct the Mike O'Callaghan – Pat Tillman Memorial Bridge (Hoover Dam Bypass), recommended modifications, and performed extensive testing.

Identified a critical design issue with the tower luffing bearings on the Hoover Dam Bypass cableways, and proposed a solution that avoided dismantling the cranes for repairs.

Determined the root cause of escalator chain failures involving lateral movement of connector pins that ostensibly were press-fit and secured with clips.

Assisted in machinery damage assessment after a fire at a facility for processing iron ore into pig iron via direct reduction.

Analyzed the root causes of failures of machinery plant-wide at an iron ore concentrator facility based on computer plant historian records and physical evidence, in light of claims of overall plant under-performance.

Analyzed damage to and repair of the world's largest tunnel boring machine being used to mine a tunnel to replace the Alaskan Way Viaduct in Seattle.

Food Machinery

Analyzed bearing failure in an ice cream freezer that resulted in a recall to address plastic material in the product.

Analyzed the rebuilding and subsequent failure of positive-displacement butter pumps that resulted in a recall to address plastic material in the product.

Analyzed contributions of mechanical component defects to fires in cracker baking and drink powder packaging lines.

Analyzed failures of wine fermenter heat exchangers leading to product contamination with coolant, and failures of wine fermenter tank hardware resulting in product spills.

Medical Devices and Equipment

Developed special machines to test the durability of neonatal warmer support arms and portable ventricular assist device pneumatic hoses.

Developed a time-lapsed cinematography technique to characterize micron-level motion of an insulin pump plunger at low dosage rates.

Analyzed the effect on dosage accuracy of insulin pump systems subjected to altitude changes.

Analyzed the collapse failure of an endoscope support arm during brain surgery, and collapse failure of a medical bed during eye surgery.

Water Supply, Wastewater, Natural Gas Piping and Plumbing

Determined that hydraulic jump due to improperly configured waste piping in a 42-story hotel/condominium building was the root cause of sewer backups.

Performed successful field testing of a large sewer line bladder plug in a remote location, coordinating with contractors sight-unseen.

Investigated numerous instances of cracking failure of enameled steel bathtubs used in hotels.

Tested the effect of out-of-tolerance polyethylene gas pipe on the integrity of a wide range of coupling methods.

Determined that water hammer associated with rapid closing of a fire hydrant was the root cause of underground pipe joint failures.

Led a multi-year, multi-million-dollar study on the design, manufacture, and maintenance of fire hydrants and the effect of different food-grade greases on corrosion of the valve operating mechanism.

Investigated multi-million-dollar hospital flood. Determined root cause was failure of ductile iron pipe bell and spigot joints due to lack of axial restraint. Identified actions by the designers, plumbers, and inspectors that, in combination, created conditions leading to the failure.

Investigated the root cause of erosion-corrosion failures of copper piping in a condominium complex with a hybrid domestic/hydronic hot water circulating system. Developed a flow model to demonstrate that the system could function correctly when properly balanced.

Successfully performed laboratory testing to replicate the slow crack growth field failure of a high-density polyethylene (HDPE) water main fitting at a fusion weld.

Investigated the root cause of electrofusion saddle fitting field failures and replicated failures in the laboratory.

Performed testing of gas distribution valves according to consensus standards, in order to qualify the valves for a public utility application.

Automotive Technology and Engines

Analyzed the depreciation of peer brands and models of cars in light of recall publicity.

Developed an analytical model for the behavior of truck power steering systems under impact conditions.

Determined the root cause of cylinder liner cracking in Fairbanks-Morse opposed-piston Diesel and gas engines.

Determined the root cause of the catastrophic failure of a Caterpillar marine engine.

Determined that repeated crankshaft fatigue failures in automobile engines used in an industrial application were due to vibrations peculiar to four-cylinder engines.

Determined the root cause of the catastrophic failure of a state-of-the-art piston engine powered by anaerobic digester gas at a wastewater treatment facility.

Analyzed repeated failures of various torsional couplings in engine-generator sets and the contributions of engine/coupling/generator spring-mass torsional vibration and engine speed controller response.

Builder of approximately 20 small internal combustion engines from raw materials, including a five-cylinder radial aircraft engine, multiple single-cylinder compression-ignition engines, six each opposed-piston horizontal twin-cylinder engines, and two hit-and-miss farm engines. The work includes fabricating piston rings, winding valve springs, and make fasteners from scratch.

Consumer Products

Tested window shade cord strangulation safety release devices as part of a Consumer Product Safety Commission (CPSC) inquiry.

Authored proposed Window Covering Manufacturers Association test standards for roll-up window coverings (shades). Standards are being revised to incorporate tests for cord release devices intended to reduce risk of child strangulation.

Analyzed existing and improved designs for pocketknife safety latch mechanisms as part of a CPSC inquiry.

Analyzed the design and manufacturing of tract home air conditioner coils in light of allegations of premature failure due to corrosion.

Tested automotive service jacks and jack stands according to industry consensus standards and representative misuse. Subjected jack stands to gross overload until failure, showing that a hypothesized failure event was inconsistent with facts.

Electricity Generation and Energy Transport

Determined the cause of malfunction of a generator brush spring mechanism that led to a flashover event and outage.

Analyzed the catastrophic over-speed failure of a steam turbine generator due to the combination of trip valve oxidation and governor valve wear.

Identified the root cause of gas turbine compressor blade damage in sister turbines based on physical evidence inspection, finite element analysis, and review of operating records.

Analyzed weld cracking due to vibration-induced fatigue that led to a flashover event in a steam turbine generator. Subsequently assessed the efficacy of tuning masses added to the generator housing to reduce vibration amplitudes.

Performed ISO 281 bearing capacity and life analysis for wind turbine main rotor bearings, considering bearing clearances and preloads.

Determined the failure of a steam turbine babbitt bearing was due to insufficient cooling and turning gear rotation following emergency shutdown.

Consulted on the analysis and repair of a steam turbine generator that was significantly damaged by an over-speed event and subsequent thermal shock.

Analyzed the root cause of lubrication system failure and ensuing damage in an 8,000-horsepower gas transmission turbo-compressor. Evaluated near-miss of a catastrophic gas explosion due to overheated rotating components in the presence of leaked gas. Provided recommendations for a simple hardware upgrade that would have mitigated the lubrication failure risk.