

Exponent®
Engineering & Scientific Consulting

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Professional Profile

Joseph Rakow, Ph.D., P.E., is a principal engineer and group vice president overseeing three Exponent practices: Mechanical Engineering, Thermal Sciences, and Vehicle Engineering. He has over 20 years of experience in composite structures, aerospace vehicles, turbine engineering, and mechanical failure analysis. He advises law firms, insurers, manufacturers, and government agencies on failure analysis, intellectual property disputes, and performance assessments across aviation, energy, consumer products, sporting goods, and industrial equipment.

Composite Structures & Materials

Dr. Rakow is a leading international expert in the failure analysis of composite structures, including high-performance carbon fiber reinforced plastics (CFRP), glass fiber reinforced plastics (GFRP), fiberglass, and sandwich structures. He advises clients on the root causes of composite failures arising from manufacturing, design, and use. His consulting spans the full lifecycle of composite components, from design and qualification through field use and field failures.

Dr. Rakow is a contributing author to the International Civil Aviation Organization (ICAO) *Manual of Accident and Incident Investigation* (Chapter 9: Composite Materials), he has authored peer-reviewed publications on composite laminate and sandwich structure failure, and he teaches introductory composites courses to the U.S. Department of Defense and to professional engineers through ASM International. Dr. Rakow also serves as Working Group Chair for the industry standards organization Composite Materials Handbook (CMH-17), funded by the Federal Aviation Administration and other agencies. He is a visiting lecturer in the Department of Aeronautics and Astronautics at Stanford University, and he has served as an expert witness in composite materials litigation and proceedings.

Aerospace Failure Analysis

Dr. Rakow provides failure analysis, design review, and performance assessment consulting for aircraft, spacecraft, and satellite systems. He advises aerospace manufacturers, insurers, and legal counsel on matters involving structural and mechanical failures, thermostructural damage, manufacturing nonconformances, and in-service degradation in fixed-wing aircraft, rotorcraft, launch vehicles, and commercial satellites. His work encompasses specialized mechanical systems as well as metallic and composite aerospace structures, with particular depth in the behavior of advanced materials under combined mechanical and thermal loading.

Dr. Rakow advised the U.S. Government Accountability Office on their Sept. 2011 report to Congress on the safety of composite commercial aircraft (Boeing 787, Airbus A380), and he holds a University of Southern California Aviation Safety and Security Certificate including Aircraft Accident Investigation, a program that utilizes Dr. Rakow's publications for course material. He is a long-time member of the

International Society of Air Safety Investigators, and he serves on the Industry Advisory Board for the Department of Aerospace Engineering at the University of Michigan and the External Advisory Board of the Department of Physics and Astronomy at the University of California, Davis. Dr. Rakow has testified as an expert witness in aviation-related personal injury, product liability, and international arbitration proceedings.

Dr. Rakow has specific and extensive experience with communications satellites and failure analysis, spanning his career of over 20 years. These engagements have been in the context of product development and system qualification, as well as in-service performance issues, consulting directly with OEMs. He has addressed failures in a wide variety of satellite subsystems, including primary structures; propellant systems; solar arrays; deployment and actuation mechanisms; antennae; stabilization and vibration control mechanisms; electronics hardware; and launch vehicle integration components. Dr. Rakow has led large multidisciplinary investigations into numerous on-orbit failures of communications satellites and their components. Through a combination of telemetry analysis, computational modeling, and physical ground testing, he has successfully identified the root cause of on-orbit failures, and he has worked with clients in implementing corrective actions that have been adopted in the industry.

Turbine Failure Analysis

Dr. Rakow conducts failure analysis and performance assessments for wind turbines, gas turbines, and steam turbines, advising energy producers, equipment manufacturers, insurers, and legal teams on the root causes of turbine component failures and the implications for continued operation, repair, or replacement. His wind turbine consulting — encompassing blades, bearings, towers, generators, gearboxes, hydraulic systems, and other components — provides structural integrity evaluations, and life extension analyses for aging fleets, representing a significant and internationally recognized portion of his practice. He applies the same rigorous analytical framework to gas turbine and steam turbine systems, addressing blade fractures, rotor dynamics, thermal fatigue, and manufacturing-related failure modes in power generation and industrial settings.

Intellectual Property Disputes

Dr. Rakow provides technical consulting and expert witness services in intellectual property (IP) litigation and patent disputes involving highly specialized mechanical devices, composite materials, aerospace systems, and industrial equipment. He assists counsel in evaluating infringement claims, assessing the validity of patents, and explaining complex mechanical and materials engineering concepts to judges, juries, and arbitration panels. He is particularly adept at designing and executing customized laboratory tests to evaluate product performance versus claim language.

Dr. Rakow’s IP work spans a wide range of unique and specialized mechanical systems — from proprietary manufacturing equipment to consumer products to advanced structural components — where deep engineering expertise is required to evaluate novelty, functionality, and alleged infringement, and ultimately provide expert witness testimony. Dr. Rakow is an inventor on two patents for specialized mechanical devices.

Specialized Mechanical Equipment

Dr. Rakow applies his broad mechanical and structural engineering expertise to the failure analysis and performance assessment of highly specialized — sometimes unprecedented — mechanical systems and industrial equipment. His consulting in this area spans power plant equipment, sporting equipment, consumer products, industrial machinery, transportation systems (cars, trucks, and specialized vehicles), and unique engineered devices encountered in manufacturing and processing environments. He leads multidisciplinary investigations that integrate laboratory testing, theoretical analysis, and numerical methods — including finite element analysis (FEA) — to deliver scientifically grounded conclusions for

clients facing high-consequence engineering challenges. Dr. Rakow is an elected Fellow of the American Society of Mechanical Engineers.

Academic Credentials & Professional Honors

Ph.D., Aerospace Engineering, University of Michigan, Ann Arbor, 2005

M.S., Aerospace Engineering, University of Michigan, Ann Arbor, 2000

B.S., Physics, University of California, Davis, 1999

Fellow, American Society of Mechanical Engineers

Top Conference Paper, International Society of Air Safety Investigators, 2006

Best Student Paper Award, American Institute of Aeronautics and Astronautics, 2004

Rollin M. Gerstacker Graduate Research Fellowship, University of Michigan, 1999

Citation of Excellence in Physics, University of California, Davis, 1999

Tau Beta Pi Engineering Honor Society

Sigma Pi Sigma Physics Honor Society

Licenses and Certifications

Professional Engineer Civil, California, #76562

Professional Engineer Mechanical, California, #33403

University of Southern California Aviation Safety and Security Certificate including: Aircraft Accident Investigation

NAUI Certified Open Water Diver

FEMA Urban Search and Rescue Program

Academic Appointments

Stanford University, Department of Aeronautics and Astronautics, Invited Lecturer

University of California - Davis, Department of Physics, Advisory Board

University of Michigan, Department of Aerospace Engineering, Industrial Advisory Board

Professional Affiliations

American Society of Mechanical Engineers

American Institute of Aeronautics and Astronautics

ASM International

International Society of Air Safety Investigators

Patents

Patent No. 7814597: Method and Apparatus For Determining Cloth And Fluid Motion In A Washing Machine, October 2010 (with J.M. Fife and A. Starkie).

Patent No. 8080498: Elastic Hollow Particles for Annular Pressure Buildup Mitigation, October 2009 (with P.D. Pattillo and J.E. Shepherd).

Patent Application No. 60/791,279: Convectively Cooled Sandwich Panel for Structural and Heat Exchange Applications, April 2006 (with A.M. Waas).

Publications

Moalli JE, Rakow JF, "Failure Causes of Composites." In ASM Handbook, Volume 21: Composites. ASM International, 2026.

Skujins, TS, Rakow JF, Pre-existing Fracture in a Helicopter Composite Rotor Blade System. Proceedings of the International Society of Air Safety Investigators Annual Conference, San Diego, CA, September 2017.

Rakow JF, Skujins, TS. Analysis of Aged Wind Turbines for Continued Operation. Wind Systems Magazine, Vol.09, Issue 07, p. 17-19, July 2017.

Rakow JF, Wilson, CL. Void Content in Out-of-Autoclave Manufacturing Processes. Proceedings of MS&T Microscopy and Microanalysis, July 2016.

Rakow AS, Edmonds JS, Rakow JF, Brody RD. Root cause failure analysis of a 373 megawatt steam turbine generator exhibiting both reversible and irreversible thermal sensitivity. Proceedings, ASME 2011 Power Conference, July 2011.

Rakow AS, Caflisch ML, Rakow JF. The role and process of machinery root cause failure analysis. Proceedings, Machinery Failure Prevention Technology Conference, April 2010.

Rakow JF, Pettinger AM. Failure analysis of composites: Sandwich structures. Adv Mater Processes 2009; 167(8):24-26, August.

Rakow JF, Pettinger AM. Failure analysis of composites: Laminate behavior. Adv Mater Processes 2009; 167(7):16-18, July.

Rakow JF, Pettinger AM. The emergence of composite aircraft: An introduction for aviation attorneys. Proceedings, SMU Air Law Symposium, February 2009.

Rakow JF, Pettinger AM. Failure analysis of composite structures in aircraft accidents. ISASI Forum, January-March 2007, p.17-23.

Rakow JF, Pettinger AM. Failure analysis of composites: A manual for aircraft accident investigators. First Edition, International Society of Air Safety Investigators, 2007.

Rakow JF, Waas AM. Response of actively cooled metal foam sandwich panels exposed to thermal loading. AIAA Journal 2007; 45(2):329-336.

Rakow JF, Waas AM. Thermal buckling of metal foam sandwich panels for convective thermal protection

systems. J Spacecraft Rockets 2005; 42(5):832-844.

Rakow JF, Waas AM. Size effects and the shear response of aluminum foam. Mech Mater 2005; 37(1):69-82.

Rakow JF, Waas AM. Thermomechanical response of actively cooled metal foam sandwich panels for thermal protection systems. Paper #2005-1953, AIAA Structures, Structural Dynamics, and Materials Conference, Austin, TX, April 2005.

Rakow JF, Waas AM. The response of actively cooled metal foam sandwich panels to thermal loads. Symposium on Materials and Structural Systems for Hypersonic Vehicles, ASME International Mechanical Engineering Conference, Anaheim, CA, November 2004.

Rakow JF. Thermomechanical response of metal foam sandwich panels in structural thermal protection systems for hypersonic vehicles. Ph.D. Dissertation, University of Michigan, Department of Aerospace Engineering, 2004.

Rakow JF, Waas AM. Thermal buckling of metal foam sandwich panels for actively cooled thermal protection systems. Paper #2004-1710, AIAA Structures, Structural Dynamics, and Materials Conference, Palm Springs, CA, April 2004.

Rakow JF, Waas AM. Size effects in metal foam cores for sandwich structures. AIAA Journal 2004; 42(7):1331-1337.

Rakow JF, Waas AM. The effective isotropic moduli of random fibrous composites, platelet composites, and foamed solids. Mech Adv Mater Struct 2004; 11(2):151-173.

Rakow JF, Waas AM. Size effects in metal foam cores for sandwich structures. Paper#2003-1946, AIAA Structures, Structural Dynamics, and Materials Conference, Norfolk, VA, April 2003.

Rakow JF, Waas AM. Shear deformation of aluminum foam produced by the melt route. Paper#P033, EuroFoam, Manchester, U.K., July 2002.

Selected Presentations

Rakow JF. An interactive case study on composite failure analysis. MS&T, Columbus, OH, October 2011.

Rakow JF. The role of manufacturing in solving composite product failures. Composites, Las Vegas, NV, February 2010.

Mitchell EA, Schwall ML, Rakow JF. Bicycle failure analysis and product liability. Interbike, Las Vegas, NV, November 2009.

Caflisch ML, Rakow JF. Failure analysis and reliability of wind turbines. Windpower, Chicago, IL, May 2009.

Rakow JF. Thermostructural failure in aviation-related accidents and incidents. Annual Conference of the International Society of Air Safety Investigators, Fort Worth, TX, September 2005.

Rakow JF, Waas AM. Thermomechanical response of metal foam core sandwich structures for hypersonic vehicles. Symposium on Materials and Structural Systems for Hypersonic Vehicles, ASME International Mechanical Engineering Conference, Washington, D.C., November 2003.

Rakow JF, Waas AM. Shear response of metal foams. Annual Meeting of the Society of Engineering Science, Ann Arbor, MI, October 2003.

Rakow JF, Waas AM. Metal foam sandwich structures for crashworthy applications. Automotive Composites Consortium, Ann Arbor, MI, November 2002.

Rakow JF. Bounds on elastic moduli for composite materials and metal foams. Sandia Summer Seminar Series, Livermore, CA, August 2001.

Rakow JF, Dike JJ. A comparison of inter-element continuity of stress-based quantities in hex and the finite element schemes in DOE in-house codes. Sandia Summer Seminar Series, Livermore, CA, August 2000.

Invited Presentations

Rakow JF. Tutorial: Investigating composite structures. International Society of Air Safety Investigators, Vancouver, Canada, August 2013.

Rakow JF, et al. Failure analysis: The science of what went wrong. ASME Professional Development Seminar, Santa Clara, CA, March 2013.

Rakow JF. Resolving marine claims with engineering and science. International Union of Marine Insurance, Paris, France, September 2011.

Rakow JF. Failure analysis of satellite components. Space Systems/Loral Bob Dodd Seminar, Palo Alto, CA, February 2009.

Rakow JF. Failure analysis of composite structures in aircraft accidents. Symposium on International Challenges in the Investigation of Air Accidents under Safety Management Systems, Santiago, Chile, November 2007.

Rakow JF. MRO and NDT: Managing damage and failure in composite aircraft structures. Swiss Re Center for Global Dialogue, Zurich, Switzerland, January 2007.

Rakow JF, Pettinger AM. Failure analysis of composites in aircraft accidents. New York City Bar Association, Aeronautics Committee, January 2007.

Rakow JF. Structural instabilities in advanced aerospace structures—Experimental and analytical techniques. Invited Speaker, NextGen Aeronautics, Torrance, CA, August 2004.

Rakow JF. Development of an advanced structural thermal protection system for aerospace vehicles. Invited Speaker, Aerospace Corporation, El Segundo, CA, April 2004.

Book Chapters

Rakow JF, Pettinger AM. Chapter 9. Structures Investigation: Composite Materials. Manual of Aircraft Accident and Incident Investigation, Part III, International Civil Aviation Organization, Doc 9756-AN/965.

Television

"Hijack," Surviving Disaster, Freemantle Media, October 2009.

"Plastic Planes," Dan Rather Reports, HDNet, September 2007.

"MythBusters: Shredded Airplane," Discovery Channel, September 2005.

"Coming Home: The Science of Re-entry," Discovery Channel, May 2003.

Additional Education & Training

Stanford Executive Program (SEP), Stanford University Graduate School of Business, 2024