



**Exponent**<sup>®</sup>  
Engineering & Scientific Consulting

## Joseph F. Rakow, Ph.D., P.E.

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### Professional Profile

Dr. Rakow advises clients on complex engineering problems from design, manufacturing, and qualification, to field use and field failures, with particular expertise in failure analysis. He leads diverse multi-disciplinary investigations to deliver scientific answers to clients' technical challenges. Dr. Rakow has expertise in the areas of mechanical, structural, and aerospace engineering, with extensive experience involving a wide variety of devices and components: gas, steam, and wind turbines; aircraft and spacecraft; industrial machinery; pumps, tanks, and pipelines; cars and trucks; cranes and lifts; consumer products; sporting equipment; and a variety of civil structures. Dr. Rakow employs laboratory experimental methods supplemented with theoretical and numerical analysis to identify and illustrate scientific solutions for clients.

Dr. Rakow has published a number of scientific articles and is frequently invited to present at national and international technical conferences, where he is well known for the failure analysis of composite structures. These include high-performance carbon and glass fiber composites as well as commercial-grade fiber-reinforced plastics (FRP) and fiberglass. He is a contributing author to the International Civil Aviation Organization (ICAO) Manual of Accident and Incident Investigation, having contributed the chapter on composites. He teaches introductory composites courses to the Department of Defense and to professional engineers through the American Society of Materials. He is also a Visiting Lecturer in the Aeronautics and Astronautics Department at Stanford University.

Dr. Rakow serves as the Director of Exponent's Mechanical Engineering Practice, and he is a Fellow of the American Society of Mechanical Engineers. Prior to joining Exponent, he held teaching and research positions at the University of Michigan and Sandia National Laboratories. As a volunteer, Dr. Rakow is a Structures Specialist with FEMA Urban Search & Rescue.

### Academic Credentials & Professional Honors

Ph.D., Aerospace Engineering, University of Michigan, Ann Arbor, 2004

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

Licensed Professional Mechanical Engineer, California, #M33403

Licensed Professional Civil Engineer, California, #C76562

NAUI certified SCUBA diver

University of Southern California Aircraft Accident Investigation Course

FEMA Urban Search and Rescue Program, Structure Specialist

## Professional Affiliations

American Society of Mechanical Engineers

American Institute of Aeronautics and Astronautics

American Society of Materials

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

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, Cafilisch 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.

Caflich 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.