Exponent
Failure Analysis Associates®

Exponent
149 Commonwealth Drive
Menlo Park, CA 94025

telephone 650-326-9400
facsimile 650-326-8072
www.exponent.com

Brad James, Ph.D., P.E., FASM

Principal Engineer and Practice Director

Professional Profile

Dr. Brad James is a Principal Engineer and the Director of Exponent's Materials and Corrosion Engineering practice. Dr. James specializes in failure analysis, failure prevention, and integrity assessment of engineering structures and components. His specific expertise includes metallurgy, materials science, fracture, fatigue, material degradation, corrosion, life prediction, and design.

In his many years of engineering experience, Dr. James has conducted hundreds of failure analysis investigations on widely varying engineering structures, ranging from miniscule medical devices to power-plant components. Dr. James also helps clients from various industries prevent failures, assess the integrity of their designs or equipment, as well as interact with governmental agencies. Dr. James has special interest in fractography, fracture mechanics, wear, corrosion, embrittlement phenomena, microstructural development, heat treatment, material selection, and welding and joining. The common thread in each of Dr. James' investigations is the application of metallurgical, materials science, and engineering mechanics fundamentals to help understand and solve complex problems.

Dr. James serves as a Lecturer for the Stanford University Material Science Engineering Department, where he teaches a graduate-level engineering failure analysis course. Dr. James also teaches graduate–level failure analysis and fracture mechanics courses as an Adjunct Professor for the Santa Clara University Mechanical Engineering Department. He has taught several courses for The American Society for Materials (ASM International) involving failure analysis, design, and life prediction/validation of medical devices, and has been a Visiting Lecturer at San Jose State University. Dr. James was the co-Chairman of the 2011 ASM International Materials and Processes for Medical Devices (MPMD) conference. Prior to joining Exponent, Dr. James was employed as a Research Engineer, Materials Performance Division, at the Babcock and Wilcox R&D Center.

Academic Credentials and Professional Honors

Ph.D., Metallurgical and Materials Engineering, Colorado School of Mines, 1994
B.S., Metallurgical Engineering, University of Washington, 1988

ASM International Fellow, 2011

Licenses and Certifications

Registered Professional Metallurgical Engineer, California, #MT1867

Publications

Briant P, Lieberman S, James B. Residual stress distribution in MP35N due to plastic deformation and comparison to finite element analysis. International Medical Device Conference and Expo, Chicago, IL, October 5–6, 2011, in press.

Briant P, Siskey R, Rau C, Easley S, James B. Effect of strain rate on nitinol constitutive modeling in the clinically relevant strain range. Proceedings, ASM Materials and Processes for Medical Devices, Minneapolis, MN, August 8–10, 2011, in press.

James B, Lieberman S. Analysis of a brake cylinder failure. Journal of Failure Analysis and Prevention 2011; 11:193–196.

James B, McVeigh C, Rosenbloom S, Guyer E, Lieberman S. Ultrasonic cleaning-induced failures in medical devices. Journal of Failure Analysis and Prevention 2010; 10(3): 223–227.

James B, Sire R. Fatigue-life assessment and validation techniques for metallic vascular implants. Biomaterials 2010; 31:181–186.

Fasching A, Kuş E, James B, Bhargava Y, Eiselstein L. The effects of heat treatment, surface condition and strain on nickel-leaching rates and corrosion performance in nitinol wires. Materials and Processes for Medical Devices, ASM International, Minneapolis MN, August 2009.

James B, Sire R, Caligiuri R. Determination of the failure mode and the rupture pressure in a mechanically damaged pipeline. Journal of Failure Analysis and Prevention 2008; 8(3):223–230.

Eiselstein L, Sire R, James B. Review of fatigue and fracture behavior of nitinol. ASM Symposium on Materials and Processes for Medical Devices, ASM International, pp. 135–147, Boston, MA, November 14–16, 2005.

James B, Eiselstein L, Foulds J. Failure analysis of NiTi wires used in medical applications. ASM International Journal of Failure Analysis and Prevention 2005; 5(5):82–87; Materials and Processes for Medical Devices, ASM International, pp. 44–49, St. Paul, MN, August 2004.

Eiselstein L, James B. Medical device failures—Can we learn from our mistakes? Proceedings, Materials & Processes for Medical Devices Conference, ASM International, pp. 3–11, August 2004.

James B, Wood L, Murray S, Eiselstein L, Foulds J. Compressive damage-induced cracking in nitinol. Proceedings, International Conference on Shape Memory and Superelastic Technologies, ASM International, pp. 117–124, Baden Baden, Germany, October 2004.

James B, Murray S, Saint S. Fracture characterization in nitinol. Proceedings, International Conference on Shape Memory and Superelastic Technologies, SMST Society, pp. 321–329, May 2003.

James B, Matlock D, Krauss G. Interactive effects of phosphorus and tin on carbide evolution and fatigue properties of 5160 Steel. 38th Mechanical Working and Steel Processing Conference, Vol. XXXIV, pp. 579–590, October 1996.

Jones D, Hoppe R, Hechmer J, James B. An experimental study on the effects of compressive stress on the fatigue crack growth of low-alloy steel. Journal of Pressure Vessel Technology 1994; 116:317–324.

James B. Interactive effects of phosphorus and tin on carbide evolution and fatigue and fracture properties in 5160 steel. Ph.D. Thesis, Colorado School of Mines, 1994.

Merlano N, James B, Matlock D, Krauss G. Effects of tempering and residual element content on mechanical properties of 5160H steel. Proceedings, Gilbert R. Speich Symposium, Iron and Steel Society, pp. 101–109, Montreal, Canada, October 1992.

James B, Paul L, Miglin M. Low cycle fatigue crack initiation in SA-210 A1 carbon steel boiler tubing in contaminated boiler water. Proceedings, Pressure Vessels and Piping Conference, ASME-PVP Vol. 195, pp. 13–19, Nashville, TN, June 1990.

Presentations/ Seminars

James B. Nitinol processing, properties and design. ASM MPMD lecture, Medtronic Vascular, Galway, Ireland, December 2010.

James B. Fracture, fatigue and corrosion for medical device engineers. ASM MPMD lecture, Medtronic Vascular, Galway, Ireland, December 2010.

James B. Failure analysis for medical device engineers. ASM MPMD lecture, Medtronic Vascular, Galway Ireland, December 2010.

James B. Fracture surface interpretation. Invited lecture, St. Jude Medical Cardiac Rhythm Management Division, Sylmar, CA, September 2010.

James B. Medical device fatigue design. Invited lecture, Medtronic Cardiovascular Innovation Seminar (CVIS), Santa Rosa, CA, July 2010.

James B. Fatigue design and validation of implantable medical devices. Invited lecture, St. Jude Medical, Cardiovascular Division, Maple Grove, MN, January 2010.

James B. Ultrasonic cleaning-induced failures in medical devices. Materials and Processes for Medical Devices, ASM International, Minneapolis MN, August 2009.

James B. Fatigue design and validation of implantable medical devices. Invited lecture, United States Food and Drug Administration (USFDA) Office of Science and Engineering Laboratories (OSEL) Science Seminar, June 2009.

James B. Medical device failures—Lessons learned. Invited lecture, Bio2Device Group, Sunnyvale, CA, March 2009.

James B. Medical device design validation and failure analysis. Materials and Processes for Medical Devices, ASM International Educational Course, 2008–present.

James B. Medical device failure analysis—Practice and pitfalls. Invited lecture, ASM International, Materials and Processes for Medical Devices Conference, Cleveland Clinic, August 2008.

James B. Medical device failure analysis. Invited lecture, San Jose State University, April 2008.

James B. Failure analysis for the medical device engineer. Materials and Processes for Medical Devices, ASM International Educational Course, 2005–2007.

James B. Fracture, fatigue and corrosion for the medical device engineer. Materials and Processes for Medical Devices, ASM International Educational Course, 2005–2007.

James B. Engineering design for medical device fracture, fatigue and corrosion performance. ASM International, Materials and Processes for Medical Devices Conference, Cleveland Clinic, October 2006.

James B. Medical device failure analysis. Invited lecture, San Jose State University, July 2006.

James B. Nitinol fatigue and fracture—Beyond the fundamentals. Invited lecture, International conference on shape memory and superelastic technologies, Monterey, CA, May 7, 2006.

James B. Compressive damage-induced cracking in nitinol. International Conference on Shape Memory and Superelastic Technologies, ASM International, Baden Baden, Germany, October 2004.

James B. Failure analysis of NiTi wires used in medical applications. Materials and Processes for Medical Devices, ASM International, St. Paul, MN, August 2004.

James B. Metallurgical failure analysis. Invited lecture, Stanford University, April, 2004.

James B. Fracture characterization in nitinol. International Conference on Shape Memory and Superelastic Technologies, SMST Society, May 2003.

James B. Interactive effects of phosphorus and tin on carbide evolution and fatigue properties of 5160 Steel. 38th Mechanical Working and Steel Processing Conference, Cleveland OH, October 1996.

James B. Effects of tempering and residual element content on mechanical properties of 5160H steel. Gilbert R. Speich Symposium, Iron and Steel Society, Montreal, Canada, October 1992.

James B. Low cycle fatigue crack initiation in SA-210 A1 carbon steel boiler tubing in contaminated boiler water. Pressure Vessels and Piping Conference, ASME, Nashville, TN, June 1990.

Current Academic Appointments

- Lecturer, Stanford University, Materials Science and Engineering Department
- Adjunct Professor, Santa Clara University, Mechanical Engineering Department

Editorial Boards

- *Journal of Failure Analysis and Prevention*

Peer Review

- ASM Handbook, Volume 19, *Fatigue and Fracture*
- *Biomaterials*
- *Materials Engineering and Performance*
- *Acta Biomaterialia*

Professional Affiliations

- ASM International (member)
- International Organization on Shape Memory and Superelastic Technologies (member)
- ASTM International, Committees E08 – Fatigue and Fracture, F04 – Medical and Surgical Materials and Devices

Project Experience

The following provides a brief list of Dr. James' project experience within several industries.

Medical Devices

Dr. James has conducted hundreds of medical device failure analysis investigations. He has also assisted dozens of device manufacturers assess and validate device fatigue and corrosion performance of their implants and surgical tools. Selected examples are as follows:

- *Cardiovascular implants*: Has conducted failure analysis investigations of dozens of stents, filters, and coronary/peripheral devices. Also has directed several fatigue, corrosion, and/or fretting studies of cardiovascular implants for various medical device manufacturers.
- *Pacemakers*: Has conducted several failure analysis investigations of fractured pacemaker leads. Dr. James has also helped pacemaker manufacturers with lead material selection, as well as fatigue and corrosion testing and validation.
- *Orthopedic implants*: Dr. James has conducted failure analysis investigations on dozens of orthopedic implants, including hip and knee prostheses, pedicle screws, bone plates, nails, and various other joint prostheses. He has also evaluated metallurgical, embrittlement, fatigue, coating, and corrosion issues to help manufacturers solve problems or validate device performance.
- *Heart Valves*: Has investigated several heart valve failures, and has extensive experience conducting and reviewing fatigue testing programs to help validate heart valve fatigue performance.
- *Catheters*: Has helped manufacturers design and develop catheters, as well as validate fatigue performance and investigate failures.
- *Surgical tools*: Dr. James has conducted several failure analysis investigations of surgical tools that have fractured or failed during service. He has also helped manufacturers conduct surgical tool fracture, fatigue, corrosion, and embrittlement studies.
- *Needles*: Has conducted failure analyses to determine the cause of needle breaks, as well as examined the effect of manufacturing processes on needle sharpness.
- *Neuro-implants*: Has conducted failure analysis investigations of neuro-vascular implants, as well as helped manufacturers validate neuro-vascular device fatigue performance.
- *Diabetes/insulin monitoring devices*: Has conducted failure analyses of insulin monitoring devices, as well as assisted manufacturers with coating and electrode development.
- *Obesity devices*: Dr. James has helped manufacturers develop and test various obesity devices.
- *Ventricular-assist devices*: Has conducted failure analysis investigations, fatigue performance validation, and material selection of ventricular-assist devices.
- *Corrosion testing*: Experience with potentiodynamic, open-current leaching, galvanic, and fretting testing to assess expected implant corrosion performance.

Pipelines

Dr. James has conducted dozens of failure analysis investigations of liquid and gas transmission pipelines and components. Dr. James has also helped assess the fitness for service and flaw tolerance of pipelines and associated components. The following list a few examples of his pipeline work.

- *Hydrotest failure analyses*: Dr. James has conducted failure analysis investigations to determine the cause of gas pipelines that ruptured during hydrotesting.
- *Sierra-Nevada Pipeline Leak*: Analyzed a pipeline leak in the Sierra-Nevada mountains that occurred due to damage from improper installation that occurred some 50-years prior to the leak. The local damage resulted in increased stresses that initiated slow-growing "near-neutral" stress-corrosion cracking.

- *LEFM-fatigue analysis*: Assessed the risk of fatigue-crack growth, leakage, and rupture in pipelines with seam-weld defects of varying depths and lengths using linear-elastic fracture mechanics. This work provided the basis for the client to establish a methodology for seam-weld defect assessment.
- *Estuary pipeline rupture*: Investigated the cause of a pipeline rupture that occurred within an estuary. Evaluated the cause and extent of corrosion that led to the rupture.
- *High pH SCC rupture*: Evaluated the cause of a gasoline pipeline rupture that occurred in a high-population area in Arizona. The cause of the rupture was high-pH stress-corrosion cracking (SCC). Dr. James recommended hydrotesting of adjacent pipeline areas, which revealed other SCC locations that were close to rupture.
- *Nevada 3rd party damage*: Conducted a failure analysis investigation of a gasoline pipeline that leaked in the desert outside of Las Vegas. This pipeline had suffered a gouge from third-party digging. A fatigue crack initiated from the gouge and eventually grew through wall to cause a leak.
- *Bellingham Washington pipeline*: Helped investigate the cause of a ruptured gasoline pipeline rupture that tragically killed three youths. Dr. James participated in investigations at the NTSB and Exponent laboratories. The pipeline failed several years after it had been severely damaged by an excavator.
- *Seam weld defect- Sacramento*: Investigated the cause of a gasoline pipeline leak that occurred along an electric-resistance weld (ERW) seam near Sacramento, CA. The leak was caused by fatigue crack growth that initiated and grew from the seam weld defect.
- *Seam weld defect – Texas*: Investigated the cause of a gasoline pipeline rupture that occurred in Texas. Metallurgical examination indicated the rupture occurred at an improperly welded ERW seam. A fatigue crack initiated and grew in the weld seam until it reached sufficient length to cause the rupture.
- *Australian Gas Pipeline SCC risk assessment*: Participated in a study to assess the risk of rupture in an Australian natural gas pipeline that exhibited significant stress corrosion cracking (SCC). This analysis included using the results of in-line inspection coupled with fracture mechanics to help determine the risk of rupture.
- *Attachment vibration-induced fatigue*: Participated in a root-cause failure analysis investigation to help determine why several pump-station attachment piping fractured in a newly commissioned gas pipeline. The analysis confirmed that significant choked-flow conditions resulted in harmonic vibration-induced fatigue in attachment piping.

Food/Chemical Processing

Dr. James has conducted several failure analysis investigations of various food and chemical processing industry components. A representative list is shown below.

- *Process piping weld specifications*: Helped a food-processing plant revise their weld specification, testing, and validation procedures to eliminate leaks and stress-corrosion cracking of their 316L jacketed piping.
- *Food processing piping failures*: Examined the cause of leaks, fractures, and ruptures of piping and associated equipment in food processing plants. These failures have been caused by poor welding, vibration-induced fatigue, and stress-corrosion cracking.

- *Ammonia refrigeration piping failures*: Examined and determined the cause of failures in ammonia refrigeration units for ice cream and fruit processing plants. These failures have been caused by insufficient supports, vibration, and poor welds.
- *Chemical processing valve*: Determined the cause of failure of a large gate valve at a chemical processing plant. A combination of insufficient bolt torque and vibration resulted in insufficient bolt clamping force, which resulted in fatigue failure.
- *Piping creep*: Inspection of piping at a chemical processing plant revealed local bulging of adjacent piping. The cause of the failure was creep-rupture from excessive temperatures, and that the higher than desired temperatures occurred because of deposits that restricted cooling.
- *Valve bolt failures*: Bolts at a gasoline processing facility fractured causing a large loss. Analysis indicated that the bolts fractured due to stress-corrosion cracking. Material and environmental changes were recommended to eliminate the problem.
- *Tee failure*: A tee at an oil refinery ruptured resulting in release of product and environmental damage. Metallurgical analysis indicated that the tee failed due to a creep-rupture mechanism, caused by excessive temperature.
- *Ethanol storage tank weld*: An ethanol storage tank fractured at a weld, resulting in significant loss of product and damages. Analysis indicated that the tank fractured from stress-corrosion cracking at the weld heat-affected zone.
- *Gasoline storage tank failure analysis and integrity assessment*: Analyzed the cause of a gasoline tank failure, and conducted a fracture mechanics-based fitness for service analysis for floor-to-shell repair welds.

Structural

Besides piping and other infrastructure analyses, Dr. James has conducted metallurgical failure analysis investigations on many structural components, including several scaffolding and crane failures. Listed below is a sampling of Dr. James' metallurgical analyses of engineering structures.

- *Olympic stadium bolt failure*: Examined the cause of bolt failures that occurred during construction of the Salt Lake City Olympic stadium.
- *Swing scaffolding*: A scaffolding supporting workers on the side of a building in Sacramento fractured, resulting in significant injuries. Metallurgical analysis, including fractography, metallography, fracture toughness, and tensile testing indicated the cause of the failure was overload.
- *Paint Scaffolding*: A hoist connection of a swing scaffolding fractured in San Francisco, resulting in significant injuries to one of the workers. Failure analysis indicated the hoist connection suffered bending-induced fatigue crack initiation and growth due to scaffold misuse.
- *Bay Bridge scaffolding*: Portions of an aluminum scaffolding used for painting the San Francisco/ Oakland Bay Bridge fractured, resulting in a worker's death. Metallurgical analysis, including fractography, metallography, and mechanical property testing, in combination with weld and structural analysis was used to determine the cause of the failure.

- *Las Vegas sign welds*: Analyzed welds that fractured in a high-rise sign during a windstorm to determine whether proper welding procedures were followed.
- *Cranes*: Dr. James has conducted several crane failures. These analyses have included root-cause assessment of wire rope, axle, rail, lug, and attachment cracking and fractures.

Fire Protection

Dr. James has extensive experience conducting failure analysis investigations of fire protection components. These analyses include determining the cause of many unintended sprinkler activations, as well as analysis of sprinkler piping leaks and ruptures. Selected examples of Dr. James' fire protection analyses are listed below:

- *Fire sprinkler*: Dr. James has conducted many failure analyses of fire protection sprinklers that either activated in the absence of a fire or did not activate as designed. These have included many fusible-link solder as well as glass-bulb sprinkler designs.
- *Sprinkler pipe weld-o-let leaks*: Examined the cause of sprinkler pipe weld-o-let leaks in a large government building. Assessed the leaks and the likelihood that any additional could occur after hydrotesting.
- *Sprinkler Pipe*: Dr. James has conducted several analyses of fire-protection sprinkler piping that ruptured or leaked. Causes of the failures have been ranged pitting (and possible microbial-influenced corrosion), grooving corrosion, improper roll-grooving, and freezing.
- *Corrugated stainless steel piping*: Investigated the cause of leakage in a corrugated welded stainless steel sprinkler piping. Fractographic and metallographic examination indicated sensitization and stress corrosion cracking.
- *Fitting fracture*: Dr. James had examined several fire sprinkler-system fitting fractures to determine the cause of failure.

Aerospace and Motor Vehicle

Dr. James has conducted several aerospace and motor vehicle failure analysis investigations. These investigations typically involve metallurgical and mechanical analyses to examine the cause of a component failure, or to assess the integrity or expected lifetime of a specific component.

- *Cut copper conductors*: Helped predict the remaining life of stranded copper conductors that had been cut during the fabrication of a satellite using both stress-life and fatigue-crack growth methodologies.
- *Ultrasonic weld fatigue*: Conducted analysis and testing to predict the fatigue performance of ultrasonically welded components in satellite applications.
- *Single-engine airplane propeller shaft*: Conducted a root-cause failure investigation of a propeller shaft that fractured in service. The subject shaft fractured due to unidirectional torsional fatigue.
- *Steering knuckle investigation*: A rash of steering knuckle failures was observed in specific sport utility vehicle. Dr. James conducted a metallurgical investigation into the cause of the failures and presented the results to NTSA on behalf of the client.

- *Engine Mount*: Determined whether a broken engine mount could have contributed to a vehicle crash. Analysis confirmed the knuckle fractured by overload, and therefore was broken during the crash, rather than causing it.
- *Spot weld analyses*: Dr. James has participated in several analyses to examine fractured spot welds following vehicle accidents. These analyses assess spot weld size and failure mode.
- *Steering system failure analysis*: Dr. James has investigated several steering system failures, including projection weld fractures and bellows cracking.
- *Motorcycle gas tank ejection*: Examined fasteners associated with the gas tank ejection following a motor cycle accident. Conducted testing to determine the amount of thread engagement necessary to recreate the accident bolt features as well as to retain the tank in an accident.
- *Chopper weld failure analysis*: Conducted a failure analysis investigation of broken welds in a custom chopper to assess failure mode and any welding issues.
- *Wheel-off*: Dr. James has conducted several investigations of wheel assemblies that became detached from the vehicle while driving. These studies have included fractographic examination of the bolts, loosening studies, torque versus pre-load calculations, examination of the effect of painted hubs, and Goodman-based fatigue calculations of fatigue life as a function of bolt torque and pre-load.
- *Leaf spring failure analysis*: Dr. James' Ph.D. thesis involved embrittlement, fracture, and fatigue of leaf-spring steel, and he has done several failure analysis investigations of leaf springs that fractured in service.
- *Brake cylinder*: Conducted an investigation of a fractured brake cylinder involved in a meter maid traffic accident. The investigation determined that the brake cylinder indeed fractured, resulting in the accident. Improper assembly, just prior to the accident, cracked the cylinder leaving it susceptible to failure.

Sporting Goods

Dr. James has conducted failure and life assessment analyses for both industrial and legal clients. Examples of these investigations are listed below:

- *Bicycle fork analyses*: Dr. James has conducted several examinations that have involved determining the cause of bicycle fork failures. He has also worked directly with manufacturers to examine potential metallurgical issues involving bicycle forks.
- *Seat-post bolts*: Conducted multiple failure investigations of broken seat-post bolts.
- *Bicycle weld analysis*: Assisted a bicycle manufacturer with the evaluation of novel welding materials and methods with metallurgical and mechanical testing.
- *In-line skate bolt fatigue analysis*: conducted fatigue testing and analysis for an in-line skate manufacturer. Based on results, recommended bolt grade, size, and torque levels to client.

Electronics

Dr. James has conducted failure analysis investigations and life testing for industrial and legal electronics clients. Representative analyses are listed below:

- *Ultrasonic welded ignition module*: Conducted a failure analysis investigation of a diesel engine ignition module that had an ultrasonically-welded lead fracture that reportedly resulted in engine stall and an accident. Although severe post-fracture damage was observed, the lead fracture was determined to have been caused by thermal fatigue.
- *Capacitor fatigue*: Participated in an analysis to determine the cause of capacitor fractures. Fractographic analysis combined with finite element modeling indicated that the capacitors fractured in reverse-bending fatigue due to harmonic oscillation during service.
- *Cables and strain reliefs*: Dr. James has conducted several strain-relief failure analysis investigations for both electronics and medical device manufacturers. He has also conducted several fatigue life analyses, including testing, to assess and predict cable strain-relief fatigue performance.