

**Charles A. Rau, Jr., Ph.D., P.E.**  
**Principal Engineer**

**Professional Profile**

Dr. Charles Rau is a Principal Engineer based in Exponent's Materials and Corrosion Engineering practice. He specializes in failure analysis, life prediction, design, and testing. Dr. Rau focuses on issues related to fatigue, fracture, and corrosion of materials. In addition, his research includes assessment of structural and mechanical designs, human performance, mechanical reliability, and risk prediction, as well as manufacturing technology, quality control, nondestructive inspection, and accident reconstruction. Dr. Rau's expertise includes aircraft, railroad, and automotive equipment; explosions; pressure vessels and tanks; piping; boilers and steam generators; tubing; firearms; turbines and rotating equipment; and welded steel structures. Dr. Rau has served as a Vice President and Office Director at Exponent.

Previously, Dr. Rau held various research and engineering management positions with the Pratt & Whitney Aircraft Division of the United Technology Corporation and Union Carbide Corporation. He has also taught in the Graduate School of Metallurgy at the University of Connecticut and lectured at Penn State University, UCLA, Lehigh University, and San Jose State University.

**Academic Credentials and Professional Honors**

Ph.D., Materials Science and Engineering, Stanford University ("The Effect of Drilled Holes on Notch Toughness"), 1967

M.S., Materials Science and Engineering, Stanford University (University Honors Fellowship), 1965

B.S., Metallurgical Engineering, Lafayette College (Outstanding Metallurgical Engineering Graduate, College Scholars Program), 1963

Phi Beta Kappa; Tau Beta Pi; Alpha Sigma Mu

**Licenses and Registrations**

Registered Professional Engineer, California, #CR835

Registered Professional Engineer, Saskatchewan, Canada, #7369

## Publications

“Probabilistic Fracture Mechanics Evaluation of Local Brittle Zones in HSLA-80 Steel Weldments,” *Fracture Mechanics: Twenty-Third Symposium*, p. 808, ASTM STP 1189, R. Chona (ed.), American Society of Mechanical Engineers, Philadelphia, PA, 1993 (with L.E. Eiselstein, D.O. Harris, and T.M. Schoonover).

“Analyzing Failures - Some Advice and Examples,” *Mechanical Engineering*, Vol. 106, No. 7, p. 22, 1984 (with J.N. Robinson).

“Probabilistic Fracture Mechanics Can Improve Failure Analysis,” *Heat Treating*, p. 32, June 1982.

“Analysis of a Turbine Rotor Containing a Transverse Crack...,” *Rotor Dynamic Instability Problems in High Performance Turbine Machinery*, NASA Publication 2250, 1982 (with G. Rogers et al.).

“Statistical Aspects of Design: Risk Assessment and Structural Integrity,” *Philosophical Transactions*, A 299, p. 111–130, The Royal Society of London, 1981 (with P.M. Besuner).

“Prediction of Structural Crack Growth Behavior Under Fatigue Loading,” *Fatigue Crack Growth Measurement and Data Analysis*, ASTM STP 738, p. 256, 1981 (with S.W. Hopkins).

“The Role of Micromechanics Models in Risk Analysis,” *Metal Science*, p. 463–472, The Metals Society, London, England, 1980 (with P.M. Besuner and K.G. Sorenson).

“Quantitative Decisions Relative to Structural Integrity,” *Journal of Engineering Materials and Technology*, Vol. 102(1), 1980, p. 56 (with P.M. Besuner).

“The Impact of Inspection and Analysis Uncertainty on Reliability Prediction and Life Extension Strategy,” Proceedings Defense Advanced Research Projects Agency/U.S. Air Force, Review of Progress in Quantitative Nondestructive Evaluation, AFML-TR-78-205, 1979.

“Failure Analysis and Failure Prevention in Electric Power Systems,” *Nuclear Engineering and Design*, Vol. 43, p. 1, 1979.

“Risk Analysis by Probabilistic Fracture Mechanics,” *Product Engineering*, p. 41, October 1979 (with P. Besuner).

“Flow Localization and the Fracture Toughness of High Strength Materials,” *Fracture 1977*, Vol. 1, p. 215, 1977 (with T. Cook and E. Smith).

“The Effects of Inclusions on the Fracture Toughness of High Strength Materials,” Proceedings, NANCY Conference, p. 490, 1977 (with T.S. Cook and E. Smith).

“The Effect of Various Programmed Overloads on the Threshold for High Frequency Fatigue Crack Growth,” ASTM STP 595, 1976 (with S.W. Hopkins, G.R. Leverant, and A. Yuen).

“The Modeling of Flow Concentration in Two-Phase Materials,” *Journal of Engineering Materials and Technology*, ASME H, Vol. 98(2), p. 180, 1976 (with T.S. Cook and E. Smith).

“A Critical Review of Anisotropic Fracture Mechanics,” *Prospects of Fracture Mechanics*, Leyden, Nordhoff, The Netherlands, 1974 (with T.S. Cook).

“Correlations Between Fracture Surface Appearance and Fracture Mechanics Parameters for Stage II Fatigue Crack Propagation in Ti-6Al-4V,” *Metallurgical Transactions*, Vol. 5(8), p. 1833–1842, 1975 (with A. Yuen, S.W. Hopkins, and G.R. Leverant).

“Thermal-Mechanical Fatigue Crack Propagation in Nickel and Cobalt Base Superalloys Under Various Strain-Temperature Cycles,” ASTM STP 520, 1973 (with A. Gemma and G. Leverant).

“Fatigue Crack Propagation from Small Holes in Linear Arrays,” *International Journal of Fracture Mechanics*, Vol. 9(1), p. 43–51, 1973 (with L. Burck).

“Fatigue of Nickel-Base Superalloy Sheets Containing Various Diameter Small Holes,” *Engineering Fracture Mechanics*, Vol. 2, p. 211–221, 1971 (with L. Burck).

“The Stress Distribution Around a Crack Perpendicular to an Interface Between Materials,” *International Journal of Fracture Mechanics*, Vol. 6, p. 357–365, 1970 (with D.O. Swenson).

“Elastic-Plastic Strain Concentrations Produced by Various Skew Holes in a Flat Plate Under Uniaxial Tension,” *Experimental Mechanics*, Vol. 11(3), p. 133–141, 1970.

“Effect of Two Drilled Holes on the Elastic and Elastic-Plastic Strain Distribution Around a Charpy V-Notch,” *Experimental Mechanics*, Vol. 10(9), p. 1, 1970.

“The Effect of Thickness and Drilled Holes on the Notch-Toughness of Charpy V-Notch Bars,” *Fracture* 1969, Chapman and Hall, London, 1969 (with A.S. Tetelman).

“The Critical Tensile Stress Criterion for Cleavage,” *International Journal of Fracture Mechanics*, Vol. 4(2), p. 147–157, 1968 (with A.S. Tetelman and T.R. Wilshaw).

“A General Model to Predict the Elastic-Plastic Stress Distribution and Fracture Strength of Notched Bars in Plane Strain Bending,” *Engineering Fracture Mechanics*, Vol. 1, p. 191–211, 1968 (with T.R. Wilshaw and A.S. Tetelman).

“Strength Through Holes,” *New Scientist*, Vol. 103, April 14, 1966 (with A. Tetelman).

“The Effect of Small Holes on the Notch Toughness of Iron-Base Alloys,” Proceedings, First International Conference on Fracture, Vol. 2, p. 691–709, 1965 (with A.S. Tetelman).

## **Presentations**

“Probabilistic Assessment of Crack Initiation and Growth in Shrunk-On Disks,” Life Prediction of Corrodible Structures International Conference, Cambridge, U.K., NACE International, September 1991 (with L.E. Eiselstein et al.).

“Connections of Jumbo Sections: Cracking, Testing Criteria and Flaw Tolerance,” Eighth International Conference on Metal Structures, Gdansk, Poland, 1989, *Inzynieria i Budownictwo*, December 1990 (with P. Moncarz).

“Stress and Fracture Mechanics Analysis of Weld Cracking in a Rotary Ball Mill,” American Society of Mechanical Engineers Winter Annual Meeting, Paper 89-WA/DE-17, San Francisco, CA, December 1989 (with K. Parnell, H. Wachob, and E. Kennedy).

“Failure Analysis of the Collapse of a Welded, Hollow Section Steel Coal Load-Out Structure,” Stanford University, May 1988.

“Personnel Errors and Power Plant Reliability,” Reliability and Maintainability Symposium, Institute of Electrical and Electronics Engineers, 1980 (with J. Finnegan, T. Rettig, and J. Weiss).

“Elastic/Plastic Fracture Mechanics,” Intensive Course in Fracture Analysis Applications and Limitations, San Jose State University School of Engineering, San Jose, CA, May 1982.

“Application of Risk Analysis to Aircraft Products Litigation,” Society of Air Safety Investigators, September 1981.

“Failure Analysis and Risk Assessment,” Am. Public Works Association, San Francisco, CA, 1981.

“Failure Analysis - Strategies to Prepare for Human Error and Risk,” Construction Industry Manufacturers Association Annual Meeting, Chicago, IL, 1981.

“Role of Microstructural Mechanisms on Structural Reliability,” Joint ASM and SEM Meeting, Santa Clara, CA, 1980.

“Practical Applications of Damage Tolerant Designs,” UCLA, April 1980.

“Fracture Mechanics Technology in the Nuclear Power Industry,” WESTEC 1976, Los Angeles, CA, March 1976.

“The Modeling of Flow Concentration in Two-Phase Materials,” ASME, Troy, NY, June 1975 (with T. Cook and E. Smith).

“Fatigue Crack Propagation,” Materials Science Symposium of TMS AIME, October 1974 (with G. Leverant and S. Hopkins).

“The Influence of Directional Solidification on the Thermal-Mechanical Fatigue Crack Propagation in Nickel-Base Superalloys,” TMS AIME Spring, 1974 (with G. Leverant and B. Langer).

“Micromechanics of Yielding and Strain Hardening in Precipitation Hardened Materials, Part I—Ordered Precipitates, Part II - Comparison of Precipitate Types,” TMS AIME Spring Meeting, 1974 (with T. Cook, E. Smith, and D. Swenson).

“The Influence of Hole Drilling Technique on the Low Cycle Fatigue Properties of a Wrought Nickel-Base Superalloy,” TMS AIME Spring Meeting, 1974 (with B. Langer and G. Leverant).

“The Effect of a Monolayer of Surface Grains on the High Cycle Fatigue of Single Crystal and Directionally-Solidified Nickel-Base Superalloy,” TMS AIME, Philadelphia, PA, 1973.

### **Conferences Attended**

- National Association of Corrosion Engineers, International Symposium, Cambridge, U.K., 1991
- Failure Analysis of Corrosion Related Problems, NACE, Los Angeles, California, 1986
- Metal Treating Institute, Spring Meeting, Monterey, California, 1982
- Air Transport Association Nondestructive Testing Forum, Long Beach, California, 1980
- Micromechanisms of Crack Extension, University of Cambridge, England, 1980
- The Royal Society, Fracture Mechanics in Design and Service, London, England, 1979
- Structural Integrity Technology Conference, ASME, Washington, D.C., 1979
- Progress in Quantitative NDE, DARPA / USAF, San Diego, CA., 1978, 1979, 1980, 1981, 1982
- Symposium on Fatigue at Elevated Temperatures, University of Connecticut, 1972
- International Conferences on Fracture, 1965, 1969, 1973, 1977

### **Professional Affiliations**

American Society for Metals—ASM International (Fellow); The Metallurgical Society—AIME (member); American Society of Mechanical Engineers (member); Society for Experimental Mechanics (member); American Society for Testing and Materials (member); National Association of Corrosion Engineers—NACE International (member); American Nuclear Society (member)