Introduction

Since the 1950s, the development of the field of "fatigue mechanics" has been driven by several major observations. First, Irwin's crack-tip stress-field analysis and the monumental "stress-intensity factor" at the Naval Research Laboratory laid the foundation for future discoveries. Using the "cyclic" stress-intensity factor range, Paris and Anderson at the Boeing Company produced overwhelming data to support the correlation of fatigue-crack growth rate behavior for metallic materials. At the same time, a group under Hardrath at NACA (later NASA), also studying the fatigue-crack growth phenomenon, made a similar observation concerning a "sharp notch" stress-field parameter. McEvily and Illg's notch-root stress-field parameter correlated fatigue-crack growth rate data equally as well as the cyclic stress-intensity factor range. Later, it was shown that the notch-root parameter was directly proportional to the stress-intensity factor. But the eloquence and momentum of the "stress-intensity factor" quickly displaced the notch-root parameter throughout the aerospace industry. Surprisingly, a decade of research on fatigue-crack growth had failed to uncover the next major discovery.

In 1968, Elber at the University of New South Wales observed that fatigue-crack surfaces contact with each other even during tension-tension cyclic loading. This simple observation and the explanation of the crack-closure phenomenon began to explain many other crack-growth characteristics almost immediately. Hardrath, to whom this symposium and book are dedicated, recognized very quickly the importance of the crack-closure concept in fatigue applications and was instrumental in recruiting Elber to NASA. Since the discovery of "plasticity" induced closure, several other closure mechanisms have been identified. These new closure mechanisms and the influence of the plastic wake on the local crack-tip strain field have greatly advanced the understanding of fatigue-crack growth and fracture behavior of metallic materials.

After nearly 20 years of research, most researchers now agree that closure occurs. However, no consensus of opinion exists on how to best measure closure effects or crack-opening behavior. Some numerical methods are now available to calculate crack-opening stresses, but they are complicated to use in practical applications. On the other hand, the crack-closure concept has been extremely useful in many practical applications such as the correlation of crack-growth rate data and for predicting crack growth under variable-amplitude loading. Therefore, in hopes of advancing the state-of-the-art, an International Symposium

on Fatigue Crack Closure was organized to provide a forum for exchanging information and experiences on crack-closure measurement techniques, on crack-closure analysis methods, and on practical applications of the crack-closure concept. The symposium was divided into four major topic areas: Mechanisms, Measurements, Analyses and Applications. R. O. Ritchie, A. J. McEvily, E. P. Phillips, and J. M. Potter served as respective session chairmen. A panel discussion was held in a well-attended evening session. The panelists were A. J. McEvily, P. C. Paris, R. O. Ritchie, and J. Schijve. Keynote addresses were given on "Observations on Understanding Fatigue Crack Growth Through Crack-Closure Effects" by P. C. Paris and "Fatigue Crack Closure: Observations and Technical Significance" by J. Schijve. Dr. Paris' crack-growth "law" has revolutionized the treatment of fatigue-crack growth, and this concept has provided a foundation for damage-tolerance analyses. Even Elber's effective stress-intensity factor range has its basis in the cyclic stress-intensity factor range. Professor Schijve has been a leading proponent of the crack-closure concept, and he has made many lasting contributions to its understanding.

The symposium and book are dedicated to the memory of Herbert F. Hardrath. At the symposium, an engraved dedication plaque was presented to Mrs. Gladys Hardrath, his wife, and to his son and daughter, Bill and Janice.

A Special Achievement Award was also presented to Dr. Wolf Elber for his discovery of the fatigue-crack closure mechanism and for his significant contributions to fatigue and fracture mechanics. The award consisted of an engraved wooden plaque to which the "original" Elber-displacement gage was mounted.

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